EXPLORING THE INTEGRATION OF SUSTAINABLE SYSTEMS THROUGH ARCHITECTURE:

Towards the design of a seafood market.

By

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Requirements for the degree of Master of Architecture

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DECLARATION

Submitted in fulfilment of the requirements for the degree of Master of Architecture, in the Graduate Programme in Architecture, University of Kwa-Zulu Natal, Durban, South Africa. I declare that this dissertation is my own, unaided work and carried out exclusively by me under the supervision of Viloshin Govender. All citations, references and borrowed ideas have been duly acknowledged. It is being submitted for the degree of Master in Architecture in the faculty of Humanities, within the school of Built Environment & Development Studies, Kwa-Zulu Natal, Durban, South Africa. None of the present work has been submitted previously for any degree or examination in any other university

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Jane Pascoe

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DEDICATION

This thesis is dedicated to the local fishing industry and will hopefully shed light on problems that are present in the Durban Harbour area.

ABSTRACT

This research explores sustainable systems through architecture to create a positive environmental response. Such a response was then incorporated into the design of a seafood market located in the Durban Harbour.

This research explores the use of materials located in the immediate environment of Durban – the main food resource in Durban being seafood. If the sea and its ecosystems were utilised, by mimicking both systems and architecture that have evolved and developed within their natural environment, one could create a positive architectural response, through systems.

This research explored how architecture can be utilised to improve the surrounding ecosystems and local businesses by creating a prototype that with time can clean the Durban Harbour as well as create job opportunities to the local fishing community. This was done through a case study methodology and researching local and global literature.

The concepts of sustainability, socio-ecological systems and critical regionalism were explored throughout the study through a case study methodology. This involved case studies for background, interviews for specialists' views, and site visits.

The research resulted in a design of a seafood market in Durban that adopts sustainable and socio-ecological systems to create jobs and reintroduce a lost culture.

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CHAPTER ONE: INTRODUCTION

INTRODUCTION

1.1BACKGROUND MOTIVATION/JUSTIFICATION OF THE STUDY

Human's effect on nature has become evident through the impact of rapid population growth and global warming (Turpin, 2014:2). Such a situation requires a different mind-set, consequently supporting the view that an architectural response to limit the use of natural resources, waste, and reduce localised issues of environmental degradation is important. Architects are becoming more conscious of the value of nature and the environment in which buildings are built (Secretariat, 2014:19).

The built environment and architecture are one of the main consumers of natural resources, creating a need for understanding socio-ecological systems in architecture (Saggio, 2014:26). This research will explore the potential of integrating social and environmental sustainability by utilising socio-ecological systems theory in order to generate an architectural response that can cater to the needs of users in creating a seafood market for Durban. Socio-ecological systems thinking and critical regionalism limit the use of natural resources, consumption and waste to an acceptable level through effective, sustainable systems whilst understanding and integrating local cultures in the Durban Harbour area. Infrastructural systems are designed to provide and address the processes associated with the production and consumption of water, energy and the integration of waste. These systems are essential in architecture as they directly translate to the success or failure of a building (Green, 1989:5).

As Durban is a coastal city, there is great potential to plug into the ocean's resources as there is a direct connection between the land and the sea in the Durban Harbour. This connection will be explored and utilised to create a link between people and the environment through architecture and systems.

1.2 DEFINITION OF THE PROBLEM, AIMS AND OBJECTIVES

1.2.1 DEFINITION OF THE PROBLEM

With the growing population there is a bigger demand for natural materials, and more accumulation of waste. This research will explore the option of using social and ecological attributes as a resource instead of technology, to create socio-ecological systems that could

potentially create a symbiotic relationship between people, the environment and architecture. These systems will limit the use of natural resources and waste within markets.

People in developing countries often overlook the need to be sustainable, as their main goal is to feed their families and try and survive in a harsh environment. South Africa has one of the highest unemployment rates globally therefore the need to survive outweighs the need to save the environment (Klasen and Woolard, 2009:2).

Markets are a place where people can interact with the environment as well as society. This document explores how we can harness local natural resources that are located within the city and encourage the use of local sustainable produce rather than imported unsustainable produce that we so often buy from the supermarkets. The research shows that in markets located in South Africa, ecological components have been sacrificed in order to maximise profit.

This research explores creating a more sustainable market through socio-ecological systems that will create a positive architectural response to pollution, waste and the use of natural resources. Socio-ecological systems are systems that have both social and ecological components and benefit each other equally. This research will encourage the use of resources that Durban has, and that the market can directly plug into, with minimum transport and resources being used.

1.2.2 AIMS

Aim

The aim of this research is to explore how sustainable systems can be applied in a seafood market to inform an architectural response.

The objectives of this study are:

- To explore what sustainable systems exist and are currently used in markets;
- To investigate what sustainable systems promote diversity and limit ecological impacts;
- To explore ways in which socio-cultural wellbeing is promoted through the creation of space that is integrated with the natural environment; and
- To explore ways of facilitating harmonious integrations between man-made structures and the natural environment.

1.3 SETTING OUT THE SCOPE

1.3.1 DELIMITATION AND LIMITATIONS OF RESEARCH PROBLEMS

1.3.1.1 DELIMITATIONS

This research focuses on both local and global markets to explore advanced technologies and systems that are used throughout the world, and the importance of markets to both the environment and society.

The researcher acknowledges that this study alone cannot provide all the answers, or the theoretical concepts with regards to such a broadly contested field; this is because sustainability is an extensive concept and therefore extends beyond the realm of architecture and the built environment. In this study, the researcher limited the research to architecture and sustainable systems within architecture. While there is abundant research available worldwide, this research focused on systems and culture located in Durban, South Africa, and any global research that was explored was relevant to the South African coastal climate, specifically Durban's climate.

1.3.1.2 LIMITATIONS

Communication was difficult in Maputo and in Warwick as most people in Maputo speak Portuguese and most people in Warwick speak IsiZulu. Due to the language barrier, a translator was present during all visits to Warwick and the Maputo Fish market. Having a translator is a challenge as they have to interpret what individuals are saying and rephrase these through their own lens.

Traveling to Maputo to collect data was a challenge. Everything had to be planned out to make sure all the information was collected as the researcher could not travel to and from the market when needed as the other two case studies.

1.3.2 DEFINITION OF TERMS

Anthropocene: New era we are in that looks at the connections we as people have on the environment and how to better the environment.

Black water: water that is contaminated by toilets or other waste systems.

Critical regionalism: Critical regionalism explores the potential of introducing cultural characteristics into a building or system to show cultural identity in a rapidly changing technically driven age.

Environmental asset: Environmental assets are naturally occurring entities that provide environmental functions or services. These assets also include those which have no economic value but bring environmental benefits. (OECD Glossary)

Environmental sustainability: Environmental sustainability focuses on improving the environment from what we as a society have done to it.

Grey water: Relatively clean water that is collected from baths or sinks. This water still needs to be filtered before it is clear water, however it can be used to flush toilets.

Holism: Where each design objective, or in this case systems, are significantly important in any project, yet a truly successful project is where objectives are identified early on and held in proper balance during the design process.

Hybridisation: Hybridisation is the idea that architecture needs to be reactive and evolve with the relative context

Integrate: Combining two or more components to create a whole.

Interact: Something acts in a specific way that generates a reaction of something else.

Market: A market is a carefully crafted, intentional and diverse medley of shops or stalls trading in a specific space for a period of time.

Regionalism: To uphold local architectural features and culture above universal ones.

Social sustainability: Encouraging life enhancing conditions within communities through improving infrastructural and sustainable systems.

Socio-ecological systems: Socio-ecological systems are a set of components both socially and ecologically that can potentially influence the environment positively. These systems need both people and the environment to function together.

Sustainability: Sustainability is a term that is defined as enabling us to meet our current needs as well as allow future generations to meet theirs.

Sustainable: This involves using natural products and energy in a way that does not harm the environment.

Sustainable principles: Set of guidelines that are used to reach sustainability due to the numerous definitions accumulated over time.

Sustainable systems: Sustainable systems are products, processes or services that relate to the constraints of sustainability.

Systems: A series of components that work together to achieve a specific action.

Waste pickers: People who make a living from collecting recyclable material from anywhere possible.

1.3.3 STATING THE ASSUMPTIONS

This dissertation assumes that people and nature can both benefit through exploring the potential of integrating socio-ecological systems in order to achieve and generate a more sustainable approach to infrastructural systems. Integrating systems is the most effective way of achieving sustainability in developed countries, and this can be mimicked in developing countries to achieve the same goals. These systems will be most effective when incorporating local industry and produce into a market to eliminate environmental problems such as pollution, waste and resource management.

1.3.4 PURPOSE

To understand how sustainable systems can be incorporated into architecture, to create a positive response to cleaning up the environment. This research also explored how a building can reintroduce a lost culture and support local communities.

1.3.5 KEY QUESTIONS

PRIMARY QUESTION

How can sustainable systems thinking in an urban context inform an architectural response in creating a seafood market in Durban?

SECONDARY QUESTIONS

1. What energy, waste and water systems are currently prevalent in markets?
2. How can aspects of nature be integrated into the built form?
3. How can the built form respond to sustainable systems?

1.3.6 METHODOLOGY

APPROACH

Throughout the research process a pragmatic and qualitative approach was used. This approach is appropriate because different countries and municipalities have different ways of dealing with waste, water, and energy systems. By understanding the way markets use socio-ecological systems thinking, one can start evaluating what is currently used in markets. A case study methodology explores learning through observing people, the environment and the infrastructure that is used to see the dynamic interaction between the three components.

Three sites were chosen as case studies. All three case studies are food markets that contribute to the complexity of the users and the infrastructural systems. Two of the three case studies are

located in Durban, South Africa. One study is located in Maputo, Mozambique. Bangladesh market is located in a suburb south of Durban. Warwick Market and Maputo Seafood Market are located in large city centres. The Maputo Fish market is located along the coast of Maputo. Warwick Market is located in the centre of Durban's CBD and main transport hub and is managed by the eThekwini municipality. All the information collected was sourced from real life scenarios. This data was compiled and cross-referenced with appropriate theories to generate a comprehensive overview.

Case studies:

Case study one: Warwick Junction

Location: Durban CBD, South Africa

Reason for selecting Warwick Early Morning Market. Warwick is the largest daily market in Durban. This case study explored the elements of socio-ecological systems that make up two markets in Warwick Junction. The location of the market and the ideas of suitable functioning through socio-ecological systems thinking were engaged with.

Case study Two: Bangladesh Market

Location: Chatsworth, South Africa

Reason for selecting Bangladesh Market: Bangladesh Market is located in one of the poorest neighbourhoods in Chatsworth, South of Durban. The market is a lot smaller compared to the markets located in the big cities such as Durban or Maputo. The social and environmental connection could be greater in this market.

Case study Three: Maputo Seafood market

Location: Maputo, Mozambique

Reason for selecting Maputo Seafood Market: This market is different to the others as it is located in Mozambique, where the regulations and systems are different to the systems used in local South African markets. The market was funded by the Japanese and has Japanese and Portuguese influences. This market is on the edge of the sea, and in context it is different to the other inner city markets. The location, systems, and regulations will be observed.

Methods: Data was collected through 7 methods of data collection including:

1. **In-depth and Shorter Interviews**: Three in depth interviews with three specialists in the field were conducted. These interviews were open-ended in a formal and informal setting and the discussions were based on key questions. The first interview was with Richard Dobson, the project manager at Asiye eTafuleni. This is a non-profit organisation that collaborates between informal traders in Warwick and allied professionals. The second interview was with Edilson Manjate, the tour guide at the Maputo a Pe (Maputo on Foot) Walking Tours and has been doing tours through the Maputo markets for many years. The last interview was conducted with Rodney Harber, a well-renowned architect in Durban. He has designed many markets through his architectural career.

2. **Focused interviews**: During the second and third case studies, vendors who agreed to participate were interviewed and asked to fill in a questionnaire. This questionnaire focused on the social experience of systems and their malfunctioning or functioning.

3. **Observation:** The researcher observed the infrastructural systems of water, energy, and waste, as well as the relationship between these systems and people. These systems were understood through plans and mapping of important spaces. Both water and energy systems were observed on site.

4. **Visual documentation:** Photos and videos were taken throughout the case study to cross-reference with the data collected. These videos and images have been used to back up facts that were accumulated.

5. **Documents:** Informal notes were taken throughout the case study, of the researcher's findings and general analysis. These notes accumulated information that the observation method overlooked.

6. **Report:** Throughout the case study, formal reports were done, ending in an in-depth concluding report on the findings of the completed case studies. The reports consist of all the information accumulated throughout the seven methods of research.

7. **Precedent studies:** Architectural journals and papers were sourced for precedents of market systems with a specific connection to utilising socio-ecological systems and critical regionalism. The precedent study research addressed more specifically the typology that the researcher generated design principles for. The precedent studies were structured and analysed in the same manner as the case studies.

Analysing Data

Different markets both locally and internationally were compared throughout the research, precedent studies and case studies. The data accumulated throughout the studies was cross-referenced with the research questions and objectives. These case studies were used to explore social and environmental infrastructural systems in architecture within food markets nationally and internationally.

1.3.7 LOCATION OF STUDY

This research focus was to generate the design of a fish market located in the harbour of Durban, South Africa. The site of the market is located on the north side of the harbour below the Royal Natal Yacht Club as seen in this figure below.

Figure 1: Indicating the site of the new fish market
Source: Google Maps

1.4 CONCEPT AND THEORIES

1.4.1 PRIMARY CONCEPT: SUSTAINABILITY

SUSTAINABILITY

Sustainability was a response to the concern around environmental degradation and poor resource management (McKenzie, 2004:4). The four main authors within the area of sustainability that will be explored are Joseph Fiksel, Charles Kibert, Mark Doughty, and

Stephen Kendall. Fiksel's research explores sustainable systems, whereas Kibert, Doughty, and Kendall relate sustainability to markets, architecture, and the built environment.

Environmental sustainability focuses on the environment or what can be done to reduce environmental impacts, whereas social sustainability explores the building of social capital and improving living conditions in communities in a socially and environmentally just manner (Ralph and Stubbs, 2014:72). In this research, social and environmental sustainability explores enhancing infrastructural systems to improve conditions for people and the environment within a market. This research document explores infrastructural systems such as water, waste, and energy and how they connect with people, the environment, and architecture. This creates a sustainable architectural response to enhance social and environmental conditions for people in markets.

SOCIO-ECOLOGICAL SYSTEMS

Socio-ecological systems can be defined as a set of social and ecological components that are constantly evolving interdependently to create balance (Berkes et al., 2000:2, Redman et al., 2004:161). In terms of socio-ecological systems thinking, the following author's views will be explored: Paul Sillitoe, Fikret Berkes, and Elinor Ostrom. Paul Sillitoe and Fikret Berkes explore socio-ecological systems, whereas Elinor Ostrom explores creating a socio-ecological systems framework, to achieve sustainability as explained below.

The figure below indicates that people and society are the users, whereas the resource units and systems are the ecological actors, in the form of natural resources or ecosystems from which we as people benefit (Ostrom, 2009:420). This research explores places where there are interactions between people and nature, and utilise the opportunities through architecture, to

create a sustainable space and systems that will benefit both the environment and local communities.

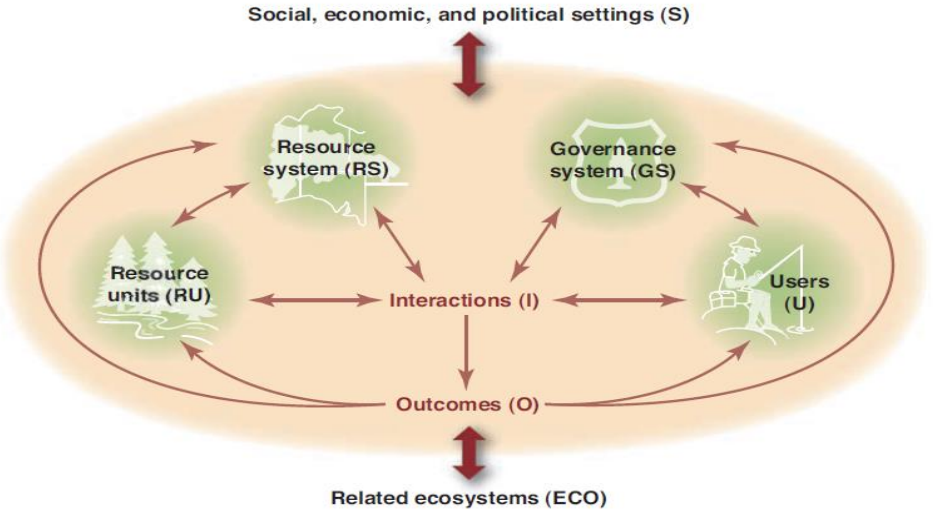


Figure 2: Indicating the interactions and relationships between the social and ecological actors within her socio-ecological systems thinking
Source: Ostrom, 2009:420

CRITICAL REGIONALISM

Critical regionalism explores the potential of introducing cultural characteristics into a building or system to show cultural identity in a rapidly changing technically driven age. The main authors that are researched are Renzo Piano and Kenneth Frampton. Both explore critical regionalism that relate back to local context, technology and local culture. Kenneth Frampton talks about including local culture, knowledge, experiences and technologies into each design, as each site is different (Frampton, 1987:17, 26).

The reason for using critical regionalism is because it takes into account the technology and experiences behind the systems, along with the culture of the community, local culture and nature. This research explores how a seafood market can be used to aid local communities thriving in Durban Harbour. This research will bring local cultures and nature together by encouraging sustainability that will potentially improve the link between community and nature, as well as bring back a lost local culture.

CHAPTER TWO: HISTORY OF MARKETS AND SUSTAINABILITY

2.1 INTRODUCTION

This chapter explores the history, and various types of markets that have developed and evolved over time. Markets are iconic spaces that create opportunity for development within a city or space, as well as provide a place for people to socialise. This chapter explores the history of fish markets and the fishing culture of Durban. The effect that humans have on the environment led to the labelling of this period as the Anthropocene era and one can see the vital environmental crises people are creating. There is a drastic need for sustainability. This will be explored and related back to the context and local culture of the sites under study.

Food is a human right and a vital part of human life. In contemporary society, people are more aware of what they are eating and consuming. People flock to markets because the produce is often cheaper and is perceived to be fresher and healthier than that bought from a supermarket (Hardesty, 2008:1289). Food or farmers markets encourage local trade and help people sell local produce rather than imported food – this will then be explained further when zooming in on Durban as a focus of this research. This chapter will explore why sustainability is important in markets and look at sustainable principles that will be introduced throughout the research. The fishing industry, the utilisation of local resources such as the sea and generating local industry and trade within the city of Durban will be explained.

2.2 MARKET HISTORY AND INFLUENCING CITIES DEVELOPMENT

Lewis Mumford and Ronald J Horvath discuss the pivotal influence that markets have on urban life. Historically, each town had at least one market, or the temple took on the role of the market (Mumford, 1966:70). This can be seen in Ethiopia where most of the city centres are used for trading and economic growth (Horvath, 1968:48). The figure below shows a typical market layout, centrally located in a town in Ethiopia. With the development of markets, trade routes and transport routes connected cities together, and in the 1900s, railways were also created to connect cities (Horvath, 1968:45).

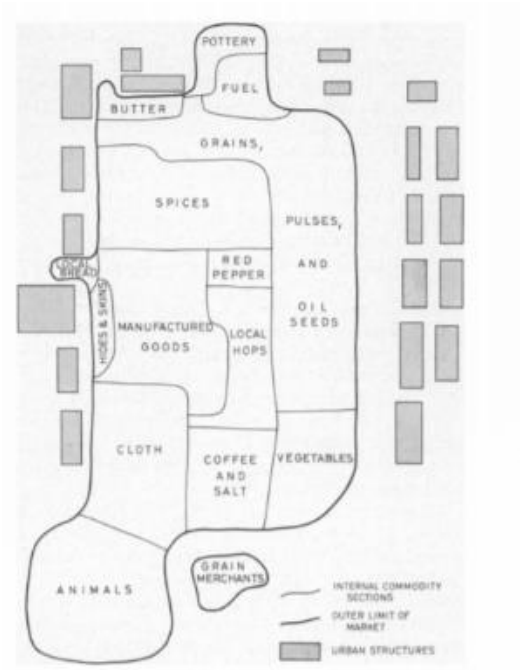


Figure 3: Typical market layout in Ethiopia
Source: Jstore.org

Lewis Mumford states that markets create an economically secure environment that leads to population growth within the city, and interconnectivity between people from different communities. This can be seen in ancient towns such as Athens where the first marketplace was developed below the Acropolis between 1550 and 1100 BCE (Joshua J. Mark, 2009). This area was known as Agora, meaning open place of assembly. This market still exists today and is known as the Monastiraki Flea Market. This market culture was a way of life which created economic stability within the city (Mark, 2009). This market developed with strong trade, knowledge, understanding and different languages. Summers, when more people from far and wide visited were known as the time of many tongues (Mumford, 1966:71).

Figure 4: Entrance to Agora market in Athens Greece
Source: https://brewminate.com

Markets are still present today, however many things have changed. Modern markets encourage local trade, whereas historical traditional markets were a space where merchants could bring their products to sell within the city (Mumford, 1966).

2.2.1 MARKET SQUARES

Market squares developed during this time as safe public areas where people could gather. The importance of market squares became evident and part of the urban fabric. The market square was a land mark within the town and was used to demarcate land. These squares often had religious buildings connected to them. This can be seen in some religious countries like Italy and Greece. The figure below shows the layout of Trajan's Market, with the temple located adjacent to the market space.

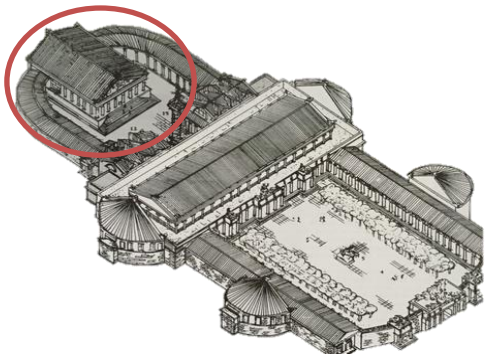


Figure 5: 3D View of the Trajan's Market with a religious temple connected.
Source: https://www.quora.com

Historically, market squares were not only used as a market space but also a place for public gatherings, punishment and sometimes even executions. Over time, some of these market squares became rundown and neglected (Online, 2011). When neglected, the square can become a place where drunks hang out or gather at night. Homeless people move in making it a place to be avoided rather than to gather. During war times, the squares used to fill with military people and the sound of military bands and singing.

With people moving longer distances to explore new trade routes, explorers started to seek out new lands. In 1824, Henry Fynn landed in the Durban bay and developed the first settlement in the Point area. The figure below indicates where the first market square in Durban formed

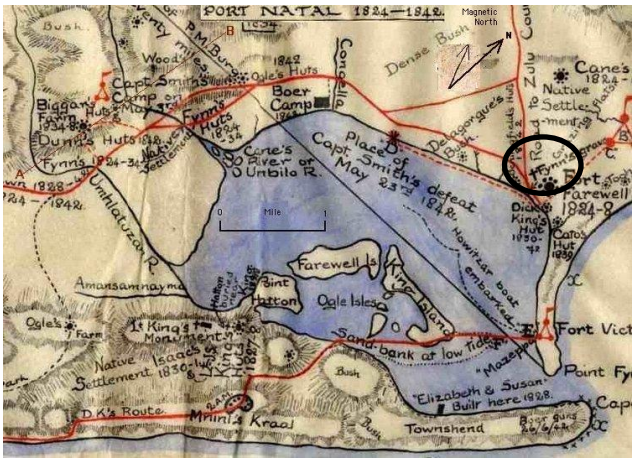


Figure 6: Indicating the first market square developed in 1824.
Source: https://www.south-africa-tours-and-travel.com/

2.2.2 MARKET CULTURE

Giampietri emphasises how vital a market is during the development of a town. Markets that are managed and maintained as a space of safety and comfort as well as a space of gathering can become a place where people meet and socialise in a safe environment (Giampietri et al., 2016). Market culture is a vibrant social culture that encourages people of different cultures and races to interact in a healthy safe environment through the activities that happen within a space (Giampietri et al., 2016). Markets have many social activities happening, as well as being a space where different cultures and religions are able to interact. Some of the various uses of markets are:

1. A safe place for people to meet away from wild animals.
2. Religious purposes, with churches located in the market squares.
3. Punishments and executions.
4. Public auctions.
5. Public gatherings.
6. Military gatherings and celebrations.
7. Elections and election celebrations.
8. Celebrations.
9. Selling of goods.

These activities have both positive and negative connotations to them, however all contribute to this diverse social culture that is present today. These activities have not only shaped the way we see markets but also the urban fabric of today.

This market culture can be seen in many African markets. A good example is the Khan El Khalili market in Cairo, Egypt. This market, for centuries, has encouraged local economic potential (Yousry and Mekawy, 1998:1). Traditional markets have been noticed to have kept surrounding areas, traditions and culture intact more effectively than any other space (Yousry and Mekawy, 1998:1). The Djenné mosque market in Mali, to this day, has public punishments – this market is discussed in more detail in chapter four.

Figure 7: Showing the Islamic style of the architecture and the connection people have with their culture. Source: http://riaanrove.blogspot.com

Critical regionalism talks about utilising knowledge of the past and incorporating what we as a community have learnt in order to best adapt to our surroundings and context. The idea of both a place where produce is sold and a place where people can meet and gather for any public function, if done effectively, can achieve sustainability.

2.2.3 FISH MARKETS IN DURBAN

Govender explains that in 1926, fish was not only sold at the fishing points, but was also transported to the Victoria Street Indian Fish Market. This market was the first fish market in Durban and people fishing from the harbour used this market as a trading space to sell what they caught. With the amount of fish and seafood that was available and collected in the bay, this market supplied the local community with fish and seafood (Govender, 2014). This market will be explored in chapter five. It has been running since the 1900s, even though it was moved for a short period of time (Saunders, 2010). It has seen generations of clients that still use it today. The Victoria Street Indian Fish Market has historical connections and this is what makes the market such an attraction to people in and around the area.

More than half of the thirty stalls were controlled by the Natal Indian Fisherman's Association (South African History Online, 2011). In 1954, these fifteen stalls merged to become one large

stall. During the quieter periods, the store was not fully utilised, however during the busy periods the space was inadequate and more space needed to be hired (South African History Online, 2011).During the busy periods, there was limited refrigeration and the prices of the remaining fish had to be dropped drastically to move the catch before it rotted.

The figure below indicates the local context and where the Victoria Street Market was located in the Urban Context of Durban in 1930. The green arrows indicate the areas the produce came from and the red indicate the food going out.

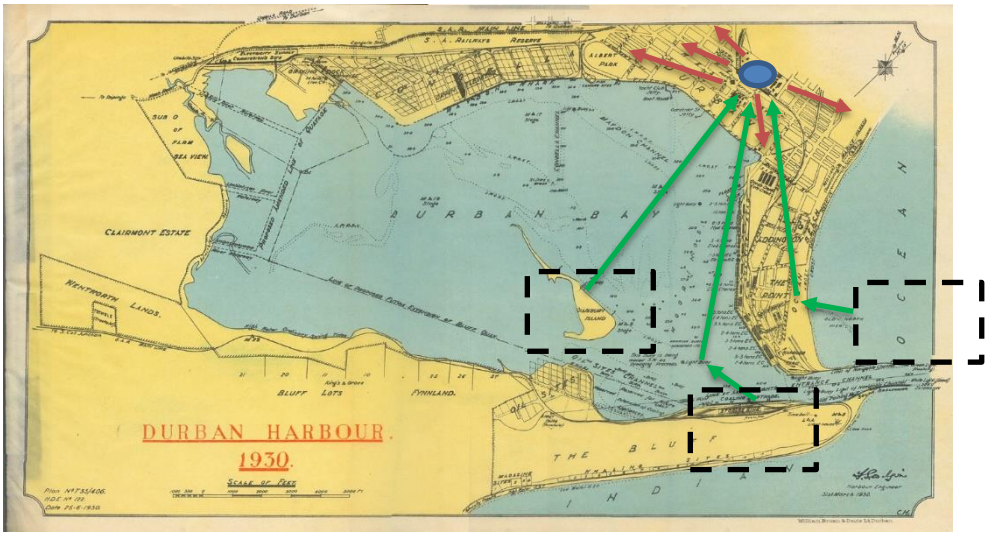


Figure 8: Indicating how the fishing areas of Salisbury Island, the fishing village, the whaling station slip way and Vetch's beach connect to Victoria seafood market.
Source: https://www.fad.co.za/

2.3 WHY PEOPLE ARE ATTRACTED TO WATER AND THE DEVELOPMENT OF THE FISHING INDUSTRY.

Wallace Nichols, in his book the Blue Mind starts to explain why people connect with the ocean and water. He explores how people have different perspectives, emotions, empathy, creativity, and health and healing when experiencing water. Wallace Nichols calls this connection to water the 'blue mind' (Nichols, 2014).

We are in an age where we are pounded constantly by stress, technology and are exiled from nature. Often people use water as a way of escaping. Different people have different connections to water – examples include simply watching the ocean from the beach, or experiencing it by swimming and being one with the ocean. People feel inspired, rejuvenated empowered or even just relaxed by being near the ocean (eccochiccayman, 2017). Nichols

suggests that one can see the strong connection proven when looking at the way people have developed themselves around water – 80% of the world's population are estimated to be located about 60 miles away from some sort of water body (Nichols, 2014). Archaeologist Brian Fagan writes that people have different perspectives and emotions when they are in close proximity to water, but that everyone feels something (Fagan, 2011).

Figure 9: What people use the ocean for.
Source: https://bdnews24.com

Historically fish has not only been a source of food but a source of cultural beliefs. Fish can be seen painted on the walls in caves and historical texts and scrolls. There has also been evidence of shells and fish bones that have been used as tools and weapons. Fish have always been a good source of food as they are easy to catch with little tools needed. Larger marine mammals were vastly more difficult, but their sheer size and reward, may it be meat or oil, made the challenge worth it. With time, fishing methods became more effective and developed with the evolution of people. An example can be seen in the figure below of a traditional fishing method that has been used for centuries in Brazil.

Figure 10: Traditional fishing method in a dugout canoe and hand-held "throw net," Amazon River, Brazil
Source: http://www.eolss.net/

2.4. HISTORY OF THE FISHING CULTURE IN DURBAN HARBOUR

Govender suggests that the fish markets in Durban were supplied by local fisherman. Most came from Salisbury Island – an island in Durban Harbour, and the surrounding Durban Harbour area. The fishing community had rich local culture, knowledge and experience. Fishing has always been a way of life for people living in Durban, whether to supply food for their family, to sell, or just as a hobby (Govender, 2014); this shows the diversity of needs people in Durban have, and how people use the sea as a resource or a source of enjoyment. The commercial fishing industry in Durban came about in the 1860s, when indentured Indian labourers arrived in Durban (Govender, 2014). They were brought from India to work in the sugar mills and fields. In 1870, the Harbour Authority allowed the Indian community with fishing skills to lease land and in exchange they had to start the first commercial fishing industry in Durban (Govender, 2014). This was run from the banks of Salisbury Island as seen in the figure below.

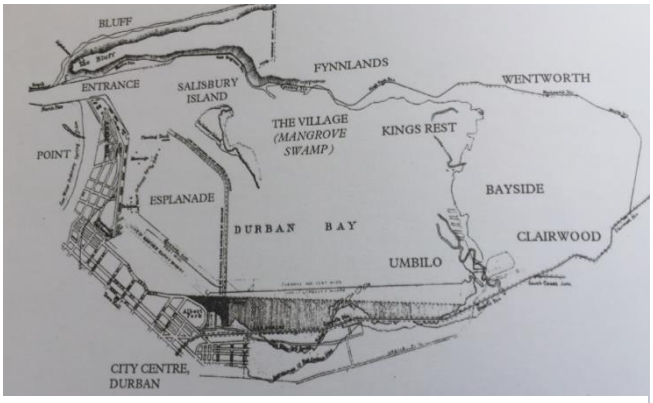


Figure 11: Map of Durban Harbour with Salisbury Island visible
Source: Govender, 2014: 62

This new industry had people who specialised in different methods of fishing, ranging from seine-netters to shrimp netting and mussel collecting (Govender, 2014). The image below shows the different types of fishing that took place throughout the bay area.

Figure 12: Crayfish Trap
Source: Govender, 2014: 70

Figure13: Blue crabs that were collected off the marshes
Source: Govender, 2014: 70

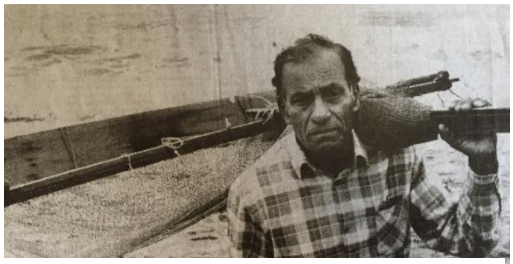


Figure 14: Villager carrying a shrimp net on his shoulders
Source: Govender, 2014: 71

In 1883, regulations came in to ban fishing in the bay, thus forcing people to move towards Addington beach and Vetch's pier (Govender, 2014). In 1888, people were moved from Salisbury Island to a fishing village between Salisbury Island and Fynnlands Station (Govender, 2014).

In 1912, the Durban whaling industry took off (Govender, 2014). This attracted larger game fish to the area as the fish and sharks would be attracted to the whale carcasses that were left outside the whaling station slipway. Far larger fish were fished off the shore during this time.

Figure 15: Whale carcasses outside the whaling station slip way.
Source: Govender, 2014: 97

In 1951, seine-netting was introduced to Isipingo beach (Govender, 2014). Soon after this, people who were living in the bay area were re-settled in Chatsworth due to the Group Areas Act. This is one of the main causes for the depletion of the fishing culture in the Durban Harbour (Govender, 2014). It became more difficult for the fishing community to get to their fishing areas and to keep in contact with their crew. They were separated from one another in townships. The fishing industry disintegrated and people started importing and allowing large international industries to take over the fishing industry.

The increasing difficulty in obtaining a commercial fishing license also contributed to ending the commercial fishing industry and culture within the harbour. Few local fishermen have commercial licenses as many of the licenses go to large international companies (Mlaba, 2014). This unsustainable way of fishing reduces not only fish but marine life in local waters. The large commercial fishing boats fish with nets that catch not only fish but all types of marine species. A couple of local fishermen were interviewed and they elaborated on the fact that the

local fishing industry is still struggling as regulations and rules make it difficult to get commercial fishing licences.

This fishing culture is a culture of family and companionship. Fishing with seine-nets is not a one man job. Local communities and knowledge is vital for the development of a seafood market. History shows that there is potential to utilise local communities and resources to benefit people living in the area. The figure below shows a family pulling up a great catch.

Figure 16: Addington Beach: A crew of seine-netters beach a haul of shad.
Source: Govender, 2014: 68

By utilising local fishing in a more sustainable manner, we can encourage smaller fishing industries to fish with rods rather than nets and only take what is needed. The demand for sustainable fishing creates potential for a local sustainable fishing industry to develop in South Africa. If net fishing is banned in South Africa the amount of marine life will increase exponentially.

2.5. THE IMPORTANCE OF SUSTAINABILITY AND THE CONSEQUENCES OF UNSUSTAINABLE SYSTEMS

Sustainability and sustainable development has evolved with time. Ellisa Giampietri and Dieter Kneafsey talk about the globally increasing purchase and production of seafood, creating a need for sustainable harvesting and catching (Giampietri et al., 2016:1). With growing global pollution, there is contamination of food, and consumers are demanding a more sustainable food product (Giampietri et al., 2016:1). Farmers and food markets have shown an interest over the last two decades in the production of more organic and sustainable products, especially markets that have direct access to the farms or resources they are selling (Giampietri et al., 2016:1).

Even though Singapore is known as one of the most sustainable cites in the world, 95% of the country's vegetables are imported (Astee and Kishnani, 2010:108). The transportation of these resources is contributing to the world's carbon dioxide emissions. The figure below indicates the distance that produce has to travel before it reaches the consumers. By encouraging the consuming of local produce there are less carbon dioxide emissions, thus making local produce a more sustainable alternative.

Figure 17: Map of the distance produce is transported before reaching Singapore.
Source: Astee, Kishanini,

The Mediterranean Sea is known as the most overfished sea (Vierus, 2015). Overfishing is when a species is not able to reproduce enough to handle the demand, therefore species are sometimes completely fished out of an area or even sometimes fished to the brink of extinction (Vierus, 2015). 91% of the Mediterranean Sea species have been overfished (Vierus, 2015).

For overfishing in general, regulations do get implemented to allow nature to reproduce to a point of stability, however this takes time and people often interfere, causing the destruction of an ecosystem completely or causing the species to take longer to reach a stable population (Vierus, 2015).

Figure 18: Commercial fishing boat in the Mediterranean Sea
Source: https://www.livingdreams.tv

Studies in Hong Kong markets and Tolo harbour have looked at the effects people's pollution is having on mussels that are both a natural filtration device as well as a popular food source (Wong et al., 2000:165). The results showed that due to sewerage waste being pumped into the sea, mussels are absorbing large amounts of metals that are contaminating the food people eat (Wong et al., 2000:165). This shows the importance of effective sustainable sewerage systems. With the growing population, if sewerage is not responsibly disposed of, the sea and vital resources will be contaminated to a point where nothing will be able to be consumed by people. High water temperatures and low salinity increases the filtration process of mussels (Wong et al., 2000:165). With knowing how mussels filter water, we can potentially introduce them in high temperature and low salinity water, as a filtration system in order to purify the water, but then these mussels should not be used for human consumption.

Figure 19: Tsukiji Yamataka Seafood Market
Source: https://www.gotravelly.com/

2.6. SUSTAINABILITY SYSTEMS AND PRINCIPLES IN THE BUILT ENVIRONMENT

Fiksel defines a sustainable systems as "A product, process, or service contributes to sustainability if it constrains environmental resource consumption and waste generation to an acceptable level, supports the satisfaction of the important human needs and provides enduring economic value to the business enterprise" (Fiksel, 2003:5330). Architecture can potentially be used to connect people and the environment. The typology of a seafood market naturally ties in all three categories as identified by Fiksel, as it is a social building and has an economic component that connects people to the environment through the design, location and context.

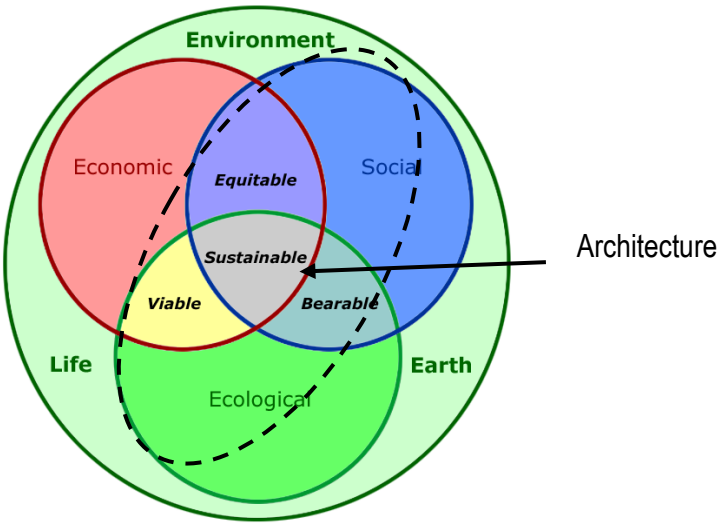


Figure 20: The three categories of sustainability
Source: http://www.thwink.org/

Lindsey emphasises that sustainable principles are guidelines that researchers have developed in order to achieve sustainability, and that there are over 70 definitions of sustainability with this number still increasing (Lindsey, 2011:561). With so many definitions circulating, there is a need for core principles that can be applied across all segments of sustainability. These principles are important as sustainability has been developed and amended numerous times, between 1974 and 1992. This research explores Timothy Lindsay's sustainable principles that have been modified slightly to be relevant to this research.

The initial focus of sustainable principles is controlling and cleaning up the most immediate environmental problems worldwide. Firstly, improving sustainability is achieved through reducing waste and pollution. A good example of recycling is seen in Sydney's markets, where they reduced the percentage of waste being dumped into landfills from 65% to 17% (Sustainable Matters,2016). With this improvement, the market has seen significant financial and environmental benefits. They reuse organic waste by crushing it into a liquid that is then used as a fertilising liquid. The remaining crushed matter can also be used as feed or fish food (Sustainable Matters, 2016). The plastic and cardboard is recycled and used to create building products (Sustainable Matters, 2016).

Figure 21: Organic waste crushing system
Source: https://www.sustainabilitymatters.net.au

Secondly, Lindsey suggest that sustainability is improved through implementing better systems. All systems need to be resilient and diverse. In order for systems to be successful, they need to be effective, adaptable and cohesive (Fiksel, 2003:5333). Sponges, mussels, clams and oysters are the natural systems that clean the oceans without human interference (Livesciece,2014). These are magnificent creatures that act as tiny filtration systems within the oceans. This just shows the delicacy of ecosystems and the fundamental jobs such tiny creatures have in something as vast as the ocean. These creatures are constantly sieving through the water around them in order to find the phytoplankton. Through this process, the mussels are absorbing various toxins that are polluting the sea (Livescience, 2014). By improving water quality, the other marine species that we eat from the sea will be a lot healthier.

Figure 22: Mussels filtering water.
Source: https://www.seeker.com

Thirdly, Lindsey suggest that sustainability is increased by limiting the overuse of natural resources. Overusing natural resources is a fundamental problem within the built environment and architecture, due to the high concentration of people in the world. As mentioned earlier, architecture and the built environment are the largest resource consumers on earth (Braganca et al., 2013:19). An example of good management of resources can be seen in Singapore, as Singapore has one of the most sustainable water management systems and eco-friendly transportation regulations

(Environment et al., 2014). These both use minimal natural resources. This resource management and the transport regulations are present throughout Singapore, including in the way markets are run.

Figure 23: Singapore's clean waterways through effective water management.
Source: https://custom.forbes.com/

The last principle Lindsey suggests combines the principles mentioned above. Socio-ecological systems are used to reduce the amount of resources, pollution and waste that enters the environment. Through these principles, as well as connections between social and ecological systems, architecture can be a solution to achieve sustainability. When introducing sustainable systems, we can improve both nature and social problems, by reducing waste, improving systems and by limiting the use of natural resources. The principles mentioned above are a few systems and examples of how these principles can be used and how they can be incorporated into architecture or nature. These principles relate to and were integrated into the scope of this research.

Dealing with the global problems through productive strategies can potentially eliminate the problems through better design, processes and systems (Lindsey, 2011:564). By improving the productive social and ecological strategies through infrastructural system design, we can meet the needs of today's generation without jeopardising the needs of future generations. Such a goal is engaged with through incorporating these sustainability principles into the research and design of a market located in South Africa.

Elinor Ostrom emphasises that developing countries in areas such as such as Africa, Asia and Latin America often over utilise natural resources and socio-ecological systems, by using unsustainable methods. These unsustainable systems damage the environment, as the human needs outweigh the environments capacity to provide. Introducing recycling can create social benefits for people with no jobs as well as the environment (Ostrom, 2009:422). This can be seen in Kollam, India where local fisherman are collecting all the plastic catch in their nets at sea, bringing it back to shore, sorting it and then recycling this plastic (Singh, 2018). In South

Africa and other developing countries, there are limited systems that contribute to both social and ecological sustainability. People are starting to become more aware, as mentioned above, and are trying to make a difference by taking on more responsibility.

Figure 24: Fisherman in Kollam sorting their catch and plastic from their nets.
Source: http://www.blue-growth.org

Many architects have inherited the notion of green or sustainable building. However, architecture and the built environment are responsible for more than half of all the electricity use and more than a quarter of all carbon dioxide released into the atmosphere (Bargance et al., 2013). This demonstrates the importance of limiting waste and pollution. The main elements to consider for sustainable systems that are used in architecture are as follows: energy, waste and water. These elements are used to create a connection between people and the environment, may it be the social or ecological environment. These systems respect both natural and social environments. They will be elaborated on in the third chapter of research.

The figure below shows the air pollution that is evident in India.

Figure 25: Indicating the air pollution located in India one of the most air polluted cities in the world.
Source: https://www.weforum.org

2.7 CONCLUSION

This chapter shows not only the importance of markets throughout the world but also the impact markets have on the surrounding environment. Markets benefit people, nature and the surroundings. Markets are important in all contexts of the world, may it be in developed countries to create a better, healthier lifestyle or in developing rural areas where people rely on the market to access everyday needs at affordable prices.

Seafood markets and the fishing industry show a rich culture which will be explored further in chapter four. This local culture gives the community a sense of ownership. This chapter also shows the importance of culture within markets and urban cities, as well as introducing sustainability and sustainable systems into markets to create representative and responsive architecture.

Sustainable principles were also described in relation to markets. The principles include: reducing wastefulness, implementing better systems, and limiting the usage of natural resources. These principles can be used in dealing with local and global problems through productive strategies that can eliminate the problem through better design, processes and systems. These principles allow the researcher to relate sustainability to systems and the topic at hand.

In contemporary society, it is vital to understand the importance of sustainability within architecture and incorporate sustainability into design. By incorporating effective infrastructural systems within a market, we can create a more effective, sustainable market that will benefit both people and the environment through architecture.

CHAPTER THREE: SOCIO-ECOLOGICAL SYSTEMS

3.1 INTRODUCTION

Man and the environment are interconnected, as they inhabit and share the same space and planet (Orr, 2007:23). This chapter explores the possibilities of creating architecture that connects people and the environment through socio-ecological systems thinking, to potentially create a symbiotic and sustainable framework. Socio-ecological systems are a set of components that can positively influence both the social and ecological environment (Berkes et al., 2008). Human connections as a potential resource, rather than technology, are explored and the context of being a developing country are also incorporated in the research. This research focuses on local problems in South Africa, and specifically Durban.

Once these systems are understood individually, we can integrate them and explore them as a whole. This enables us to conclude and create a closed loop system, in order to create a balance and understanding of what could be the most effective solutions for South Africa, to reduce resource consumption and waste.

3.2 SOCIO-ECOLOGICAL SYSTEMS THEORY

Redman states that humans are reliant on nature to survive. The connections we have with the environment that we are not consciously aware of, are vitally important to be understood in order to create successful systems (Redman et al., 2004:161). In order for a system to remain sustainable there needs to be a symbiotic relationship between society and the environment. Redman suggests that when people live and connect with nature they unconsciously live a more sustainable life. An example of this is the hunter-gatherers, who lived amongst nature and only killed what they needed to eat. With time, people have taken advantage of being the dominant species and this has had a devastating effect on the earth's natural resources and ecosystems.

Awareness is what is needed to create a paradigm shift as Sir David Attenborough said in the documentary Blue Planet, "People love what they can see, and protect what they love" (Attenborough, 2001). Unless people are aware of the problems, they are unable to solve them. People have taken and destroyed more than the earth can produce, making the destruction of the environment evident (Vierus, 2015). This was briefly explained in chapter two with the example of the Mediterranean Sea. People and nature need to generate an innovated awareness of integrating the social and environmental domain to create a balance between benefiting of people and the protection of the ecological environment.

Elinor Ostrom explains that people, natural resources and natural systems all share connections and interactions. It is in these interactions, where the architecture and infrastructural systems are located. These systems create a positive outcome towards both the natural and social environment (Ostrom, 2009:420).

When socio-ecological systems are explored, one needs to consider both social and ecological drivers. Socio-ecological systems emphasise the interdependent interaction between social and ecological factors (Redman et al., 2004:163). The social drivers are drivers that benefit people in one way or another, while the ecological drivers are drivers which benefit the environment.

This research will explore local people or communities and the web of systems that will reduce waste, limit the over use of natural materials, and resources to create a healthier environment for both nature and people to live together in a symbiotic relationship. An example is embodied in the Sage VIP building in South Africa (included below), where the roofs have been utilised as gardens to grow vegetables for people to consume as well as absorb carbon dioxide in the air, as seen in figure 26. These drivers positively influence long-term social and natural system dynamics. Another example of socio-ecological drivers is that of solar panels or solar geysers. Even though they are initially more expensive to install, with time one can save money on electricity, making them more affordable (a social benefit), and reducing natural resource consumption and the amount of carbon dioxide pollution released into the environment (environmental benefit). Many informal settlements in South Africa have already been fitted with solar geysers, as seen in the figure below.

Figure 26: The Sage VIP building green rooftop vegetable garden.
Source: https://www.businessinsider.co.za

Figure 27: Informal settlement that has been supplied with solar geysers in South Africa.
Source: https://www.iol.co.za

These interactions and linkages can be defined as the specific activities that mediate between the social and environmental elements (Redman et al., 2004:164). Infrastructural systems can

be seen as socio-ecological systems as they connect the social and ecological components together by producing a network of systems. These activities could potentially generate coherent social and ecological systems that emphasise resilience and sustainability and generate resources. These infrastructural systems can potentially help people monitor and connect to their surroundings and possibly solve environmental problems. People can strive to accomplish sustainability through infrastructural systems that are incorporated into architecture.

Holling and Redman argue that socio-ecological systems rely on the social actors, interacting with the natural resources or natural systems whilst being controlled by a governance system that reiterates the "Complexity of systems, of people and nature that emerges not from random association of a large number of interacting factors but from a smaller number of controlling systems" (Holling 2001:391). These systems often work best when the social actors, as influenced by architecture (design of the market), and the environmental actor (benefits this market will have on the environment) work together with a strong governing body that will make sure that everything is functioning effectively (Ramaswami et al., 2012:805).

Socio-ecological systems, if effective, can potentially:

- Minimise the use of natural materials (energy and water).
- Reduce the amount of waste and harmful gas (carbon dioxide) into the environment.
- Eliminate local health risks.
- Generate a new mind-set within people.

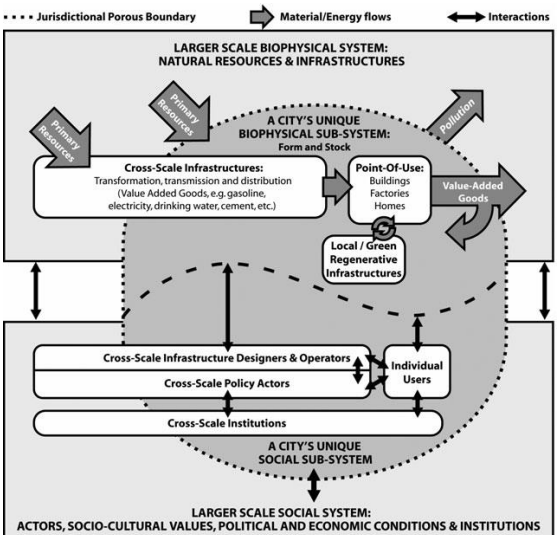


Figure 28: Indicating the close connection between people and the ocean and then the connection between people and the natural resources.
Source: Ramaswami et al., 2012:806

This thesis will break down examples of systems into three categories: social, environmental and ecological. As Holling, Redman and Ramaswami et al. all suggest, these are the three drivers that make a socio-ecological system.

Figure 29: Diagram of the three components of socio-ecological systems
Source: Author

Despite being able to focus independently, these three drivers create a net of systems that are connected in one way or another.

3.3 SOCIAL DIMENSIONS:

3.3.1 FERRY BOATS

Ferry boats are a completely human system that offers a sustainable form of public transport and has been used for generations. Rail and sea water transport are far more sustainable than vehicular (Kotowska, 2015:36). In Europe, water and rail transportation is increasing for both the transport of people and goods (Kotowska, 2015:36).

Figure 30: Ferry boat in Norway.
Source: https://www.visitnorway.com

Ferry boats have been used in Norway for centuries, not only because they are a sustainable mode of transport but due to Norway's landscape and high cliffs that were created by historical glaciers. These cliffs make the coast line extremely challenging to navigate by car, making ferry boats the most successful, effective and sustainable way of public transport in many areas of Norway. Short distance water shipping as a public transport system also has social benefits such as human interaction as one can see in Figure 30.

3.3.2GREEN ROOF

With increased urbanisation, more and more people are moving into towns and cities. These towns and cities are becoming more densely populated, resulting in very little space for farming and greenery. As a result, there is less greenery to absorb the large amounts of carbon dioxide that all these people are producing. Methods to combat this include including more plants in urban spaces. This can be seen in Hong Kong where people are using roofs for farming. This benefits both the environment and people, as the green roof is then used for a social income, as well as a green carbon dioxide absorbing system. Urban farming can be the solution to importing produce such long distances to large cities that have very little space for their own farming and agriculture, such as Hong Kong.

Figure 31: Roof top urban farming in Hong Kong
Source: https://gogreenhongkong.com

3.4 ENVIRONMENTAL DIMENSIONS:

3.4.1 ENERGY SYSTEMS

Energy systems are present in all modern designs. We rely on a constant connection to electricity and energy when we turn on a light or cook dinner. We are so accustomed to electricity being there that we take for granted where the energy comes from and what the earth is sacrificing to generate this energy. Oil, natural gas, and coal are the main resources that are used throughout the world to power buildings (Akella et al., 2009:390). These are all unsustainable fuel sources that are causing damage to both the ecological environment as well as creating an unhealthy environment for us to live in (Akella et al., 2009:390). The image

below shows the cycle of coal, oil and natural gas from when it is created to when it is used in a car.

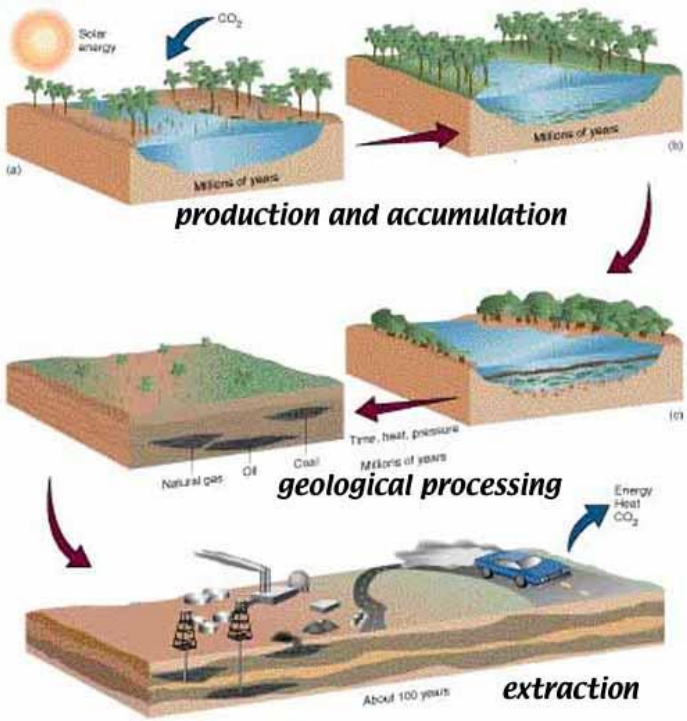


Figure 32: Indicating how coal, oil and natural gas is created
Source: https://people.uwec.edu

The natural resource depletion and demand for energy has caused the prices of these natural resources to increase drastically. People and the environment are battling to keep up with the demand and price, putting increasing pressure on the environment and less wealthy people. The demand for alternative sources of energy has caused the price of natural resources to increase with time and the price of sustainable energy to drop substantially over the last 30 years (Akella et al., 2009:390). Only 15-20% of the world's energy is from renewable sources (Akella et al., 2009:390). The figure below shows the differences between non-renewable energy and renewable energy.

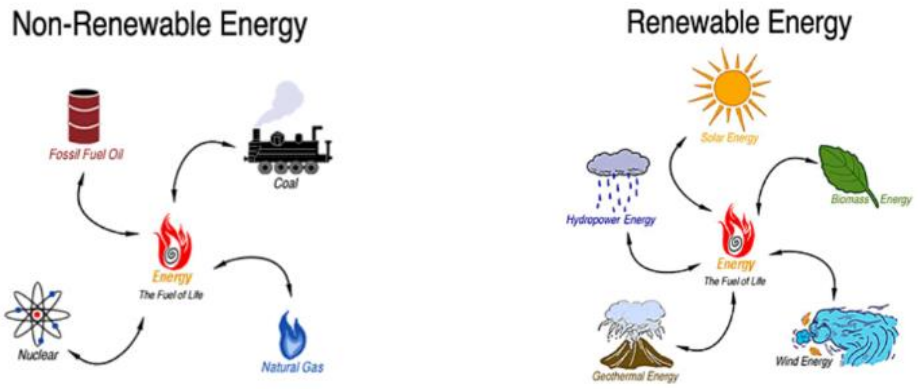


Figure 33: Different energy sources
Source: http://elainescienceassignment.blogspot.com

There are still a large percentage of people who have minimum access to energy. Many of the people in developing countries are relying on hazardous, unprocessed biofuels (Karekezi, 2002:2). In the documentary *A Plastic Ocean (2016)*, they interview a rural community in Fiji that uses plastic to start fires. They have been using this hazardous material for decades without knowing the effects it is having on their health. One of the main problems developing countries face is that survival comes first – people don't look after the environment when they are struggling to meet their own needs.

Furthermore, often people don't enjoy change or new ways of thinking and utilising electricity. This socio-ecological way of thinking is an entire paradigm and mind-set shift. People in developing countries see certain services as a sign of success and strive to reach this success. This shows the importance of changing people's mind-set. People who can afford to pay for it are now moving to more sustainable energy methods like solar panels, while the people who are struggling want to reach a point where they can use municipal electricity, because that is somehow a measure of their success.

3.4.2 WASTE SYSTEMS

Inadequate management of waste has generated environmental and health problems due to pollution. The growing population, urbanisation and technical era we are in has evolved with the times. In today's era there is far more plastic and electronic waste than ever before. This is especially evident in highly populated areas such as cities. On average, people in some South American countries and in the European Union generate 1kg of solid waste per day (European Environment Agency, 2008; Gouveia, 2012), most of which is deposited into landfills.

There are huge health and safety implications for surrounding residents with the large amounts of waste that is deposited into these landfills. In developing countries with a high density population, people live on the outskirts of these landfills. In Maputo, for example, there were people living on the edge of a landfill and 17 people died when a waste hill collapsed on the development (The Guardian, 2018, February 20).

Figure 34: Rescuers search for survivors at the collapse of a garbage mound in Maputo
Source: https://www.theguardian.com

People who live close to landfills are exposed to various toxic substances and contaminated air. A common outcome of these conditions is various types of cancer and unhealthy pregnancies (Gouveia, 2012). Reduce, reuse, and recycle are the three R's that can potentially limit waste effectively and have the most effective environmental benefits (Gouveia, 2012).

3.4.3 WATER SYSTEMS

Franklin (2016) describes the benefits of water saying:

> Water is perhaps the most overlooked yet most essential nutrient in a healthy, balanced diet, as nearly every tissue and organ system depends on it. Whilst water doesn't supply the body with energy in the form of calories, the body's actual need for it far outweighs that of any calorie-containing food. In fact, one can survive for over a month without eating but only 3-5 days without drinking water.

Water is a human right – everyone has the right to clean water. Throughout history, society has used laws to control, monitor and sanction the use of water and natural resources **(**Bohensky, 2006). South Africa has a history that was shaped by the uneven distribution of natural resources during the apartheid era. When South Africa became a democracy, water laws were replaced with a progressive piece of water legislation – the National Water Act No. 36 of 1998. The Act encourages a commitment to ecological and social sustainability.

Water is seen as a socio-ecological system in itself, as it is a natural resource that sustains life on earth. Both people and nature need water to survive. Water is a difficult resource to manage

as it has a vital connection to people and all ecosystems. There are ethical issues that could potentially arise when making policy decisions around water as water is such an important resource to sustain life (Acreman, 2001).

Water is renewable, as long as it is not polluted. Polluted water can lead to contaminated water systems. Water, where it is scarce, creates a social problem, especially in the rural areas where the government has not been able to provide water and infrastructure. Contamination of the limited water for human consumption in these rural areas is a problem as it is often not safe to drink and there are various bacteria and diseases that are colourless, making people unaware of the contaminated water they are consuming. This situation exists in many places, all over the world. The figure below shows the polluted Marilao River, in the Philippines.

Figure 35: The polluted Mariloa River in the Philippines.
Source: https://helpsavenature.com

Rainwater harvesting and filtering water is an effective way of reusing water. However, in places of high population density there is air pollution that falls on the water surface or on the surface where the water is captured, contaminating the harvested water. This water would need to be filtered before it is consumed in order to eliminate the pollution.

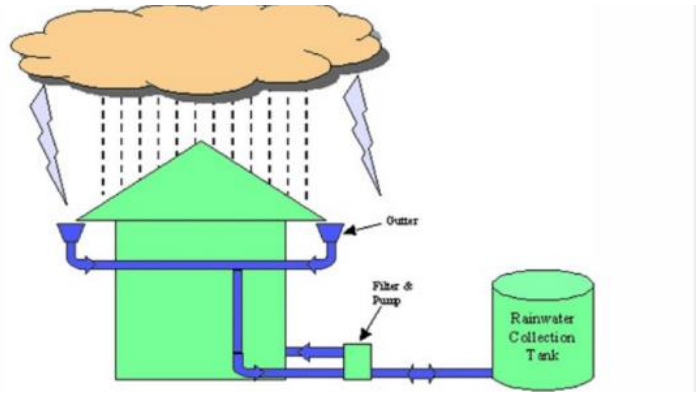


Figure 36: Indicating a typical rain water harvesting systems with a filter.
Source: https://sites.google.com

3.5 ECOLOGICAL DIMENSIONS

The ecological problems we are facing are often caused by the misunderstanding of the connection between nature and people, or just the pure neglect of nature. A good example of the neglect of nature can be seen in the figure below. This image shows the consequences of a bad waste management system in a rural settlement in China.

Figure 37: Yangtze River in a rural area of Yichang, Hubei province, China showing the amount of pollution that is dumped into the river
Source: https://www.chinadailyasia.com/

Nature has its own way of filtering water however when humans use materials that are not biodegradable, the environment can't keep up and the natural filters start to die. When this happens the area becomes a waste land. One way of filtering water along the coastline is mangroves.

3.5.1 MANGROVES

Mangrove forests have an important function both socially and ecologically (Dahdouh-Guebas et al., 2005). Mangroves are a completely natural system with no human interference. This system may benefit people and the environment. It is a beautiful, complex system, making it a vital socio-ecological system within this research.

We, as people, have already destroyed 50% of the world's mangroves in the second half of the 20th century, despite the many laws to protect them. This is a huge problem as mangroves have many benefits, including:

- the reproduction of marine species many of which we rely on for food;
- being an effective way of removing carbon dioxide from the atmosphere;
- improving the water quality and clarity;
- reducing the impact of waves during storms;
- providing habitats for threatened and endangered species;

- Preventing erosion and stabilising the shore lines (Dahdouh-Guebas et al., 2005).

Figure 38: The complexity of the mangroves ecosystems.
Source: Author

Due to population growth and urbanisation, people are destroying and removing vital ecosystems to inhabit the area. This causes damage to ecosystems that we rely on for food. A good example of this is the removing of the mangroves in the Durban Harbour. By 1846, many of the finest mangroves had already been removed by both civilians and the military (Kearney, 2013). This was done before the regulations came in to protect mangroves, and as a result they were never replaced and because of this, the harbour has become a toxic water body that drastically needs to be remedied.

3.6 BUILT FORM DIMENSIONS

3.6.1 SOCIO-ECOLOGICAL SYSTEMS THINKING IN THE BUILT ENVIRONMENT AND ARCHITECTURE

With the growing population, there is reason to believe that in the next fifty years, mankind will build more than the past five thousand years (Orr, 2007:23). Due to this, mankind is creating a turning point and paradigm shift in the way people understand the connection between humans and the environment. Most architecture is designed for people and used by society. Environmental problems have accumulated, due to the rise of consumption, waste and population growth. By reducing waste and reusing waste products through a network of systems within a building and the architecture of the building, positive environmental

benefits will occur. Due to the potential future explosion of development, it is the architect's duty to society to make sure there is not social or ecological discomfort when designing a building.

The figure below shows a space where marine vegetation is grown below the building. It creates a beneficial habitat for fish by filtering the water to create cleaner water in the harbour for the marine life to live in a healthier environment. A cleaner healthier environment will draw more people to the building and the waterfront.

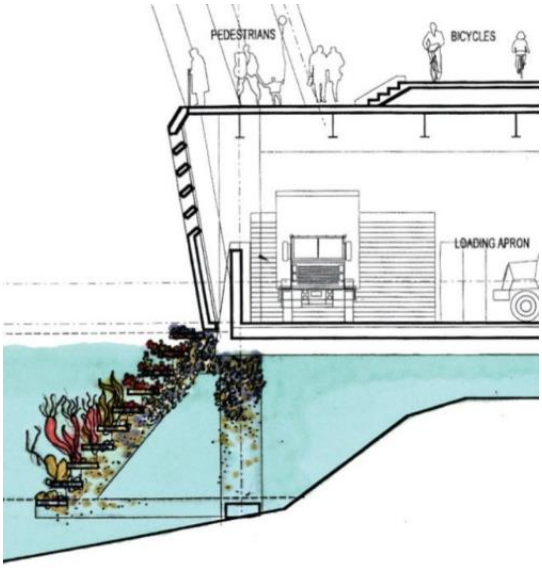


Figure 39: The Marine habitat skirting system along the Vancouver convention centre.
Source: https://www.archdaily.com

3.6.2 HYBRIDISATION BETWEEN ARCHITECTURE AND NATURE

Hybridisation is the idea that architecture needs to be reactive and evolve with the relative context (of the landscape and design), potentially making a living system that will benefit both the architecture and nature (Saggio, 2014:24). Hybridisation is not only an approach to sustainability but a way of thinking and a way that could potentially change how people understand and see socio-ecological systems in the future. Hybridisation embodies Dr David Orr's (1998) view that we need to see both people and nature as equals. Hybridisation allows architecture and reactive systems to simulate natural systems.

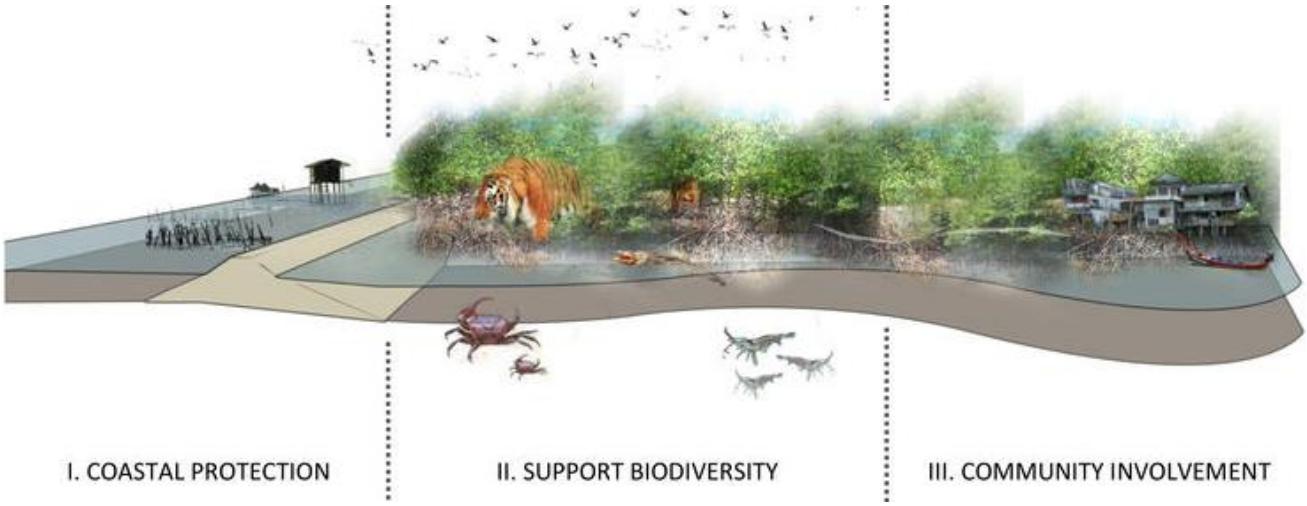


Figure 40: Symbiotic relationship between nature and architecture, through mangroves. Source: https://fluswikien.hfwu.de

The figure above indicates three examples of the benefits of mangroves (coastal protection, supporting biodiversity and encouraging community involvement) that are a result of hybridisation between architecture and nature – such an ecosystem protects and helps architecture evolve and adapt to the environment.

Saggio (2014) states that "Architecture takes what it does not have, absorbs it, transfers it, makes it its own, and reconstructs a new idea of nature". With good effective design and infrastructural systems, architects can create better solutions to problems. A good example of this is the Venlo City Hall in the Netherlands. This project makes use of green façades and green internal spaces, which reduces air pollution, and has run off sustainable energy methods. The building and the passive design techniques, such as water harvesting and wind tunnels can be seen in the section below.

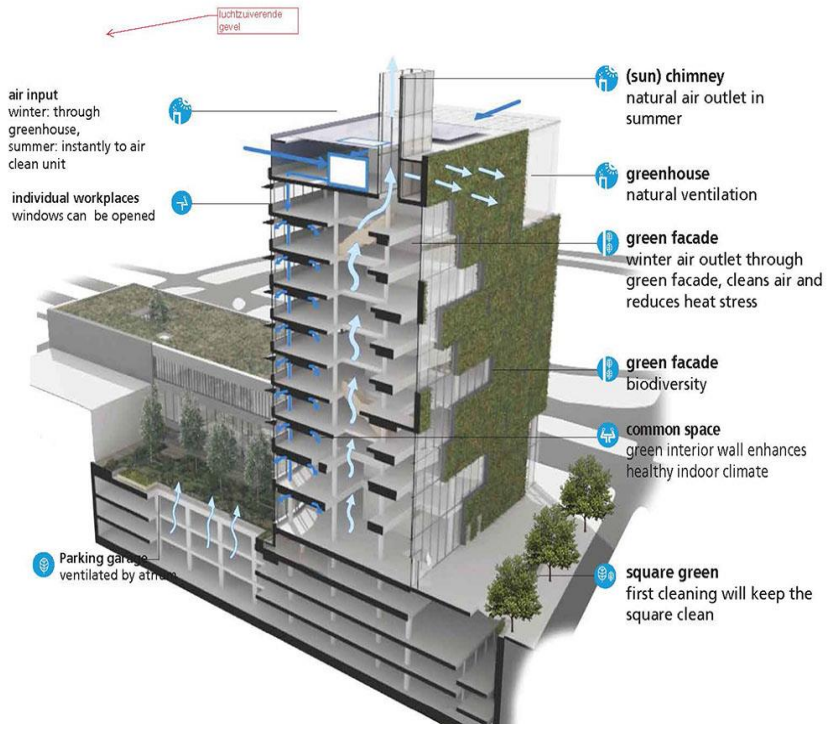


Figure 41: Section through Venlo City Hall in the Netherlands,
indicating the interconnection between environment and architecture.
Source: https://www.royalhaskoningdhv.com

3.6.3 INFRASTRUCTURAL SYSTEMS

Fikret Berkes talks about the importance of infrastructural systems in a building and how these systems can directly translate to the success or failure of the building (Berkes et al., 2000). Positive infrastructural systems can effectively be used to create a healthier environment for people and generate a local environmental response to pollution and resource consumption. These systems need to mitigate against negative effects of global warming, air temperature, humidity, air velocity and bad weather, to name a few, in order to benefit both people and the environment.

Kathleen Wolf (2003) talks about the history of infrastructural systems, and how they have been present for centuries and were first understood by the Romans. This was evident in their engineering of both road and water systems. An example of a water system that has evolved is the Roman aqueducts, as seen in the figure below.

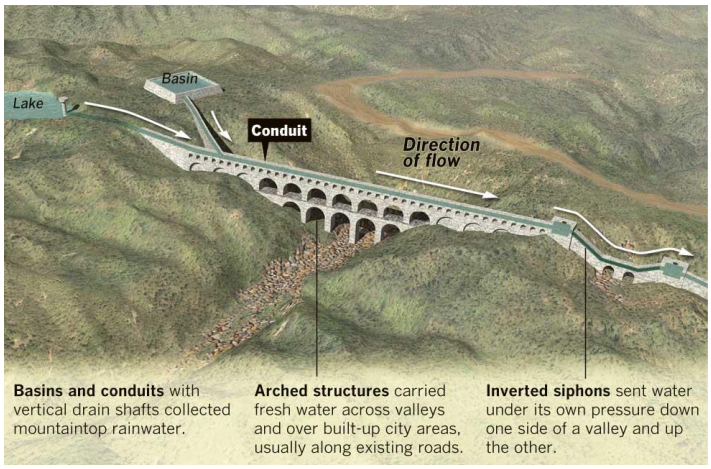


Figure 42: Ancient Roman Aqueduct water systems
Source: http://graphics.latimes.com

These water systems transported water to the cities, and were carried down through the ages. With time, systems became more complex and evolved, for example in the early 1900s, electricity was introduced and more recently in the early 2000s, telecommunication systems came about (Wolf, 2003:141). With the development of cities and urbanisation, infrastructural systems that people rely on have evolved from being a convenience to becoming a preserved need. These infrastructural systems are used to carry natural resources over large distances (Ramaswami et al., 2012:801), and this means more people have access to natural resources, thus generating a greater demand and more use of resources than ever before. This shows how systems evolve to meet human needs. With this, we are at a turning point where the earth's natural resources are unable to sustain people's needs.

3.7 BENEFITS OF RENEWABLE RESOURCES

Environmental pollution is largely linked to the increasing amount of energy consumption and packaging. This means that the more unsustainable energy we use, the unhealthier our environment is to live in, thus affecting us socially, directly through our own needs (Akella et al., 2009:391).

The natural environment is completely sustainable without human influence, therefore we need to understand and utilise these systems to benefit our everyday needs. By utilising renewable energy, fewer natural resources are used, thus creating a healthier environment for people to live in. These systems can also potentially lower costs, as renewable energy, once installed, is often cheaper or costs nothing to maintain, reducing pollution into the environment, as well as creating a better environment for future generations.

A market has the potential to be an example of a positive sustainable system. It has the potential to increase local industry and trade and reduce pollution accumulated within the market, reduce the amount of natural resources used, reduce the price of produce, and utilise resources that are directly connected to the site without the need to transport the product over far distances.

3.8 THE IMPORTANCE OF LOCAL CULTURE, MATERIALS AND KNOWLEDGE WHEN DESIGNING A MARKET IN DURBAN HARBOUR CONTEXT

Mike Michael (2009) talks about people being complexly tied to society, technology and nature all at the same time. The makeup of a person is not a simple system but a complex network of systems. Buildings are like people as they consist of complex systems that need to be understood to achieve a good design that will correctly and effectively be used to generate flow between nature and culture (Mahgoub, 2007). This shows the complexity of layers that need to be understood when exploring sustainable design. These complex layers need to be able to feed off one another to create the best sustainable and effective systems possible, for both people and the environment to co-exist successfully.

Identity is a process and not a found object that has evolved throughout history. Culture and identity are similar but have distinct differences. Culture is the way of life that people embrace when trying to fit into society, whereas identity is knowing who you are individually or in a group (Difference Between, 2014). Castells says that "cultural identity is the process by which social actors build their own meaning according to cultural attributes". Today, cultural identity in architecture has become vital as it creates and captures the uniqueness of the location and the natural environment in which the building is designed on a global level (Mahgoub, 2007). When seeing Greek architecture, for example, one can immediately identify the location. The white and blue buildings are symbolic of the context and the culture of the people, and have been for centuries.

Markets have a large cultural component, as discussed above, and they portray the community they are located in. The culture of a market is determined by available materials in the area and products created and sold by local knowledge passed down from one generation to another. A successful market needs to function effectively, and have a link to the community in which it is situated. South Africa has always had a close link to the environment, as we have some of the most diverse animal and plant life in the world (Van Wyk et al., 1997). Durban, being a coastal city, has a strong connection to the ocean that evolved commercially in 1865 (Govender, 2014). The sea and the environment was a way of life, but through time and

regulations this has been lost to a certain degree, just showing that by reintroducing these vital cultural experiences, we start to see a more direct connection not only to the sea but also the environment.

The early settlers on Salisbury Island, as explained in chapter one, were people who wanted to earn an income through nature. The island was isolated from the main town of Durban. The Point in Durban Harbour was a channel that was edged with two water systems: the first having strong pounding waves on a long sandy beach and high sand dunes with coastal dune vegetation; and the other a shallow beach that ran along the entrance to the bay. Further into the bay were lush healthy mangroves and vegetation covering most of the sand. In the bay were high sand dunes that rose above the shrubs. Both these complex water systems allowed abundant ecosystems and marine life to thrive and reproduce. With the vast amount of thriving life within the bay area, people were able to move to the island where there were enough marine species to sustain their families, as well as earn a living selling seafood to people in Durban.

3.9 CONCLUSION

In most developing countries, there is a high unemployment rate and the infrastructural systems are not dominated by technology but rely on human interaction. With the growing population, there is reason to believe that in the next fifty years, mankind will build more than the past five thousand years. Together, this growing population and increasing development causes the other main environmental problems we are facing, due to the misunderstanding of the connection between nature and people, or just the pure neglect of nature.

These environmental problems can be helped with sustainable systems. These systems need to be able to evolve and adapt to both social and ecological changes. The environment and architecture are constantly changing, therefore the problems we are facing can never be fully solved, however, with good effective design, we can create better ways around problems. It is important to use socio ecological designs that are available and that these systems are connected to the users of the architecture, as they are systems that are designed for human usage. This is a mind-set that needs to be changed in order for us to accomplish a solution that can help create sustainability.

CHAPTER FOUR: CRITICAL REGIONALISM

4.1 INTRODUCTION

Critical regionalism explores the potential of introducing cultural characteristics into a building or system in order to show cultural identity in a rapidly changing, technically driven age (Lefaivre and Tzonis, 2003:10). Critical regionalism was introduced more than 25 years ago, as a deliberate departure from postmodern architecture, which at the time was the dominant architectural style (Lefaivre and Tzonis, 2003:10). Such an approach goes as far back as the ancient Greeks as they used architectural elements to represent politics and identity (Lefaivre and Tzonis, 2003:11).

Critical regionalism is explained in this chapter, along with the fishing industry, issues of local culture, knowledge and occurrences that the fishing community experienced over time. Frampton (1981) argues that architecture and architectural forms relate to surrounding context. Identity and culture are getting lost in this postmodern architectural age we are living in as needs and experiences differ from one place to another. Each site has different people, cultures, and environments. This chapter will explore the connection culture has with nature and technology and how this relates architecture.

4.2 CRITICAL REGIONALISM AND WORLD CULTURE

Critical regionalism, as Frampton (1981) explains, is a connection to national culture and civilisation; he talks about five critical points when he breaks down the theory of critical regionalism. Modern buildings explore the technology as a driving concept and use technology to create urban forms. Some twenty years ago, culture and sociality played a role in the design of architecture and the façade and urban fabrics (Frampton, 1981). This can be seen in the figure below. The first image indicates a modern building that is driven by modern technologies and complex design structures. The second figure of a Traditional Chines Palace explores traditional Chinese architecture and technologies that have been passed down from generation to generation. This can be seen in the design of the roof. Frampton talks about always keeping a balance when designing (Frampton, 1993). The use of international techniques and technologies are important, but they should always respect the context in which they are situated – a good design finds a balance between the two.

Figure 43: National art museum in Abu Dhabi.
Source: https://robbreport.com

Figure 44: Traditional Chinese Palace
Source: http://clipgoo.com

4.2.1 LOCAL ARCHITECTONICS

The first point explores local architectonics rather than universal technologies. This shows the importance of local architecture and infrastructure in order to generate an effective building. Also important is the movement between designer and user. A good example of this is Greek construction methods. These construction techniques have been passed down through generations and the builders have mastered them and still use them today. Domes and churches have a distinct architecture, while dwellings and other buildings have another style. Common construction indicators are flat roofs, white plaster walls and blue window shutters, as seen in the figure below. This shows that different cultures have different styles, some more unique to an area than others.

Figure 45: Traditional Greek Dwelling
Source: http://surripui.net

4.2.2 CRITICAL REGIONALISM AND WORLD CULTURE

Frampton explains how critical regionalism has dominated the architecture of various countries at one point or another. Regionalism means upholding local architectural features and culture above universal ones, as well as mediating the impact universal civilisations have on a particular place (Frampton, 1981: 1). Thus, critical regionalism is architecture with the form of

a modern building that ties to local tradition. A good example of this is uShaka Marine World. It has a modern building approach and ties into local tradition.

Figure 46: uShaka Marine World exterior.
Source: https://www.sylvangrove.co.za

Figure 47: uShaka Marine World interior.
Source: https://www.sylvangrove.co.za

UShaka marine world has a strong African traditional style that comes through in the architecture. The traditional iQukwane huts were used frequently throughout the development, and are integrated with modern elements, which can be seen in the technologies such as lights, as seen in the figure above.

4.2.3 RESISTANCE OF THE PLACE-FORM AND THE IMPORTANCE OF URBAN DESIGN AND URBAN PLANNING.

One needs to understand the context and culture in the area, and not just focus on a specific site. Heidegger (1954) states that "A boundary is not that at which something stops, but, as the Greeks recognized, the boundary is that from which something begins its presenting". Understanding the context in which one builds is a vital attribute to any design. A good design fits into its surrounding context. In order for that to happen, one needs to understand what's around, through an urban design analysis or framework.

A good example of this is shown below in the analysis of the V&A waterfront in Cape Town (done by Atkins in 2007). It shows how the framework connects to the important nodes and transport systems that potentially connect to the CBD. The design of the forms are also based on the surroundings and are connected to the sea where the sea edge has adequate pedestrian

nodes. On closer examination of the site, we get an understanding of how these all work together to create an effective viable framework.

Figure 48: Overview of the V&A Waterfront
Source Atkins, 2011:444

Figure 49: 3D model of the V&A Waterfronts urban frame work
Source: Atkins, 2011: 445

4.2.4 CULTURE VERSUS NATURE

Topography, context, climate, light and tectonic forms all create a relationship with nature. Critical regionalism involves all 5 of these relationships. This encourages architects to design with what is present on site. It is important to utilise all that the site offers, and mould a design around the site and not the site around a design. Critical regionalism emphasises the strong connection architecture and culture share with the environment. Frampton concurs with this view and encourages the natural connection rather than destroying nature (Frampton, 1981). Design is not merely the building, but the entire development from the services to the walkways to visual disturbances. All these need to be understood and need to blend into the surrounding

environment. An example of this can be seen in the Pathway up to the Acropolis in Athens Greece. The walkway was designed to remove vehicles from the area and replaced the road with a foot path (Lefaivre and Tzonis, 2003:70). This foot path encourages greening the area around the acropolis. This pathway creates a strong connection between the pathway and the site topography, as seen in the figure below (Lefaivre and Tzonis, 2003:70).

Figure 50: Image of Dimitris Pikionis pathway up to the Acropolis, in Athens, Greece.
Source: https://za.pinterest.com

Figure 51 shows a resort in the Maldives that is built completely above the water. In this case, tides and environmental conditions can naturally still occur below the building with little human disturbance. Figure 52 shows the efficiency of passive design techniques that have been perfected by earlier generations. These techniques do not rely on mechanical help such as the heating and cooling of buildings. By understanding the way the environment works and designing accordingly, there is no need for intense lighting during the day or cooling and heating of the building - the site and the building work together symbiotically.

Figure 51: Maldives bungalows above the ocean.
Source: https://santorinidave.com

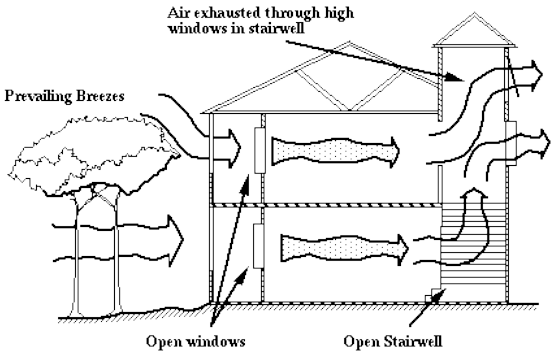


Figure 52: Passive design techniques - understanding the movement of wind
Source: http://passivesolar.sustainablesources.com/

4.2.5 THE VISUAL VERSUS THE TACTILE

This last point is related to the experience one feels in a space and the materials used to create a specific experience. A good example of connecting the building with the environment is the traditional dwellings located on the Ivory Coast. These buildings are constructed by utilising local resources around the site. The walls are adobe bricks made from mud and clay (Kumakonda, 2018). The roof is made of wood and straw. The thickness depends on the age of the dwelling as each year the roof needs to be repaired, instead of removing the layer of thatch, a new layer is added creating the roof thickness as the building ages (Kumakonda, 2018).

Figure 53: Traditional Ivory Coat dwelling made of traditional materials.
Source: https://kumakonda.com/niofoin-costa-de-marfil/

People have many sensory perceptions including sight, touch, hearing, taste and smell. Architecture needs to create an experience and these sensory perceptions can either make one feel comfortable in a space or uncomfortable.

All Frampton's (1982) critical points can be used as a framework to understand and best achieve a building that can be categorised as critical regionalism. These points emphasise the importance of using local knowledge, culture, experiences, as well as the site and its surrounding context.

Figure 54: Showing the Tjibaou Centre blending into nature
Source: https://www.archdaily.com

Renzo Piano's Jean-Marie Tjibaou Centre understood the above steps and generated a building that emphasises site and the environment as main design influences. The Jean-Marie Tjibaou Centre was designed to emphasise the culture of the Kanak, native to the area. Both traditional and global building techniques were used, as well as textures. The forms emphasise the surrounding tree texture that was brought into the architecture (David Langdon, 2015).

Passive design techniques for ventilation were used to restrict the use of mechanical ventilation such as air conditioners, making the clean fresh air part of the experience of the building (David Langdon, 2015).

The layout of the buildings took the shape of a traditional Kanak village as seen in the image below. This allows continuous flow and movement between spaces and the built form (David Langdon, 2015).

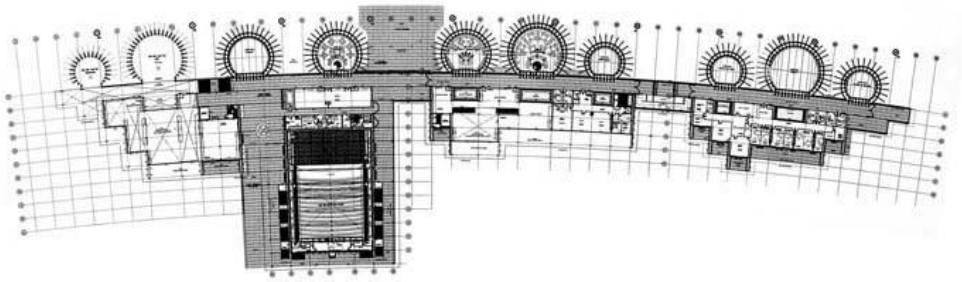


Figure 551: Plan of the Tjibaou Centre
Source: https://www.archdaily.com

4.3 BUILDING TECHNIQUES IN DURBAN HARBOUR

The images below shows the connection between people and the ocean that was reflected in their building techniques. These building techniques allowed people to build on the water edge. The buildings were built on stilts to allow for the tides to come in and out without affecting the building. The materials that were used were local materials found on the island, as it was difficult to bring materials to the island by boat. Most of these materials were scavenged from the existing mangroves and vegetation around the site. These techniques are simple yet effective, with lots of covered spaces, as seen in Figure 56. Durban's climate is extremely hot in summer, making shelter (natural shelter from trees, an informal built structure or a more formal structure with a sheltered porch) vital. People and children spend a lot of time outdoors as seen in Figure 57, showing that fishing was a culture and way of life in the town.

Figure 56: Mending a shrimp net in front of Karupan's home in the village
Source: Govender, 2014:62

Figure 57: Salisbury Island circa 1880, fish drying lines
Source: Govender, 2014:62

Knowing the fact that people were able to live completely off the sea makes us ask ourselves: what went wrong? This culture and lifestyle has completely been eliminated from the harbour due to politics.

4.4 CONCLUSION

This chapter explores technology as a driving concept and the use of technology to create urban forms, while exploring local architectonics rather than universal technologies, critical regionalism and world culture, the resistance of the place-form, culture versus nature, and the visual versus the tactile. Through understanding these principles, the houses on Durban Harbour were briefly analysed. People were driven away due to politics, as well as the pollution and depletion of most ecosystems that existed within the area.

This chapter emphasises three main focus points within critical regionalism being the connection people have with nature, technology and culture. These three connections are vital in a design and can potentially connect to the built environment and architecture. When designing a space, emphasising this link will create a site-sensitive building that relates to local cultures and nature that are respective and responsive.

These guidelines can be used in the design and in generating an understanding of the culture that can potentially be utilised by the seafood market. History has also shown us how many people earned a living off what was available in the harbour. This just emphasises the potential of reintroducing a culture that was successfully expanding before politics destroyed the industry.

CHAPTER 5: CASE STUDIES

5.1 INTRODUCTION

This chapter will explore three markets: one in Mozambique and two in South Africa. These case studies will explore how socio-ecological systems are present in existing markets located in South Africa and Mozambique. The map below shows that both Durban and Maputo have always been closely connected by the sea and have a lot of climatic and oceanic similarities. Rio do Maunte is now Maputo and Bahia de Pescaria (Bay of Fish) is Durban (due to the abundant fish).

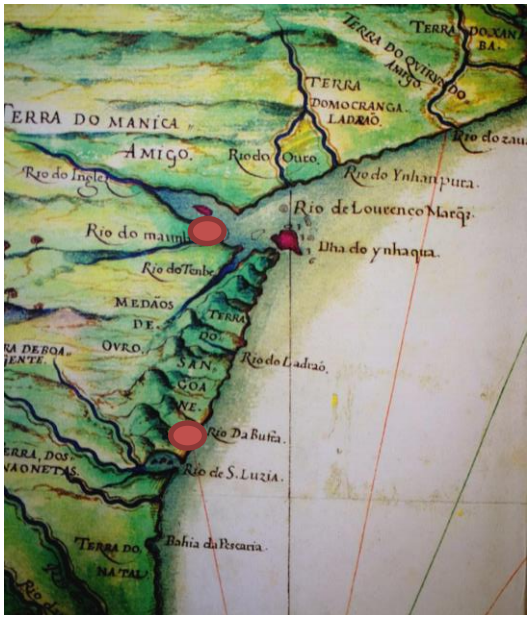


Figure 58: A secret Portuguese map dated 1630 indicating their route to India via Inhaca Island.
Source:https://fineartamerica.com

Each case study was selected for specific reasons. Warwick is the largest daily market in Durban. This case study will explore the elements of socio-ecological systems that make up the market in Warwick Junction. The location of the market and the ideas of suitable functioning through socio-ecological systems thinking will be engaged with.

Bangladesh Market is located in one of the poorest neighbourhoods in Chatsworth, South of Durban. The market is more compact compared to the markets located in the big cities such as Durban or Maputo. It is important to understand the scale of a market and its surrounding context. The social and environmental connection could be greater in this market due to its proximity.

Maputo seafood market is different to the others as it is located in Mozambique, where the regulations and systems are different to the systems used in local South African markets. The market was funded by the Japanese and has Japanese and Portuguese influences. This market is on the edge of the sea and is different in context to the other inner city markets. The location, systems, and regulations will be observed.

5.2 BANGLADESH MARKET

5.2.1 LOCATION AND HISTORY

Bangladesh Market is located south of Durban. This market is located in Chatsworth where the community is faced with social, ecological and political challenges.

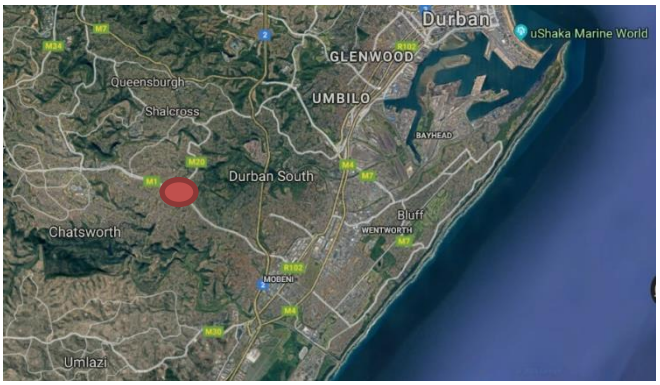


Figure 59: map of the Bangladesh Market located in Chatsworth, south of Durban.
Source: GoogleEarth.com

Figure 60: Aerial photo of the Bangladesh Market located in Chatsworth, south of Durban.
Source: GoogleEarch.com

The market was established in the 1980s, when Chatsworth was designated to the Indian community by the City of Durban to conform to the Group Areas Act. The Bangladesh housing and surrounding area is one of the poorest neighbourhoods in Chatsworth. This shows that people have little to no money for house improvements and are living day-to-day. The market is owned and governed by the municipality, however maintained by the community. This market is one of the successful markets in and around Durban and holds over a hundred and eighty stalls. It opens on Friday and Saturday between 06:00 and 18:00, to accommodate working people.

5.2.2 URBAN REALM

The Bangladesh Market is a destination market – a market that is located in an area where the end point is the market.

Figure 61: Aerial photo of the Bangladesh Market located in Chatsworth, south of Durban.
Source: GoogleEarth.com

Figure 61 indicates the multifunctional area in which the market is located, creating an economic hub within the community. This space services all the nearby residential areas. Without the market most of these residential flats would be forced to pay more in an already struggling economic situation. The market is therefore vital to the survival of this poor community.

The church, mosque, and temple seen in Figure 63, show the religious diversity of people living in the area. The market is located in a densely populated area as seen in Figure 61 There is a large multicultural population living in close proximity to the market. These mixed cultures create a welcoming feel to the market.

Figure 63: Image indicating the multicultural area of the market. Moving from left to right you have Christianity, then Hindu and lastly a Muslim religious buildings
Source: Author

5.2.2.1 PLACE TO EXPAND

With the expanding demand and success of the market, the old parking to the south-east side of the market developed and evolved into an informal market. This shows that the market has reached its full capacity. There is still parking available but this is needed as parking for the many people who use the market as well as surrounding businesses. This was observed through the observation sheets.

5.2.2.2 MARKET SPATIAL PLANNING

The market is divided into three sections: the informal market, the formal market and then the abattoir, fish market and ablution areas. This informal market has limited infrastructure, however there is access to the fundamental infrastructure due to the close proximity to the formal market. The vital services and systems such as roofs, energy and water only go as far as the formal market's boundaries, as seen in the image below. However due to the growing demand people are still using this parking space to trade and earn a living.

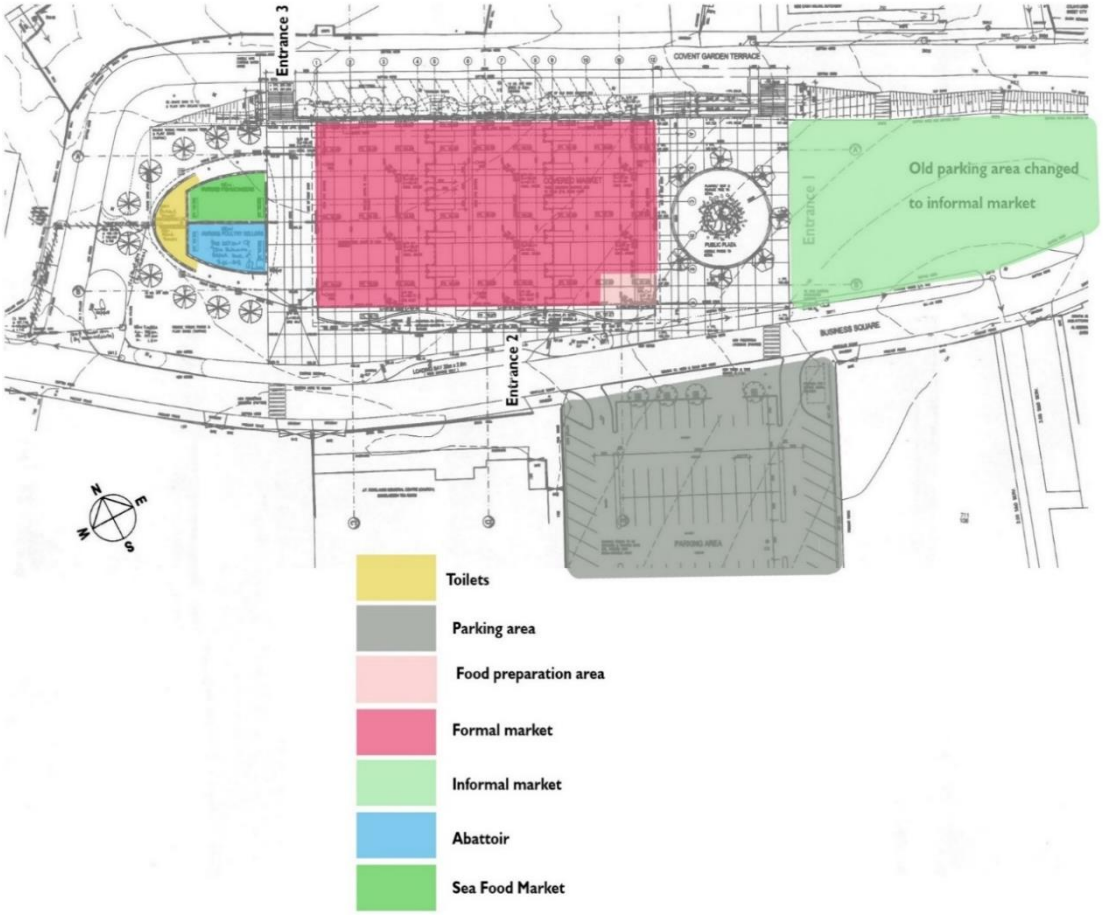


Figure 62: Site Plan indicating the layout and activities that occur within the market.
Source: [eThekwini Municipality]

5.2.2.3 TRANSPORT AND ACCESS

It is located close to bus and taxi routes, putting the market in a convenient location for people not from the area or who do not have access to a car. This transport system allows people from all cultural backgrounds to come and shop and interact in a vibrant multicultural area. This information was accumulated through three respondents who were interviewed in this case study. Respondent 1 stated: “I walk to work, as I live behind the market”.

Respondent 2 stated: “I take a taxi to work”.

Respondent 3 Stated: “I have a private car”.

5.2.2.4 WHAT ATTRACTS PEOPLE TO THE MARKET

The market sells a wide variety of products ranging from food to clothing. Markets draw people to a space to buy cheaper products, to meet friends, as well as allowing people to enjoy the outdoors and be closer to nature. The Bangladesh Market attracts people because of its convenience and prices. This market has a large population of Indians that utilise the market and surrounding area. This area and its community rely on the market. The success of this

market creates the potential to uplift people and create jobs in the area. This information was accumulated through the three respondents who were interviewed in this case study.

Respondent 1 stated: “I come to this market because I live down the road”.

Respondent 2 stated: “The food is fresh”.

Respondent 3 Stated:” I come here because I can afford the shops. The food is cheap here’’

5.2.3 SYSTEMS

The more complex the system, the more problems are likely to arise, as well as the harder they are to fix. Natural systems are best as they work without technology and electricity. They are able to adapt naturally and require very little to no maintenance. Maintenance of systems is vital to the success of a system.

People need to become part of the market and understand what the market is about. Anyone walking in the market can see the diverse cultures that are present. A good example of this is the use of Marigolds. The flowers are a natural insect repellent, as well as having cultural and Hindu religious beliefs attached to them. This specific flower can connect people with nature. These flowers are sold throughout the market.

5.2.3.1 Water Systems

In a market, water is vitally important for hygiene, safety (for firehoses in an emergency,) and to keep the market clean, especially in a food and seafood market. Water is a natural resource that needs to be carefully utilised in order to minimise consumption as much as possible. There is no recycling and reusing of water throughout the Bangladesh Market.

There are various fire hose reels present throughout the market for safety regulations. However, because of the shortage of water these fire hoses are often abused. There is one fire hose reel that is leaking and is used for water within the market. The image below shows the pipe that is leaking and wasting water.

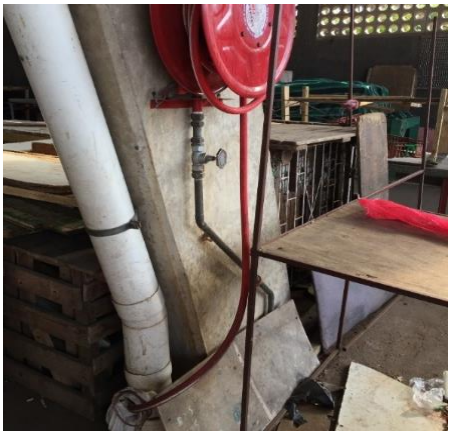


Figure 63: Leaking fire hose reel that is simply connected into the municipal storm water pipes
Source: Author

Store owners have made a hole in the municipal stormwater pipe to place the firehose that is constantly leaking. This just shows the amount of water that is being wasted. The pipe may have been tampered with or started leaking with time. This often happens in third world countries where people are so desperate for natural resources that they unintentionally sacrifice the resources in order to get what they need. The market is only used twice a week, so for 5 days a week this tap leaks into the municipal stormwater pipes and is wasted, instead of store owners using what is provided at the trough and fixing the leaking firehose.

Water is used within the market for the fish market, the abattoir, toilets and all round cleaning. The Bangladesh Market has one communal tap outside that is located behind the ablutions as indicated in Figure 64. There are other taps located in the market as seen in Figure 65 however these taps are located in stalls. Taps are present in the food preparation section, the abattoir, the ablutions and the fish market. If people in the main market need water, they need to collect the water themselves from the trough behind the ablutions.

Figure 64: Trough located on the North west side of the market.
Source: Author

No

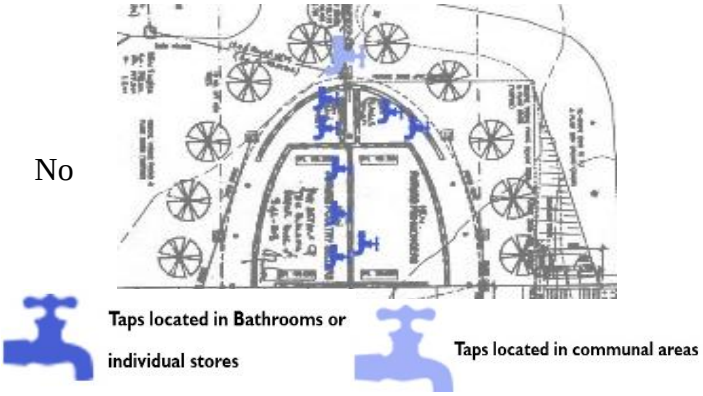


Figure 65: Taps located within the West side of the market
Source: Author and eThekwini Municipality

stormwater is collected on site. All stormwater and water runoff from cleaning runs into municipal stormwater pipes and is then removed from the site. The four water downpipes are

connected to each roof gutter and these are then connected to the stormwater man holes. The water systems have no human connection apart from water being used by traders to clean the area. This is all a wasted resource that could potentially be reused. There is great potential to store the rainwater as the roof of the market is a mono-pitch roof, as indicted in the image below. This means that only one side of the roof needs a gutter, making it easy to collect the water runoff from the roof. The figure below indicates the runoff path the water takes before it is collected in the gutter at the lowest point of the roof. There are three separate roofs that could all potentially collect water for storage, filtering and reuse.

Figure 66: Image of the roof layout, as well as how and where the water is collected in the gutters. Source: Author

When looking at reusing water, pumps are often used to remove the water from a storage space. Pumps often cause problems when creating systems. If not maintained, these pumps pack up and cause problems with the systems. It is therefore suggested that an alternative to pumps be used or situating a pump where there is constant surveillance.

5.2.4.2 WASTE SYSTEMS

There is a large amount of waste generated by a market, creating a vital need for the storage and collection of waste. The market requires a place to store waste within close proximity. At the Bangladesh Market there are various waste disposal systems. The solid waste from the market is collected in large green bins that are located around the market. Figure 67 and 68 show the green bins that are scattered throughout the market on Fridays and Saturdays when the market is open. There are about 24 bins in total around the market at any time. These bins are all standard green bins and there is no recycling of waste within the market.

Figure 67: Bins that are waiting for the municipal services remove the waste.
Source Author

Figure 68: Bins in preparation for the market
Source: Author

All waste from the green bins is dumped into one large dumpster located behind the market. This dumpster has a separate entrance where garbage removal trucks manoeuvre and remove the waste. This waste collection area offers opportunities for waste pickers to come and collect recycled materials. Waste pickers make a living from recycling glass, cardboard, tin and plastic. They come and sort through the dumpster and try and save what they can. The Bangladesh Market has no other recycling of waste other than these waste pickers. A market like this has the potential to recycle materials. With the location of the market being in an economically challenging area, there is huge potential for craft makers to create products from the recycled materials, thus creating jobs and an income.

Figure 69: Images of waste pickers accumulating recycled materials to remove off site and sell
Source: Author

Figure 70: Large Dumpster located behind the market
Source: Author

Sanitation waste goes into the municipal sewer lines and is removed off site. The toilets and abattoir area have grease traps to remove black water through the municipal sewer lines. The only human connection with the waste is when the grease traps become blocked or are cleaned. There is no recycling of water or sanitation waste done on site.

Freon gas can be used to filter and kill pathogens from sewerage, thus making the water reusable to flush toilets. This minimises the use of clean water and reduces the sewerage waste within the building. All water should be used at least twice. This was used in the Hammarsdale market as the aim was to prevent the garbage and sewer from polluting the stream.

5.2.4.3 ENERGY SYSTEMS

There is electricity that goes to numerous plug points throughout the market, as well as flood lights that extend across the roof of the market. The electrical switchgear and municipal connection point is located at the north-east entrance, opposite the guard house. The placement is in close proximity to the entrance, making it easily accessible to the municipality, as well as the guard house to prevent tampering.

Figure 71: Plug points located throughout the market.
Source: Author

Figure 72: Electrical switchgear located at the entrance
Source: Author

Within the Bangladesh Market, there are numerous demands for electricity. Firstly, floodlights are used for safety at night, secondly, electrical points are present for anyone needing electricity for their stalls, thirdly, refrigeration for the fish market is required, and finally there are electrical points in the abattoir and food preparation sections. There are a few power points located around the market, making it possible to find power despite there not being power in each store. Figure 71 is an example of a power point located in the market.

Incorporating solar panels can be an effective, alternate, way of producing renewable energy. These panels are however expensive and if not constantly monitored are often stolen. The building itself and the design needs to protect the expensive equipment; this can be done through positioning the panels where there is constant visual surveillance, and using tin roofs above the guard house and placing the panels on the corrugated metal roof, as this is noisy to

walk or move on, therefore making it difficult to steal the panels. Another potential technique to protect solar panels or even just to secure the market is barbed wire.

Electricity is not the only energy needed in the market. All the food in the market is cooked on gas in the food preparation area. All traders who rent a store in the food preparation area of the market are required to supply their own gas cylinders. Each trader is then responsible for getting these cylinders refilled when they are empty. This cooking and refilling of gas cylinders creates part of the social system we speak about. At Bangladesh Market there is no technology to refill the gas bottles on site, thus making it important to utilise people when the gas bottles need to be transported offsite to be refilled. The food preparation stalls are located close to two main entrances, making it easier to transport the gas to and from the market. This example shows how people are used within the systems. None of the energy systems used in the market are sustainable as they are all non-renewable resources – electricity and gas.

5.2.4.4 NATURAL SYSTEMS

Nature and humans are constantly competing for space. This market is a good example of how people take over nature when there is a battle for space. When people and nature compete for space, more often than not it is the people who win. A good example of this is shown in the images below. The original plans of the market indicate several trees planted around the market, however with time and the demand for space, these trees were removed.

Figure 73: Images showing the filled concrete planters where trees were originally planned to green the site. Source: Author

Figure 74: Images showing the filled concrete planters where trees were originally planned to green the site. Source: Author

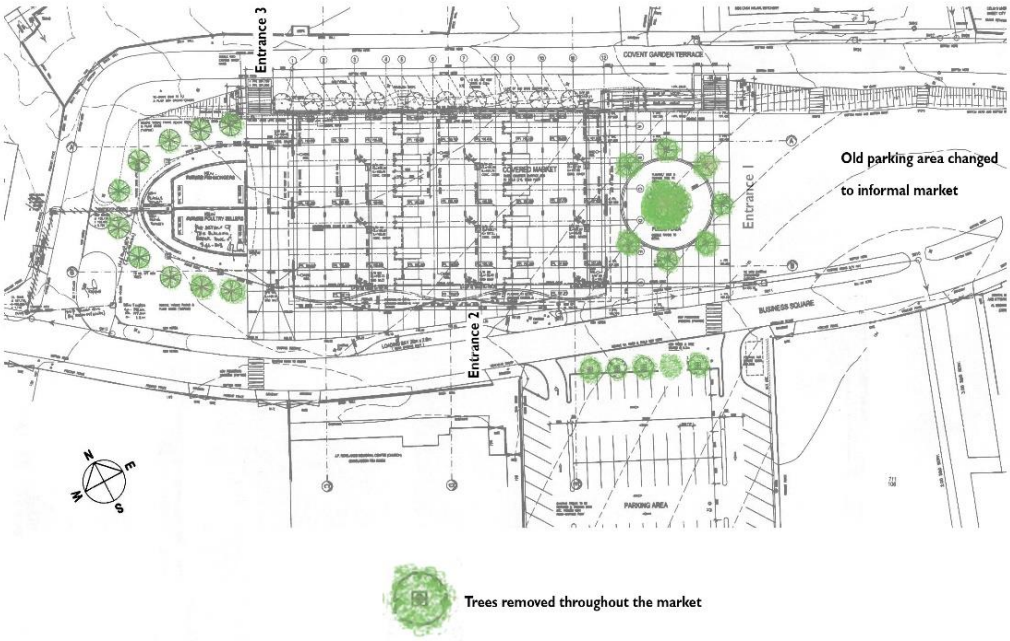


Figure 75: Indicating where trees have been removed to maximise space for traders.
Source: eThekwini Municipality

This market has lost opportunities that could potentially improve some of the businesses. There is a huge flat roof above the seafood market, abattoir and ablutions that is not being utilised other than to hold a small container with two offices, as seen in the image below. This roof is the perfect space where urban farming can take place. This space could be used to grow produce that could potentially be sold in the market. Farming so close to the market eliminates the need for transport and can benefit people who are unable to farm at home. There is also a guard present on site, 24 hours a day 7 days a week, who can make sure the produce is not stolen before it can be sold.

Figure 76: The roof that has potential for urban farming
(Source Author)

5.2.4 TECTONICS

The design of this market is the most cost effective and natural design of all the case studies. It is an open structure that is sheltered but completely open to the elements. There is natural ventilation and lighting allowing the people in the space to feel like they are in the open. The design encourages people and nature to interact. Even though the market is located in one of the poorest areas in Chatsworth, the design makes the space extremely successful and a place where people want to be. This can be seen in the great demand for space and how the market is overflowing.

5.2.5 MATERIALS

Due to the site being located South of Durban it has hot summers and cool winters. The sun can become extremely harsh due to minimal vegetation in the area. Shelter for the traders is essential. The Bangladesh Market has a distinct hierarchy when it comes to the roof structure and covered areas of the market. Looking at the figures below, we can see the market going from a formal structure with a permanent closed roof in Figure 77, to a formal open structure in Figure 78 and ending with a non-permanent informal structure in an informal trading area that used to be the parking lot in Figure 79. These images clearly show the hierarchy between the different levels of formality between stalls throughout the market.

Figure 77: The hierarchy between the different roofs throughout the market from the North west side of the market to the South East side of the market
Source: Author

Figure 78: The hierarchy between the different roofs throughout the market from the North west side of the market to the South East side of the market
Source: Author

Figure 79: The hierarchy between the different roofs throughout the market from the North west side of the market to the South East side of the market
Source: Author

The informal market traders have no formalised structures and reuse materials as seen in figure 80 and 81 below to create shelters. As seen in the images below, these materials are unfortunately elements of the market that have been broken off or removed.

Figure 80: Part of the concrete fence that has been broken to get access to the high grade steel inside the concrete
Source: Author

Figure 81: Leftover concrete used to hold down the informal roof of stalls throughout the informal market.
Source: Author

The formal market has a lightweight steel roof that spans over the area allowing light and ventilation throughout. The clear panels stop the hot wind while still allowing the light to penetrate into the market. The lower air bricks allow cooler air to enter and ventilate the market.

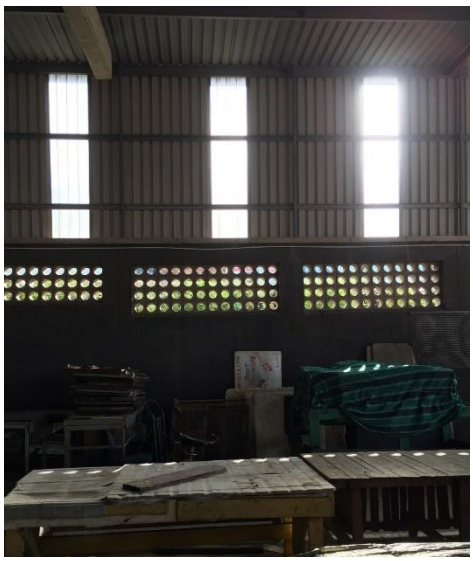


Figure 82: How light and air circulates within the market.
Source Author

Screed has been used throughout the market for the floor, making it easy to clean and needing little maintenance. The market also has screed ramps that allows for disabled people to enter the market, as well as making it easy to transport produce and products to the stalls as there is

no space to store goods on site. All goods and produce needs to be brought to the site before the market is opened making screed the most durable, cost and effective material.

5.2.6 EXPERIENCE

This market is used to sell a wide variety of products and produce with sections for seafood, meat and electronics. The market has a vibrant atmosphere, however when you move to the back of the market towards the fish and meat section there is a distinct off-putting smell. The overall atmosphere of the market is extremely open and multicultural, making anyone who enters the market feel welcome and comfortable, despite the smell.

The market is well maintained. Constant cleaning is essential due to the variety of products sold, especially the meat and seafood sections. Cleaning and hygiene is important in all markets.

5.3 MAPUTO SEAFOOD MARKET

5.3.1 LOCATION AND HISTORY

The market is located towards the outskirts of the city, along the coastal road of Maputo. This gives the market a direct link to the sea as well as creating a connection to the restaurants located along the beachfront. It supplies most of the restaurants in Maputo with fresh seafood.

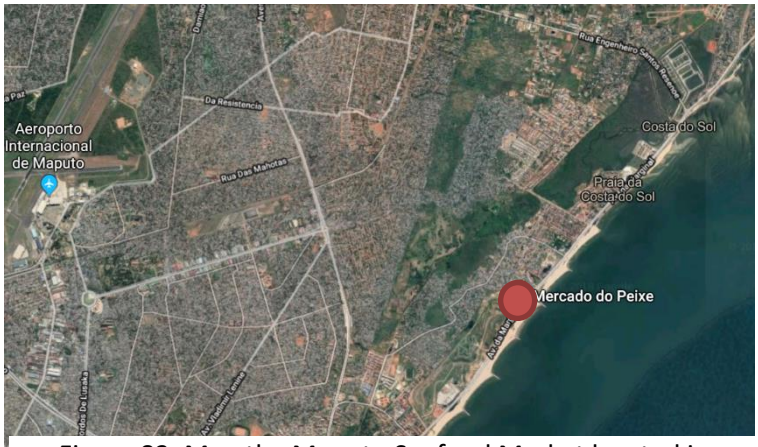


Figure 83: Map the Maputo Seafood Market located in Maputo, Mozambique.
Source: googleEarth.com

Figure 84: Aerial photo of the Maputo Seafood Market located in Maputo, Mozambique.
Source: googleEarth.com

Maputo seafood market is located in the capital city of Mozambique. This market is a government-run market that is open 7 days a week. The fish market stalls are rented by traders. It is the traders' responsibility to buy and clean the seafood bought from both local fisherman and people that come down from places such as Inhambane. The market, and all seafood sold

in the market, is monitored strictly by the market staff. They monitor the size and quality of the seafood sold in the market. Quality control is important as any seafood that is underweight, undersize or of bad quality is rejected and is not allowed to be sold at the market.

January to April is the busy season in Maputo, and there are regulations that ban fishing in specific areas, allowing the fish time to breed and grow. During this time, seafood needs to be brought in from other places. During these times, the prices increase relative to the transport costs.

The market has two times a day allocated to trucks for offloading their catch: 9:00-10:30 and then 15:00-16:30. After these times, the cleaning company comes in and cleans the delivery and outside cleaning area. Local fisherman with smaller boats are allowed to drop their catch off at any time throughout the day as the size of the catch is smaller and there is less cleaning required.

The market is divided into three sections – the restaurant, the market and the service and delivery section – as seen in the table below.

Days	Times
Sunday- Thursday Restaurant	09:00 – 21:00
Market	08:00 - 20:00
Friday- Saturday Restaurant	09:00 - 23-00
Market	08:00 -21:00

Figure 85: Table of Markets trading hours
(Source: Author)

The market has a formal area and a slightly less formal area for the restaurants where there are fixed kitchens, and less formal seating areas under donated umbrellas. When interviewing staff at the restaurants, they all wanted fixed covered space rather than the umbrellas as well as more space as each restaurant has very limited space.

5.3.2 URBAN REALM

Figure 86: Connections the markets has created
Source: GoogleEarth.com

Figure 86 indicates the connections between the local community, the sea and the market (in blue). Connections to restaurants located in close proximity to the market are indicated in red. Without the market the local community would lose a vast amount of income.

5.3.2.1 PLACE TO EXPAND

The market is located on the outskirts of the city where the urban fabric is not as dense as the other two markets. There is a large amount of space to expand if needed in time. With technology, future expansion can also take place towards the beach, or even the sea. This was observed through the observation sheets.

5.3.2.2 MARKET SPECIAL PLANNING

There are about 32 stalls located in the market with 48 restaurants situated towards the west side of the market, as indicated in the image below. The image below shows the spatial hierarchy of the market moving from the parking area to the less formal restaurant and seating area, and on to the most formal building being the seafood market.

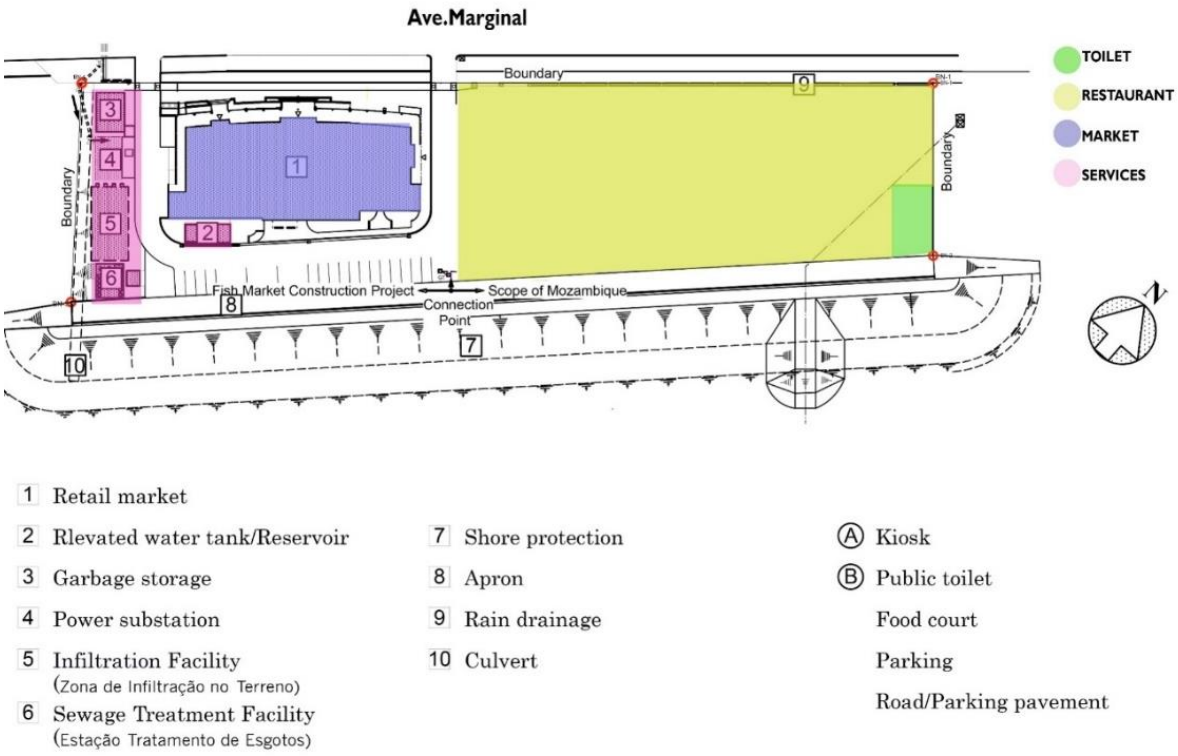


Figure 87: The breakdown of the market layout
Source: *Municipal* de *Maputo*

The market building is a closed building that has four main entrances. Three of these lead out to the street and the fourth links the market to the restaurants, as seen in the figure below. At night, the market is locked up and there are two guard houses that monitor the market. There are three security gates that get locked when the market closes.

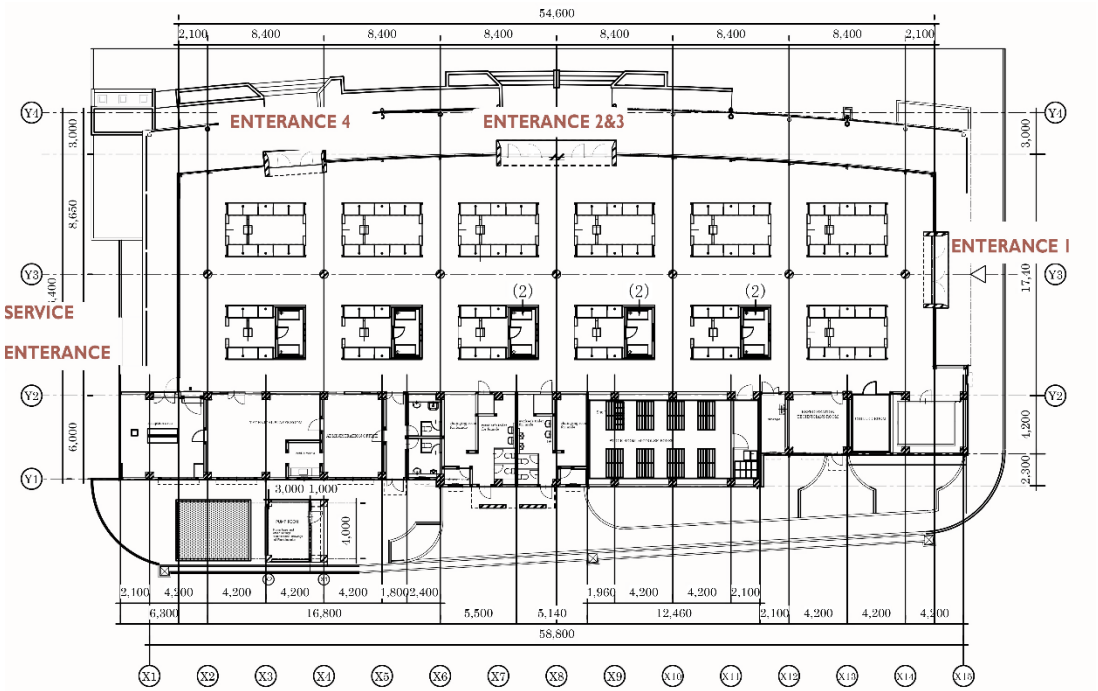


Figure 88: Map showing entrances and fences located within the seafood market
Source: *Municipal* de *Maputo*

5.3.2.3 TRANSPORT AND ACCESS

Most of the people working at the market and the restaurants come to work via bus or taxi. There is a stop just outside the market and there are constantly taxies passing. In Maputo the night life is a big part of their culture, with buses and taxies working late into the night, making transport easily accessible to both people wanting to come to the market and people working at the market. A lot of tourists are attracted to this market. The middle and higher income groups make up the regulars who frequent the market. Most of these people have access to private cars. There is a large parking area located to the north side of the market with direct access to the restaurant area.This information was accumulated through the three respondents who were interviewed in this case study.

Respondent 1 stated: “I get the bus”.

Respondent 2 stated: “I take the bus to work it drops me right outside the front of the market”.

Respondent 3 Stated: “I have a car so I can take whatever I don’t sell home”.

5.3.2.4 WHAT ATTRACTS PEOPLE TO THE MARKET

The market is well run and maintained, attracting tourists and locals to visit. The restaurants have a good vibrant atmosphere with friendly welcoming staff. The fresh produce regularly draws people to come and purchase the freshest seafood caught in the area. Restaurants and hotels use the market to buy their seafood for the day. This market is a vibrant space that feeds industry, locals and tourists in the area. There is a network of people and businesses that rely on it daily. This information was accumulated through the three respondents who were interviewed in this case study. All three respondents said they come to the market for fresh fish and seafood.

Respondent 1 added. “The restaurants have a nice vibe and the food is good because of the fresh fish or seafood that is cooked”.

5.3.3 SYSTEMS

5.3.3.1 WATER SYSTEMS

The water for the entire market is filtered through a filtration system. It is supplied by a private company and is stored in storage tanks located behind the market. From there, it is pumped into another tank that is located in a tank above a tower, as seen in the figures below.

Figure 89: The water tower.
Source: Author

Figure 90: The storage tanks on the ground
Source Author

From the elevated tower tank, the water is moved via gravity and distributed around the market. The water supplies the ice machine, cleaning stations in and out of the market, the firehoses and the toilets.

Once the water has been used it is collected and travels through a set of filtration pipes. These filtration pipes filter rainwater collected from the gutter, water that is wasted when cleaning the fish and the market, and all the sewerage collected throughout the market. The figure below shows how the water is supplied to the market and how it is filtered once used.

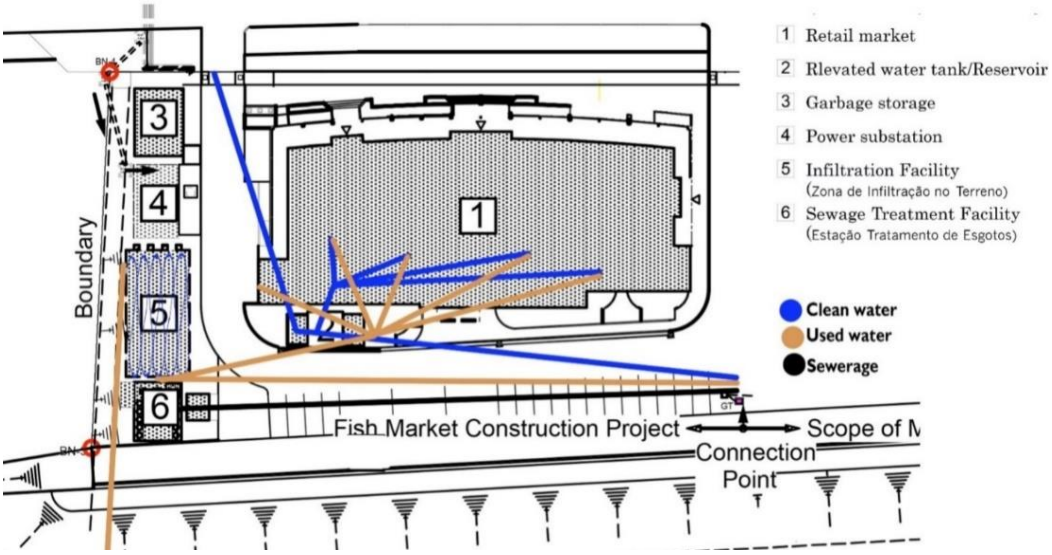


Figure 91: Water systems in the market.
Source: *Municipal* de *Maputo And Author*

Once the water has been filtered through the filtration pipes, it is then released into the sea as non-toxic water and waste. All the restaurants have water meters that monitor how much water is used and are then charged accordingly.

The rainwater is collected off the pitched roof. This water is however not utilised as it is filtered and lost to the sea. There is potential to collect the filtered rainwater that could then be used to clean the fish and water gardens or even flush toilets.


Figure 92: The roof layout and gutter systems.
Source: Author

Water in Maputo is a vital resource that is limited and many people have limited water to live off. This just shows the importance of saving this resource as much as possible through smart design.

The market with the ventilation in the roof, high ceilings, constantly open doors for ventilation and the ice to keep the fish fresh, keeps the area a cool temperature in an extremely hot environment.

5.3.3.2 WASTE SYSTEMS

Maputo waste systems are a huge problem as most sanitation and general waste is either pumped into the ocean or dumped in landfills around Maputo. The fish market has its own waste disposable point located on the east side of the market. This has a refrigerator and bins that store both organic and general waste. The seafood waste is stored in the refrigerator till a truck comes from the municipality. Most waste in Maputo is not recycled, therefore contributes to large amounts of pollution. In the last three months there have been huge problems with people getting sick from living near waste.

Figure 93: The waste area located in the market.
Source: Author

This waste area is in close proximity to the road and the service entrance, allowing easy access for the truck to come and remove the waste, as seen in the image above.

5.3.3.3 ENERGY SYSTEMS

The energy, like the water meters, is on a pay as you go system and is managed by the market staff. The water system is an advanced system that requires pumps that run on electricity. Lighting throughout the market and restaurants needs electricity. The ice machine requires electricity to generate ice and then keep it frozen in a storage freezer as seen in the figure below.

Figure 94: Indicating the lighting system within the fish market.
Source: Author

Figure 95: The ice storage freezer
Source: Author

Refrigeration is required throughout the market and restaurant area. The electricity for the entire market is municipal electricity. There is a backup generator that runs off diesel and this is used for emergency lighting. The restaurants use both gas and charcoal to cook and prepare food.

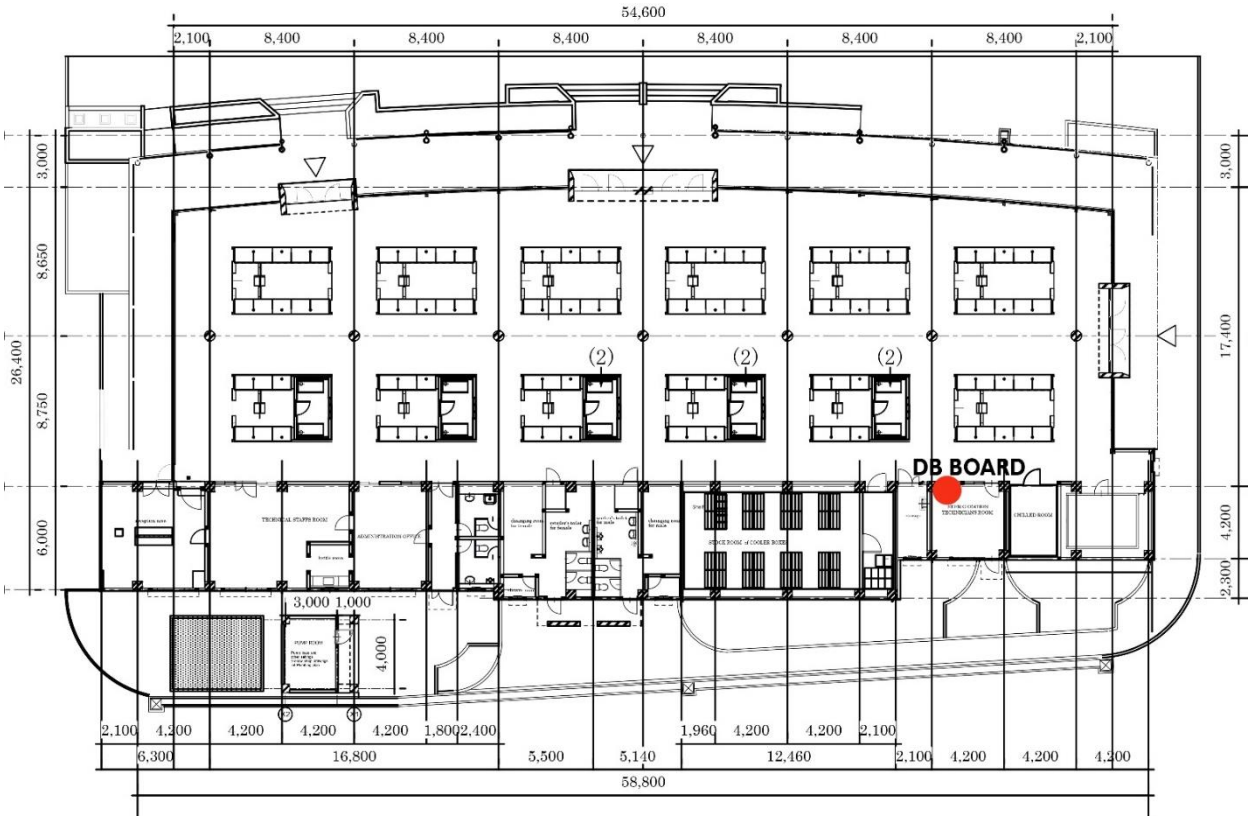


Figure 96: Indicating the location of the DB board and the fire technical room.
Source: *Municipal* de *Maputo*

The seafood market, being a larger and government-run market, has sufficient electricity whereas the smaller less formal markets located in Maputo have little if any access to electricity and facilities such as water and sanitation. All the energy that is used is electricity and therefore non-sustainable.

Maputo has a lot of sunlight and high potential for the utilisation of solar panels. There are renewable energy options in the country – there is a new solar panel store located in Maputo. The project has started with supplying solar panels to houses and will hopefully expand to other areas in years to come.

5.3.3.4 NATURAL SYSTEMS

The market has little natural vegetation other than a couple of trees located in the restaurant area of the market. These trees are still small and can be seen in the figures below.

Figure 97: Indicating the tree layout of the market
Source: googleEarth.com

Figure 98: The trees located in the market separating two restaurants
Source: Author

5.3.4 TECTONICS

Markets have a distinct science when being designed. This market's design uses large entrances as explained above, to invite people into the space. These large entrances give people the feeling of being connected to the environment due to the light filtering through the building, the sky lights and the large glass entrances. These open light spaces give one a different feeling to those of a large shopping mall with artificial lighting. Even though the Maputo market is a formal building that can be locked up at night, it still gives people a sense of connection to nature.

5.3.5 MATERIALS

The Maputo climate is similar to Durban, with hot summers and cool winters. The design of the market allows for shaded spaces. There is a small amount of vegetation, growing in the restaurant areas that will eventually create some shade, however presently umbrellas are being used to shelter customers at the restaurants. A formal building protects the seafood traders. The buildings glass façade as seen in image below allows for natural ventilation within the building. There are top windows that allow hot air to move out and light to penetrate into the market.

Figure 99: Indicating light and ventilation
Source: Author

The materials used are brick and steel sheeting for the roof. The building has a very simple construction method due to the economical standing of the country. These materials create a clean simple and effective building. The materials used are extremely durable as the building is located on the beachfront and is exposed to high moisture content in the air at all times.

Figure 100: Indicating the use of materials
Source: Author

Floor and work spaces are made of screed and concrete. This makes the surfaces easy to clean. If the surfaces are not constantly cleaned and maintained the market will start to smell and become unpleasant. Not maintaining and cleaning a fish market in a hot climate like Maputo, will potentially create an unpleasant space. The Maputo market is however well maintained and cleaned on a regular basis preventing any smell to make the space uncomfortable. This is a good example of a well-run and maintained market. The built-in work tops also prevent water from seeping into spaces under movable furniture or cracks where it can't be reached.

5.3.6 EXPERIENCE

The location and function of the market together with the locals who supply it or frequent it contributes to the rich fishing culture within the building. This culture can be seen not only in

the fish that is brought to the market but how the food is prepared and sold in the restaurants. There is a rich Portuguese tradition that comes through in the cooking of the food.

Figure 101: Cooked Portuguese clams served at
a restaurant in the market.
Source; Author

The number of tourists moving through the market creates potential for smaller local traders to make a living, as seen in the figure below. Traditional products are sold outside the market adding to the local community and allowing people to buy local products made by these local traditional communities.

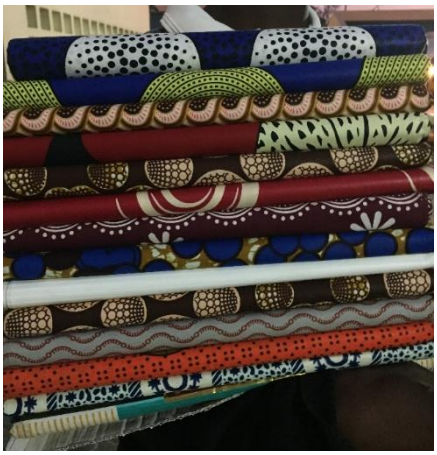


Figure 102: Traditional fabric made by the locals
Source Author

Due to the good management and maintenance of the market, the seafood that is sold at the market complies with strict regulations and is of a high standard. Seafood, if fresh, does not have an overwhelmingly fishy smell. The market is kept clean and all the fish gutting is done in closed rooms or outside the market. All the water is cleaned through filtration pipes and then pumped into the sea.

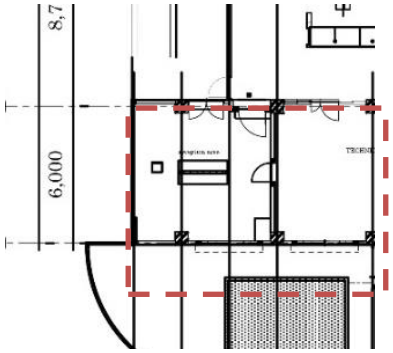


Figure 103: Indicating the cleaning space.
Source: *Municipal* de *Maputo*

The market has strict trading regulations that make it different to the last Maputo market. In the old Maputo seafood market, the traders were allowed to meet the customers at the door with live seafood and this created a social experience. In a controlled setting, this could potentially create a connection between the buyer and seller, however this was very overwhelming to some people. There is a fine line between being comfortable and being overwhelmed. Traders need to connect with the sellers. A middle line between the two markets could work, making a memorable social connection, while not overdoing it.

Figure 104: New seafood market with little connection between the seller and the buyer.
(Source: Author)

Figure 105: Old seafood market in Maputo with a seller displaying her products.
(Source: https://sites.google.com/site/heatherleila3/maputo)

5.4. WARWICK FISH MARKET

5.4.1 LOCATION AND HISTORY

Warwick Junction is in the main transport hub of Durban. It is located in the Durban central business district (CBD) and the market is located to the east side of the area.

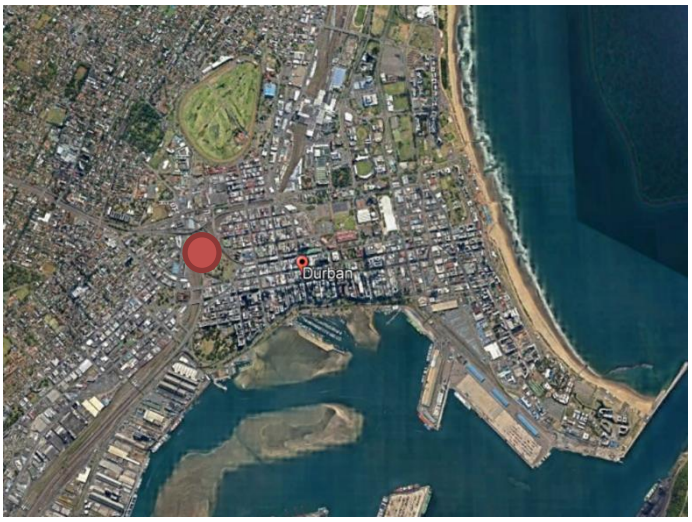


Figure 106: Location map of Warwick fish market. Source: GoogleEarth.com

Figure 107: Location map of Warwick fish market. Source: GoogleEarth.com

Historically, the South African government and authorities wanted to remove street vendors from the city and any places of importance (Working in Warwick, 2009: 1). These traders were seen as a nuisance and were banned from trading in certain places. This was monitored by regulations and forceful and sometimes violent removal. Warwick, with time, has developed into a positive space where trading is enhanced and helps local people and communities earn a living. The design of the market has been approached differently, where the needs of the people are explored rather than focusing solely on the infrastructure and buildings (Working in Warwick, 2009).

Warwick has one of the most diverse spaces for vendors in Durban (Working in Warwick, 2009: 5). Statistics received from Working in Warwick indicates just how many people move through the space: 460 000 people walk through every day; 300 buses and 1 550 mini bus taxies depart from Warwick every day; 166 000 public transport passengers use Warwick; 38 000 vehicles drive through Warwick every day; and between 5000 and 8000 people trade informally in the area (2009).

The fish market was designed in 1910. This was one of the first markets in Durban. It was aimed at accommodating small-scale traders. However the market unexpectedly burnt down and forced the traders to move next to what is known today as the Early Morning Market. The market was however rebuilt and the fish market moved back. There are a large number of traders who have worked and created family businesses in this market for generations.

The fish market has a variety of customers who use the space and because of its rich history and heritage, it has families who have supported the market for generations. There are a variety of products sold in the market.

The market is half private and half government-owned and is maintained by the body corporate. The population in Warwick has not drastically changed and the market has reached its maximum capacity.

5.4.2 URBAN REALM

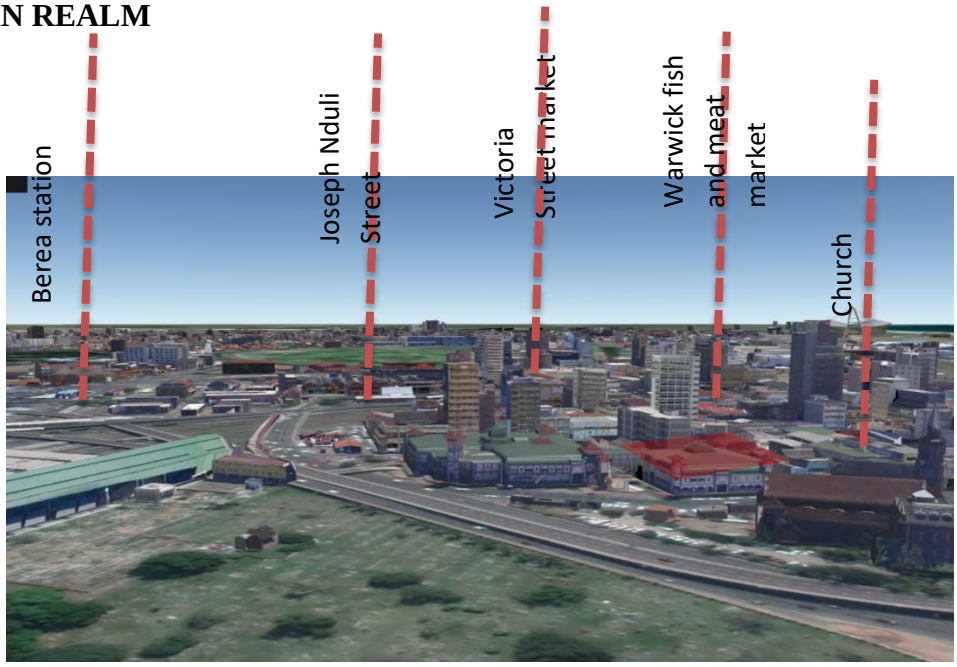


Figure 108: Surrounding context
Source: GoogleEarth.com

Warwick is a multifunctional, multicultural space. This can be seen in the image above. There are religious buildings, a train station and a taxi rank all in close proximity to the market. The market is located in the CDB, creating another connection.

5.4.2.1 Place to Expand

As seen in the image above the area has an extremely dense urban fabric. There is little space in the immediate area to expand as there are buildings located on all sides of the market.

However the building itself at this point shows no need to expand as there are numerous empty stalls available in the market. This was observed through the observation sheets.

5.3.2.2 Market spatial Planning

There are thirty three stalls located in the market. These shops are positioned as indicated below. The shops range from a simple informal space to a more complex formal space as seen in the figures below.

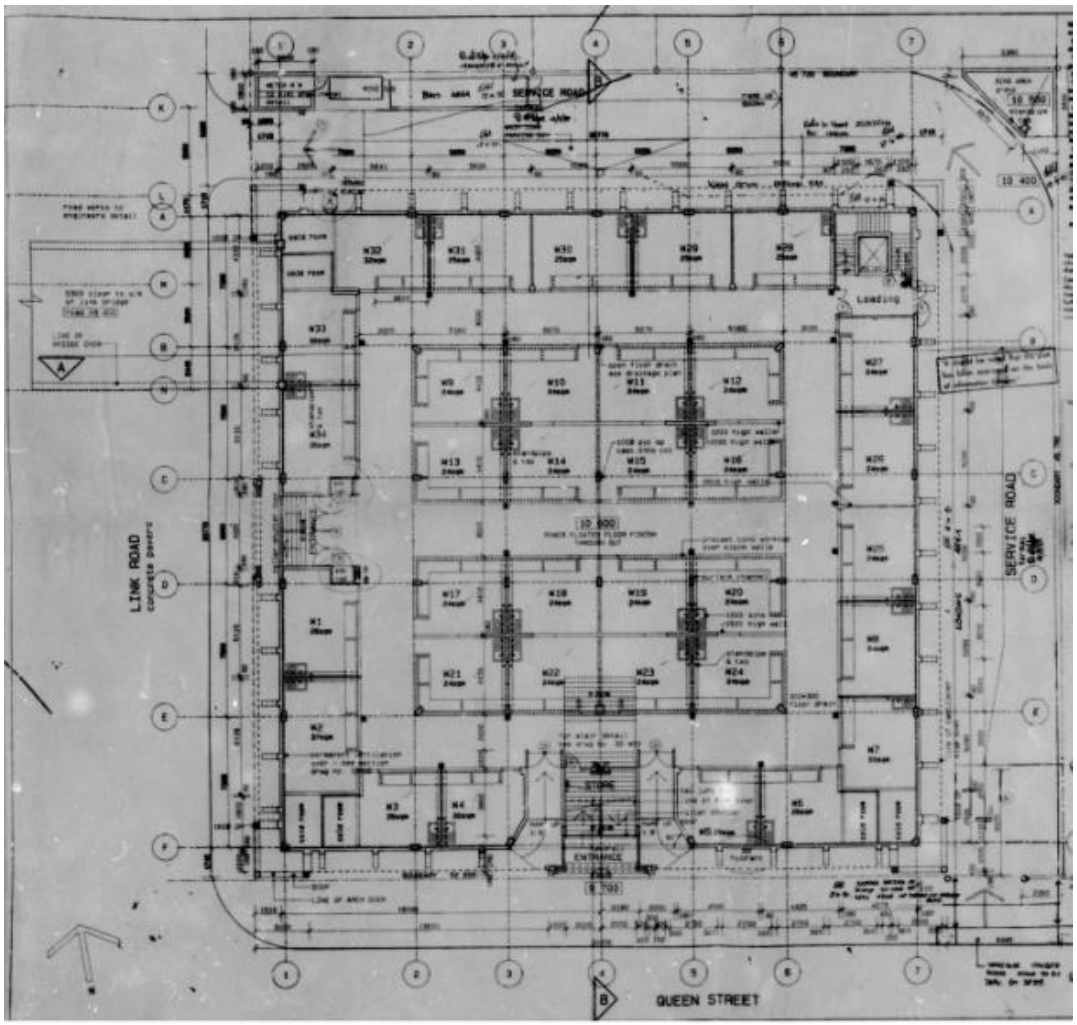


Figure 109: Indicating the layout of the Fish market
Source: eThekwini Municipality

Figure 110: Inside the market
Source: Author

Figure 111: informal trader trading outside the market entrance
Source: Author

The figure below shows all the entrances to the market. These entrances are used for removals, deliveries and are all equipped with ramps. The ramps make the market compliant with regulations regarding the disabled.

The style of the architecture has a historical component, as the first market was designed over 100 years ago. The market has a neon, Islamic architectural style. The market also has large entrances as in old traditional buildings.

Figure 112: Indicating the Neo Islamic Architecture
Source: GoogleEarth.com

Figure 113: Indicating the entrance to the market and the architecture of the market
Source: Author

5.3.2.3 TRANSPORT AND ACCESS

The market being located in Warwick allows easy access. There is a taxi rank and train station all in walking distance to the market. This can be seen in the figure above where there are taxis lining up in front of the market. Most of the people working in the market however do have their own cars but many customers come to the market by public transport. There is also a parking area just west of the market allowing people to access the market by car. This

information was accumulated through the three respondents who were interviewed in this case study. Respondent 1 stated:" I get the taxi".

Respondent 2 stated: "Taxi is easiest".

Respondent 3: stated "I share a personal car with my brother and he brings me to work".

5.3.2.4 WHAT ATTRACTS PEOPLE TO THE MARKET

Warwick fish market attracts people due to generations of customers using the same market. Their market is also in Warwick meaning that people move through the area on their way home making the market a convenient place to shop for food on one's way home. The market however being in the perfect spot has deteriorated with time making it unpleasant to shop there. There is huge potential to renovate and maintain the market. This information was accumulated through the three respondents who were interviewed in this case study. All three respondents suggested that people come to the market due to its historical status.

Respondent1 stated: "I come here because my family has come here for years and years".

Respondent 2 stated: "A family friend works here so I come to see him".

Respondent 3 stated: "The market has been here for so long. Every time I need something I just come in and get it when I pass".

5.3.3 SYSTEMS

5.3.3.1 WATER

Each store has running water supplied. This is included in the store's water and levy bills that are supplied by the municipality. There are various tap points located around the market over and above the taps located in each store.

In South Africa, the water is purified before it is distributed through taps and water supplies. This makes the water of high quality and expensive. There is huge potential to grade water, depending on the need. Harvested rainwater can be used for various activities such as flushing toilets. By grading water and activities, we can reuse water rather than waste such a vital resource. These taps are used for the fire equipment and general cleaning, as per fire regulations. The equipment is all serviced on a regular basis.

5.3.3.2 WASTE

Each store has a bin located in the store. Stores receive one bin a day. There are staff members organised by the body corporate who move around the market collecting waste. This is a good use of people as a resource to make sure that the waste is removed from the market. Once they

have collected the waste, it is placed in waste bins located in the parking area of the market where it is stored. In this area you get waste pickers who come and sort through the waste. The remaining waste is then removed daily by municipal garbage removal trucks. The position of the waste area in the parking lot creates easy access for the trucks.

In the fish market, not one person interviewed recycled. Therefore all the waste, other than what the waste pickers collect, ends up in landfills. In the seafood market there is potential to reuse the waste.

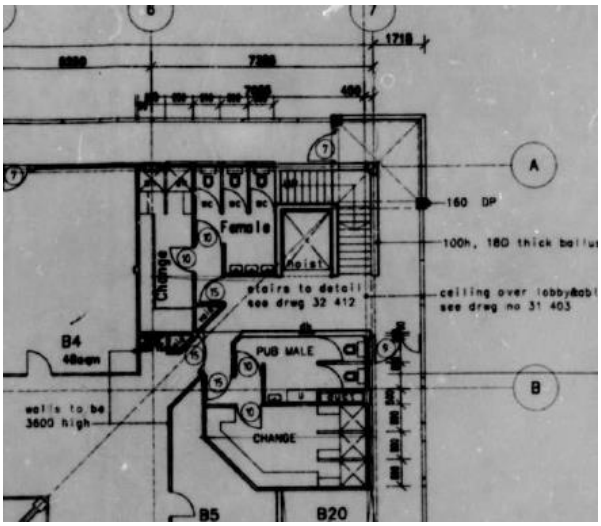


Figure 114: Indicating the layout of the toilets in the market
Source: eThekwini Municipality

Figure 115: Image showing the location of the waste area
Source: GoogleEarth.com

There are toilets located in the market; these are only for people who work in the market and customers of the market. Toilets are also used as staff change rooms.

In Warwick, people are used as a resource – this can be seen in both the porters who are hired to move goods from one part of the market to the other, as well as waste pickers who collect recyclable materials such as cardboard, plastic and glass, which are then sold to depos around

Figure 116: Cardboard Waste picker
Source:https://aet.org.za

Figure 117: A porter doing a delivery up the delivery and disabled ramp
Source Author

the city. Porters are seen throughout Warwick and are used by customers, traders and wholesalers. They weave through the people and sometimes work from about 4am till 9pm (Working in Warwick, 2009). When work is slow, one can often find the porters chatting, or sleeping outside the early morning market. There are two types of porters: the first move lighter loads often in shopping trolleys and the second are barrow operators. These porters have a great deal of physical strength as some of the loads can weigh up to 300kg at a time (Working in Warwick, 2009). All porters need to know where their clients store their goods and often work with traders to deliver their goods before their clients get to work. Other traders will guard the goods till the client gets to work.

Waste pickers and cardboard collectors are at the bottom of the employment chain. These cardboard collectors and waste pickers supply a middle man who then delivers the recyclable materials to recycling companies. Most of the cardboard gets sent to Mondi. These people are among the poorest people working in Warwick. They are often over looked and their contribution goes unrecognised, however they have a huge impact on both the city and the environment as they collect and recycle about 30 tons of cardboard alone per day (Working in Warwick, 2009).

5.3.3.3 ENERGY

Each store has a ‘pay as you go’ electrical meter and is responsible for its own usage. There is no sustainable energy supply in the market. All energy that is used is used directly through the municipality. There are a large number of cold rooms, freezers and fridges that are constantly running. Some stalls have a cold room a freezer room and display fridges and freezers. These all run off the electrical connection of the store.

Figure 118: Image of the freezers, cold room and display fridge.
Source: Author

Along the passages there are lights. There is potential for cooking food within the market as there is nowhere in the fish market that sells cooked food. In terms of renewable energy, Richard Dobson argues that solar panels are an effective way of generating energy but due to the value of the solar panels in an area such as Warwick, the panels are stolen and need to be replaced on a regular basis, costing more than the benefits they generate.

5.3.3.4 NATURAL SYSTEMS

Due to the location and design of the building, there are no trees or vegetation in the market. The building is locked at night for security reasons. There are no natural systems present within the market other than the fact that the resources sold are often natural organic resources.

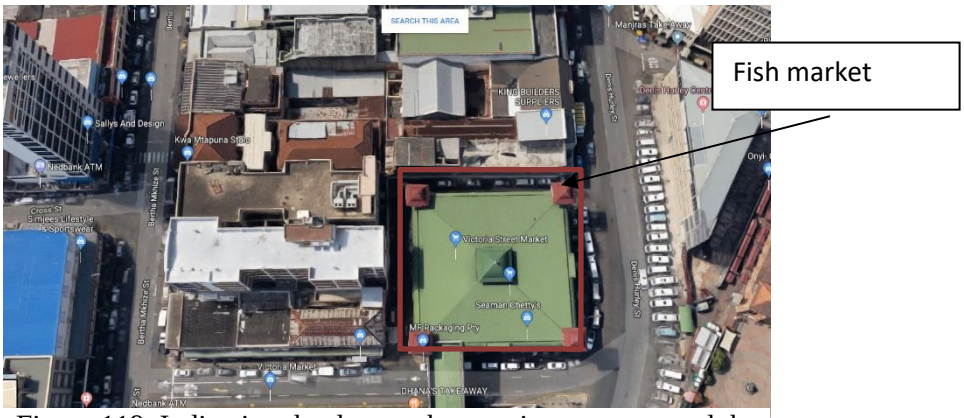


Figure 119: Indicating the dense urban environment around the market with no vegetation
Source: googleearth.com

5.3.4 TECTONICS

This building's tectonics is slightly different to that of the Maputo seafood market. This building is designed more like a shopping mall that breaks the connection to people and the environment. There is no natural light penetrating into the building. All the light is mechanical lighting. This makes the space feel less open and, with little ventilation, makes the space feel extremely stuffy. This design is a poor design for a seafood market as smell once trapped in the building with no ventilation can make the space feel very uncomfortable. This is even worse on a hot day in Durban.

5.3.5 MATERIALS AND EXPERIENCE

The climate in Durban makes it vital to have shelter within a market. The market itself is located in a completely closed building. As mentioned, the building has little light and ventilation. The market relies on electrical lighting during the day. There is also very little ventilation to move the smell of both the seafood and the meat, making it vital for the produce to stay fresh and

clean at all times. If the produce is not kept fresh, the smell can become overwhelming within the market.

The materials used are concrete with brick infill panels that are plastered and painted. The roof is corrugated iron. These materials are durable and easily cleaned. The building itself is low maintenance, making it extremely effective, as seen in the image below.

Figure 120: No windows along the ground floor.
Source: GoogleEarth.com

When entering the market there were very few customers, and there was very little to no natural sunlight, creating a feeling of being in a dark, dingy space. The maintenance and cleanliness of the market was lacking as the market had a very distinct smell of fish. As stated previously, fresh fish should smell like the ocean and this overwhelming smell should not have been there. This smell could be due to fishy surfaces or dirty water that was rotting and starting to smell.

The space makes one feel that even though the fish may be fresh, the environment does not seem fresh and clean – perception is very important when dealing with food. This emphasises the importance of hygiene for not only the fish but the entire environment, including waste water that has been exposed to the fish and may be causing a bad smell. There are also various stalls that are vacant in the market making one feel that the space is deserted.

The floor material is screed like the other two markets. This material is durable and easy to move goods in and out, as well as clean.

CHAPTER 6: PRECEDENT STUDIES

6.1 INTRODUCTION

This chapter explores two precedent studies that deal with buildings that have strong relationships to sustainability, socio-ecological systems, or critical regionalism. The first example shows how ecological and sustainable systems can be brought into architecture, and for this the Vancouver conference centre was explored. Secondly, critical regionalism is explored and the use of raw materials and the site; this is done through the analysis of the Bamboo Sports Hall for Panyaden International School. These buildings will be critically analysed in order to understand how people, nature and location interact together. Both examples relate back to the main theories of this research: socio-ecological systems and critical regionalism. These precedent studies come from different countries, architectural styles, context, culture and natural ecosystems, therefore introducing a margin to generate comparatives. The objective of this research is to see how people deal with culture, context, nature and the connections between them. These aspects, along with the literature review, will help generate a conclusion and final design.

6.2 VANCOUVER CONFERENCE CENTRE

6.2.1 HISTORY

The conference centre is located in Vancouver, Canada, with amazing sea, mountain and park views. This building was designed by LMN, DA Architects & Planners, Musson Cattell Mackey Partnership (MCM) and completed in 2009. The building aimed to bring natural ecologies, vibrant local culture and the built form together through integration and architecture (LMN, 2011).This building is designed to soften the water's edge through architecture. The main concept of the design is sustainability and understanding the connection between natural ecologies and architecture (LMN, 2011).

6.2.2 JUSTIFICATION OF PRECEDENT STUDY

The site of the Vancouver convention centre is similar to that of the Durban Harbour. They are both located along a waterfront and are connected to a large CBD. The new Seafood market will be located along the waterfront and will be connected to the Durban CBD. The Vancouver Convention Centre, being located on the water, explores sustainable ways of improving the surrounding water quality. LMN architects understand and explore the connection a positive symbiotic relationship has between architecture and the ocean. They have explored not only the movement of people but also the movement of fish below the

building, adding another dimension to the building and allowing the building to stand out above others. It makes this precedent study the perfect precedent for both the research document and the final Seafood market design. Systems within the building have been explored greatly and will be analysed in depth later in the chapter. One of Durban's largest problems is the lack of sustainable systems, making the dimensions seen in this building a possibility to be analysed and used within the Durban harbour.

6.2.3 URBAN REALM

6.2.3.1 TRANSPORT

The site is in close proximity to the train station as can be seen in the image below. It is also in close proximity to the city as well as bike tracks and walkways that connect the building to downtown Vancouver, making the site extremely accessible. There is also a sea bus that connects the site to surrounding areas as seen in the image below.

The design also comprises of 130 000 square feet of new walkways and open public space that connects the site to the sea and the city (LMN, 2011). It extends to the Vancouver waterfront park and enhances the public area along the water's edge. This project was designed to uplift the harbour as well as the surrounding spaces. The project doubled Coal Harbour's open space, and improved the pedestrian and bikeway that connects downtown to Stanley Park (LMN,

2011). It not only connects people to their surroundings, but rehabilitates the harbour and brings the salmon migration path through the harbour. The building has extended outdoor social

Figure 122: Image of the outdoor seating areas
Source: https://www.vancouverconventioncentre.com

spaces that connect people to the waterfront, as seen in the image below. These pockets of public space connect to the surrounding community. The exterior terraces and green roof allows a public social space, while creating an informal and cultural gathering space for the community (LMN, 2011). The project also allows space for future ecological development (LMN, 2011).

This space accommodates float boat activities and a terminal (LMN, 2011). The building creates a green park and allows views from the CBD through the building to the sea and water. From the building there are dual views of the city as well as sea views.

6.2.3.2 SPACE TO EXPAND

Due to the building being located on the waterfront there is space for it to expand over the water. The building hugs the coast line with a dense urban fabric pressed against the building, making the water the only space to expand, as seen in image 122.

6.2.4 CLIMATE AND MATERIALS OF THE BUILDING

Due to the climate and the location of the building, cool air (from the ocean breeze) is able to flow throughout the building. The building is shaded by tall towers located on the south side.

Figure 123: Image of the entire building and promenade
Source: https://www.archdaily.com

Figure 124: Glass façade and connection to the water
Source: https://www.archdaily.com

LMN architects designed underfloor piping that uses solar heating and is able to cool or heat the building depending on the need (LMN, 2011). The heating and cooling of the building is by renewable hydroelectricity generated by the ocean (LMN, 2011). The façade of the building is made of glass on all sides to allow the flow of light, views and to create a connection to the city fabric and the waterfront as well as allowing a connection between internal and external spaces (LMN, 2011). The west façade of the building allows for opening and closing windows that allow natural ventilation under appropriate conditions. The flooring allows air circulation without significant energy being used.

6.2.5 SYSTEMS

The building has the largest living roof in Canada, hosting over 400 000 native species of plants and grass (LMN, 2011). The roof is also home to animal species such as bees and insects. The green roof is used to insulate the building to stabilise the air temperature, and contributes to the stormwater utilisation. The honey that is produced on the roof is used in the centre's kitchen.

Figure 125: Image of the green roof
Source: https://www.archdaily.com

The design strategies make sure that 100% of the grey and black water is treated and recycled. The bathrooms all have low flush toilets (LMN, 2011). A seawater pump system takes advantage of the close proximity to the ocean. The constant seawater temperature is used to cool the building in the warmer months and heat the building in cooler months (LMN, 2011).

The figure below indicates how nature and marine ecosystems can be integrated into architecture. This building softens the edge between the water's edge and the built form (LMN, 2011). This is done by an underwater habitat skirt or artificial reef that creates part of the building's foundation, and creates habitats and ecosystems for marine life, such as barnacles, mussels, seaweed, starfish, crabs and various other marine species (LMN, 2011). LMN Design Partner, Mark Reddington, FAIA, notes that:

The Vancouver community's commitment to sustainability allowed us to develop a rich and diverse integration of the building program, natural ecology, local culture and urban context, and weave them together into a unified vision of sustainability.

6.2.6 TECTONICS

The design of the building is more like that of a mall. It has large glass windows that can be opened onto the ocean. People sitting in the ocean front restaurants still have a connection to the ocean and nature. The design has also incorporated nature into the building itself. The closed building in a densely populated area shows strong connections to both the sea and nature. The flat roof generates its own ecosystems and a space where people can be one with nature with the amazing ocean view.

6.2.7 SOCIAL CONNECTIONS AND THE USE OF THE BUILDING

The convention centre comprises of exhibition space, meeting rooms, a ballroom area and retail space. There is also a walkway, bikeway, public open space and plazas (LMN, 2011).

This multifunctional space connects people, and is used as a transition space between the city and the ocean. The building is used for both public and private events. It shows Vancouver's commitment to sustainability and sustainable technologies (LMN, 2011). One of the main objectives of the building was to make sure that it did not obstruct any views from downtown streets (LMN, 2011).

Figure 126: showing how the building does not obstruct the downtown street views
Source: https://www.archdaily.com

The green roof acts as a green transitional space between the city and the views of the down town streets.

6.3 BAMBOO SPORTS HALL FOR PANYADEN INTERNATIONAL SCHOOL

6.3.1 HISTORY

The brief of the project was to design a hall to accommodate 300 students. The project is located in Hang Dong District, Thailand. The school was designed by Chiangmai Life Architects (CLA) and was completed in 2017. This hall had to blend into nature and its surroundings and reflect the culture of its local people, as well as having a modern component. The design was based on the lotus flower that is a symbol in both Thailand, and the Buddhist religion (Chiangmai Life Construction, 2017). Bamboo was the primary material used to maintain the school's low carbon footprint (Chiangmai Life Construction, 2017).

Figure 127: Image showing the magnificent bamboo structure that spans over 18m.
Source: https://www.archdaily.com

6.3.2 JUSTIFICATION OF PRECEDENT STUDY

Even though the school is located inland, Thailand has a subtropical climate similar to that of Durban, where the summers are extremely hot, making this precedent an effective precedent to explore. The building techniques use completely raw materials that will be explored later. This way of construction has a beautiful aesthetic look with all the structural supports being visible. These will be included in the researchers design. An understanding of the structure of the building will be emphasised in the design. No part of the building is hidden. Everything is visible and people using the space can understand how the building is designed and built. The building also shows an understanding of the surrounding context and climate creating no need for mechanical ventilation. All the systems are natural. The wind cools the building with large overhangs that protect the interior from the sun.

6.3.3 URBAN REALM

The site plan below shows the design of the school in the natural context around the school.

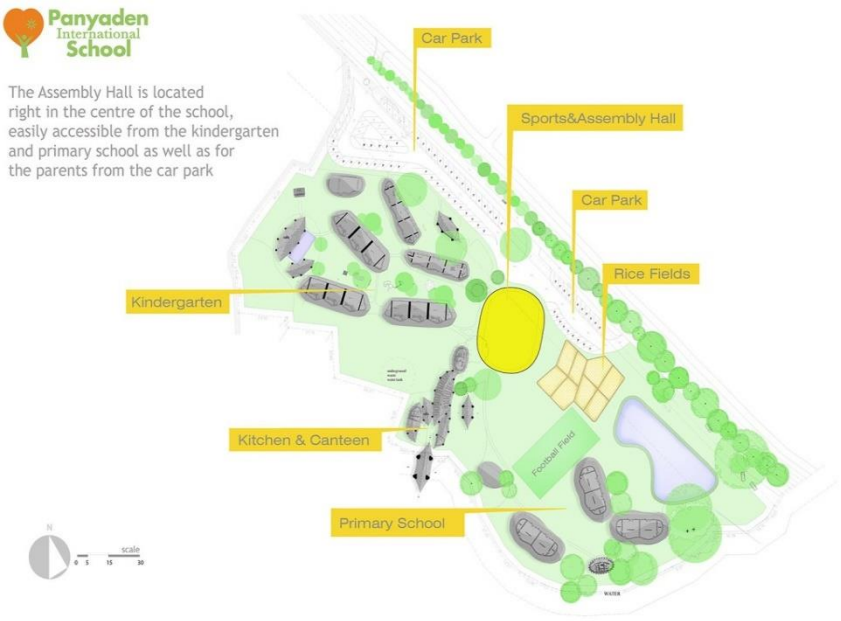


Figure 128: Site plan of the school.
Source: https://www.archdaily.com

The sports hall is located in the centre of the school creating a buffer between the primary school and kindergarten. Also in the middle are the kitchen and canteen which are shared between the primary school and kindergarten. Children's age groups need to be separated, therefore this school layout allows both the kindergarten and primary school to share the facilities at different times, maximising the use of the building whilst achieving the separation that is needed.

6.3.3.1 SPACE TO EXPAND

The site is located in a densely vegetated area, tying into the concept of being one with nature. The buildings are widely spread, allowing space for the school to expand when needed. Image 128 above shows just how widely spread the buildings are.

6.3.3.2 TRANSPORT

The school is located in the city of Chiang Mai. It is located on the North side where there is adequate public transport systems making the site accessible to the public. The school is also located close to the Chiang Mai international airport. This makes the school accessible globally.

6.3.4 CLIMATE AND MATERIAL OF BUILDING

Bamboo is the only material that is used in the sports hall (Chiangmai Life Construction, 2017). It is used to absorb carbon, and as a result this building generates a zero carbon footprint. With the materials and the design, this building is estimated to last for at least 50 years (Chiangmai

Life Construction, 2017). The design has an organic modern feel with 21st century engineering and building materials as seen in the figures below (Chiangmai Life Construction, 2017).

Figure 129: Image interior with students.
Source: https://www.archdaily.com

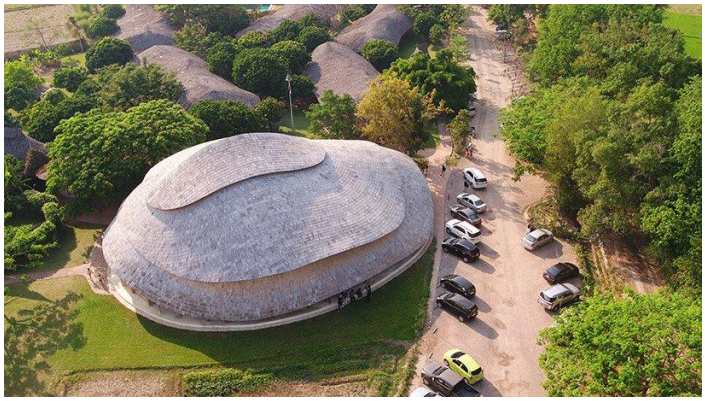


Figure 130: Image of an Aerial view of the hall showing the organic lotus flower design.
Source: https://www.archdaily.com

6.3.5 DESIGN

6.3.4.1 TECTONICS.

The hall is built to be open to the elements. The concept of being connected to nature has been captured well in the technical design of the hall. Figure 129 above shows how the building allows wind to cool it. The technical building design has an amazing effect on how people connect to the environment yet still fell protected from rain. This design shows a building can successfully connect with nature and use nature to cool and heat the building.

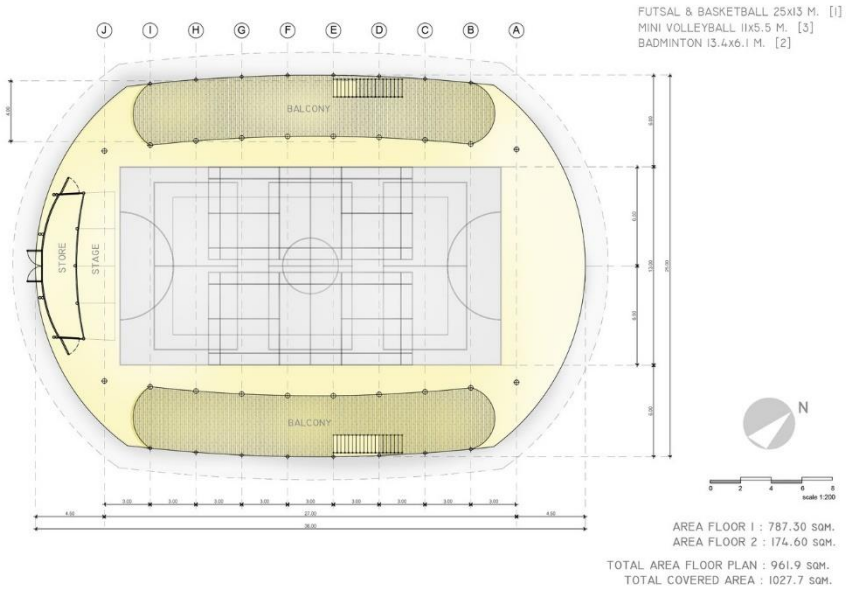


Figure 131: Plan of the sports hall
Source: https://www.archdaily.com

The entire hall is covered. There is space for basketball, futsal (a variant of soccer), volleyball and badminton (Chiangmai Life Construction, 2017). There are also storage facilities located behind the stage. The hall is designed to utilise the natural elements such as light and wind, which insulate, ventilate and lighten the building (Chiangmai Life Construction, 2017). This structure is cool all year round. The bamboo adds a pleasant aesthetically to the structure. This structure was designed to withstand the harsh external forces such as high wind speeds, earthquakes and harsh natural weather and forces that occur in this region (Chiangmai Life Construction, 2017).

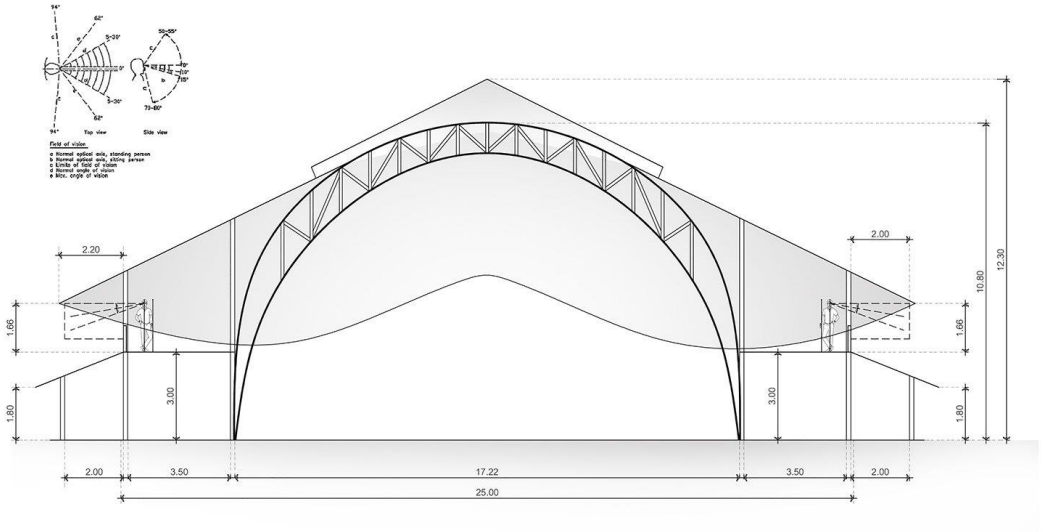


Figure 132: Section showing the construction of the hall and the bamboo technology that has been passed down from generation to generation.
Source:https://www.archdaily.com

The roof is supported by bamboo structured trusses, as seen in the section above. This detail shows how flexible the bamboo is and the shapes that one can achieve whilst keeping the structural integrity of the material. Being located in Thailand, bamboo is material that is present and widely available and sustainable, as it can be cut without destroying the plant.

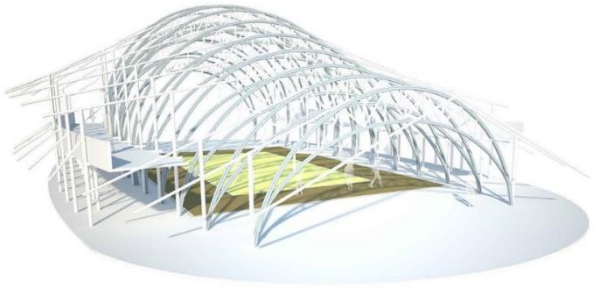


Figure 133: Indicating the structure of the building
Source: https://www.archdaily.com

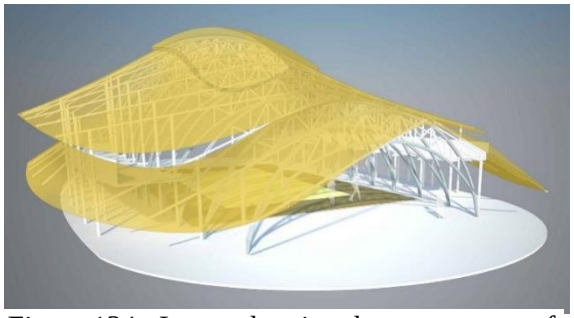


Figure 134: Image showing the structure, roof and floor of the building in different colours
Source: https://www.archdaily.com

The availability cuts down the cost of transport. Bamboo has been a building material for centuries and the design has a strong link to traditional Asian construction with a modern twist.

Concept sketches show the design of the roof and how the roof utilises natural resources such as sun and wind to light, ventilate and insulate the building when needed.

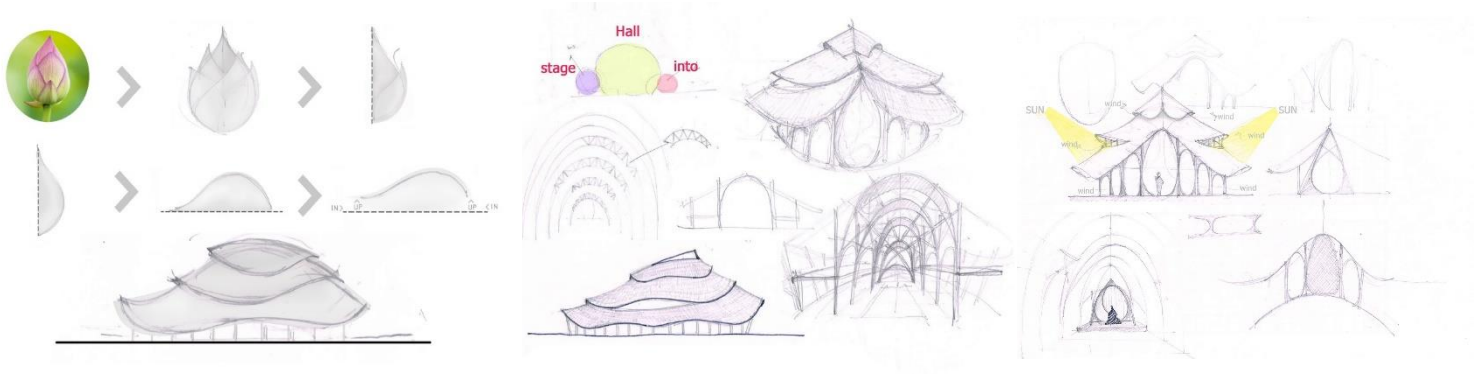


Figure 135: Concept sketches of how the building was designed with the concept of the lotus flower and the ancient structural technology
Source: https://www.archdaily.com

The lotus flower is significant in the Buddhism culture as it signifies purity and beauty (Ward, 1952:137). The flower blossoms from the mud creating a beautiful flower above the mud. The lotus flower also represents the earth (Ward, 1952:137). By understanding this, one can see the concept of being one with nature coming through, and the use of a symbolic flower as a concept of the design.

6.3.6 SOCIAL CONNECTIONS AND THE USE OF THE BUILDING:

This school was designed as a Buddhist school that teaches more than the average school (Chiangmai Life Construction, 2017). This low carbon footprint school teaches children how to live ecologically and the importance of this natural life, making the design imperative to the lifestyle these children are exposed to (Chiangmai Life Construction, 2017). The main aim of the school is to allow a holistic way of teaching these children to protect the earth, as well as educating them through a half Thai, half English school curriculum. This sports hall is a multifunctional space that may be used for school sports games or events.

Due to the choice of natural materials, one feels a strong connection to nature, even when within a structure. The passive design techniques and building style still exposes the people inside to the elements. There is a large amount of natural light that is allowed to flow into the building to heat the building when needed and then a large roof structure in summer to shade the building, while still allowing natural ventilation to move through the building to cool it. With no mechanical heating and cooling needed, the children are exposed to constant fresh air

moving through their lungs rather than stale recycled air. This ties into the Buddha's teachings and the importance of connecting with nature. This building emphasises the importance of designing for the surrounding context and community.

CHAPTER SEVEN: ANALYSIS

7.1 INTRODUCTION

This chapter investigates questionnaires and interviews undertaken by the researcher during her case studies. 9 Short interviews and 3 focussed interviews were evaluated and analysed. The researcher interviewed specialists in their fields, some who use markets, and others who make a living from the markets. The interviews were done in Durban and Maputo, showing both local and international context. The specialist interviewees were chosen due to their knowledge of markets, systems and experiences. The interviews were all extensively documented by the researcher. The main focus of the interviews was to understand the background of the interviewee and then focus on the systems and experiences within the markets.

Highlighted systems and experiences differed from one market to another as not all markets are the same and not all people experience the same thing within a space. The varying responses show the diversity of people and their experiences. There were a few answers that overlapped, usually indicating services that were lacking or what people experienced to be lacking within the market. The analysis of these interviews will be shown in this chapter to help the reader understand the study. The data is taken from the interview transcripts, seen in Appendices B and C.

Throughout this section, interviews are summarised and the key themes highlighted. Analysis on the case studies, precedent studies, and literature review will be compared to find a relationship between both primary and secondary sources. The data will analyse the key themes of socio-ecological systems, and critical regionalism.

7.2 INTERVIEWS

All three interviews were conducted in a formal environment. Each person was asked various questions. The first person interviewed was Richard Dobson, second was Prof. Rodney Harber and thirdly was Edilson Manjate.

Richard Dobson has worked in Warwick for many years and done tours through the market. He was also integral to the upgrading of the market. Recommend including that instead of simply saying he has done tours. Getting his perspective on what sustainability is and what systems are present in Warwick was extremely interesting.

One point that was highlighted over and over again was the lack of maintenance in the markets, which leads to the deterioration of systems within the area. Just improving and maintaining creates noticeable differences. Examples are the monitoring of water, and making sure waste is disposed of responsibly. He also explained behind the scene systems that are often not seen, for example how street traders pay a group of young adults to look after their merchandise at night. These are social systems that are missed during the day. The Warwick Market has people from all income brackets moving through the transport hub. Traders use what they can find on the street and make do with what they are given for their stalls.

The second person interviewed was Prof Rodney Harber. He has experience in sustainable building as well as designing markets. In his career he has always used effective functional systems when designing markets. He made the researcher understand the importance of designing for the people and using nature to achieve a goal rather than technology. The interview focused on systems used, some that worked well and others that did not. Harber, like Richard Dobson emphasised the importance of maintenance of systems, especially pumps. He emphasised the importance of using simple systems rather than complex systems. The simpler the system the less chance of it failing. This was carried out through the design.

The last person that was interviewed was Edilson Manjate. He works as a guide, doing tours through the markets in Maputo. He has a great understanding of the Maputo markets. The main focus of this interview was to understand the differences between Maputo and South Africa. In Maputo the electricity comes from the municipality and the water comes from a private company. This was interesting as most markets in Maputo don't have basic facilities and infrastructure such as electricity and running water. He emphasised problems they are experiencing with waste disposal. Waste disposal (like Warwick) is a huge problem in Maputo. Most waste gets taken to landfills, located on the outskirts of Maputo where people live. This leads to health problems and recently a slide that killed 17 people. When asked what he feels is the biggest problem in general in Maputo, he suggested maintenance and lack of infrastructure in the Maputo markets.

7.3 SHORT INTERVIEWS FINDING AND OBSERVATION SHEETS

The results of the 9 interviews were tabulated into 3 interviews per market being recorded in pie charts, as seen below.

7.3.1 URBAN REALM

The location and transport systems of an area are vital to the success of a market. If the market is not accessible for visitors or people working at the market it cannot function. The interviews revealed that people get to work in various ways. The research emphasised helping the local community. People living in close proximity to the market need to have easy access to the market. In all three case studies, people used buses, taxis, walked and a few came in their own vehicles. The pie chart below indicates (according to the case study) how people get to work at the markets.

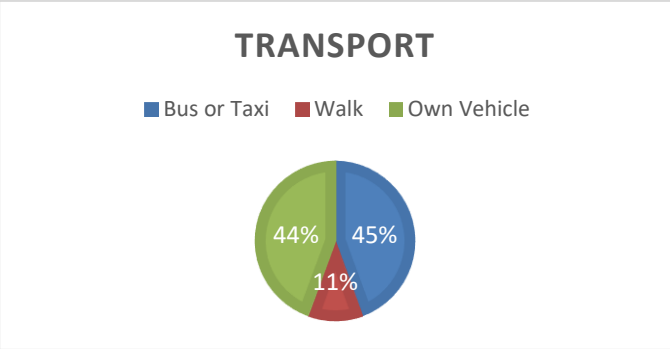


Figure 136: How people get to work
Source: Author

This shows the importance of transport and urban linkages, without them a market cannot run successfully. A market relies on access to the space. The surroundings need to be understood and parking needs to be available. If the area is not accessible and secure, people will not want to use it.

If security is good and people feel safe, the demand on the market will increase causing the market to do well and possibly expand in order to keep up with the demand. This will create opportunities for the people in surrounding areas. When a market is built, it is crucial to allow space for expansion as it grows in popularity. This can be seen at Bangladesh Market. It is spilling out into the parking lot as the demand for space increases. The market has reached its maximum capacity.

The Warwick Market on the other hand was built to its maximum capacity in terms of space, and now there are stalls available as the space is more than the demand.

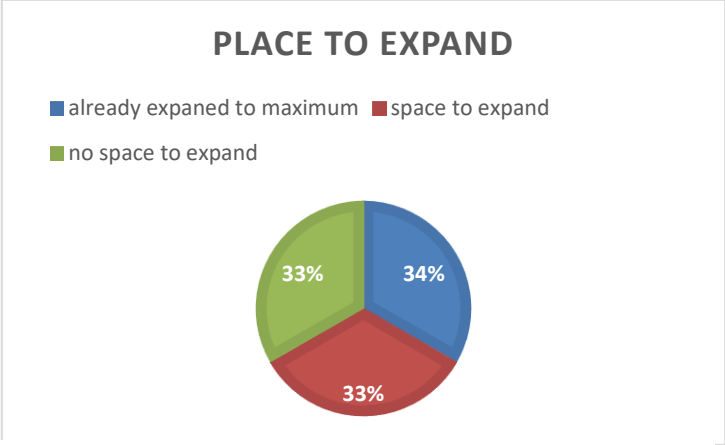


Figure 137: Is there place to expand
Source: Author

7.3.2 SYSTEMS

Systems in the markets were explored in great depth during the case studies. Recycling was however something that was not done at any of the markets. This highlights the opportunities for introducing recycling into markets both in Durban and Maputo. People in markets need to be educated on the benefits of recycling. Sometimes they are recycling without even realising it. This is evident in both Bangladesh Market and Warwick Market. In Bangladesh Market, people use the precast concrete of the fences to make their stalls and in Warwick, the waste collectors collect waste and cardboard. If awareness is created, these people could be helped by stall owners or employees when recycling. The diagram below shows the results of the interviews when people were asked if they recycled.

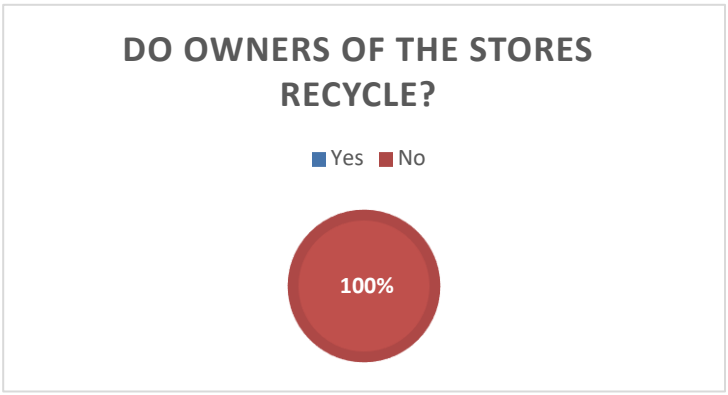


Figure 138: the lack of recycling within the three markets.
Source: Author

7.3.3 TECTONICS

The design of markets is vital. In the interviews, people were asked what they felt the markets were lacking to determine how the design of the markets can be improved. 34% of the people said that storage on site was lacking. There is very little space to store goods when the market is not open – this is a problem. When interviewing Richard Dobson, he shed light on how the young homeless men store people's goods and protect them on the streets for money in order to make a living. It shows how desperate people are for safe storage.

At the Maputo market, people were complaining that there is not adequate covered space. The climate in Maputo is unbelievably hot and the restaurants all have limited space and minimal covered areas. There are trees that are growing but are still too small to make a difference. With time they will form some more covered space, however at present the restaurant area is lacking shelter space.

People in the Warwick Market feel technology and customers are lacking as the market is in need of an upgrade and revamp. The interior is deteriorating and the lack of cleanliness in the market is quite off-putting – this shows lack of maintenance.

7.3.4 SOCIAL DIMENSION

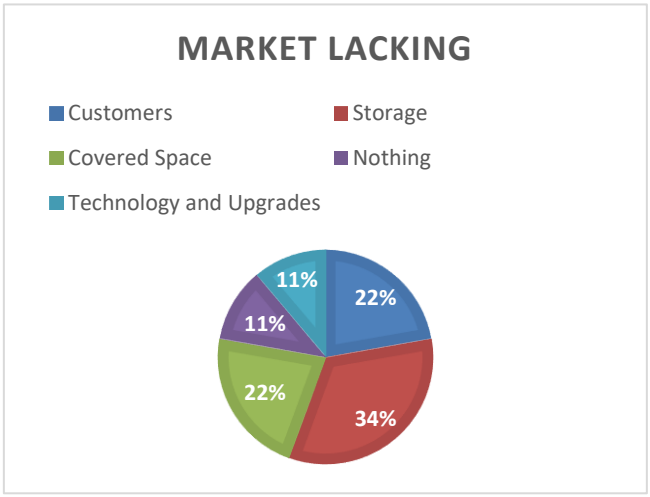


Figure 139: what people who work in the market feel the market is lacking.
Source: Author

The interviewer asked how the markets were maintained. In South Africa, markets are maintained by the municipality, whereas the market in Maputo is maintained by a private company and the municipality. Having both the municipality and a private company is an advantage as one picks up where the other is lacking. The Maputo market is always clean. They get a private cleaning company to come in and clean the market and do not have to rely on the municipality.

The municipality maintains the South African market and one can see the neglect. The Bangladesh Market is better maintained than Warwick, while Warwick is in desperate need of maintenance.

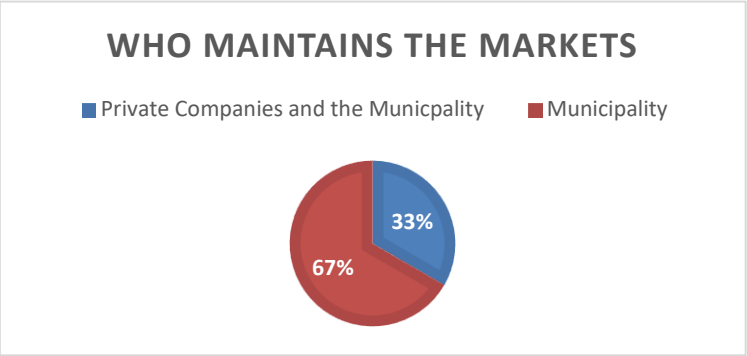


Figure 140: how different markets are maintained.
Source: Author

The figure below shows why people come to markets. 56% of the people say they come to markets for fresh fish or produce. This is evident in both the Bangladesh Market and the Maputo Seafood Market. Using markets for fresh food was discussed in chapter 2.

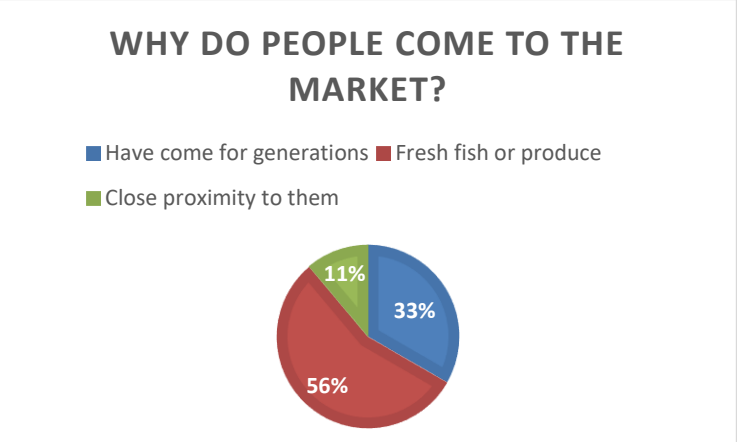


Figure 141: people come to markets for different reasons.
Source: Author

7.4 CONCLUSION

We can conclude this chapter with interesting points shared by three specialist interviewees. Richard Dobson shared his experiences of sustainability in markets, focusing on Warwick where he has done tours for many years. Professor Rodney Harber highlighted the use of simple effective systems when designing a market. Edison Manjate was able to shed light on the differences between markets in South Africa and Maputo and how we can learn from one another.

Interviews with vendors highlighted common needs experienced in all three markets. Transport, location and accessibility are crucial to all markets. Space and room for expansion needs to be taken into account when planning the market. Markets can't function without reliable systems. Emphasis was put on recycling of waste. A market should be designed for the people who are going to work there or who will frequent it. The area and people surrounding the market are crucial to its design. Bad planning and lack of maintenance has a significant impact on both store owners and visitors.

These were common issues from all three markets raised by interviewees and documented by the interviewer in the above chapter.

CHAPTER EIGHT: CONCLUSION

8.1 CONCLUSION

Throughout this research, both primary and secondary research, theories, concepts and themes have been highlighted, explained and explored. In chapter two, the history of markets was investigated. This showed us how markets started and how they are a vital part of the urban fabric (both historically and presently). Through understanding the importance of markets, the research discussed how people and the environment can benefit from positive socio-ecological systems. Chapter three also showed the importance of systems within not only a market but also the built environment, as well as how both the environment and the surrounding local community (in this case the fishing community around the harbour area) interact. The research then explored the theory of critical regionalism in chapter four. This shows the importance of local knowledge, materials, building skills and techniques. Each society has their own type of architecture and systems, some of which were referenced to show variety of local and international examples. This comparative study shows the importance of local context and the difference between South Africa and Mozambique. With the world constantly changing, there needs to be a paradigm shift in the way society understands and sees systems. These global problems such as pollution, depletion of resources and climate change we are facing needs greater awareness. Environmental concerns need to be integrated into the architecture by creating as little harm to the context and surroundings as possible. We need to see nature as our equal and encourage sustainability through systems.

This research shows how important systems are to the success or failure of a building and how people can benefit from not only man-made systems, but natural systems as well. This research also explores how people can be used as a resource. Improving how infrastructural systems connect to nature is an important way to reduce the impact society has on the environment?

Throughout the research it has been understood that nature plays a significant role in both society and architecture. With regards to context and location, nature and local society need to exist in a symbiotic way in order to live and evolve with time. This research shows that architecture and nature are both not static processes, especially when nature is introduced into the built form. With the world and environment constantly evolving and changing, architecture needs to be able to accommodate this and be able to evolve with the environment. This research shows that it can be done through systems. An example of this is correcting what society has

removed from nature and introducing it into urban schemes or the architecture itself, as seen in the Vancouver Convention Centre, or simply reintroducing vegetation or mangroves. By understanding this connection, we can show the link between the built forms that are site sensitive to local cultures and nature. This architecture will be responsive and respectful of both culture and nature.

8.1.1 TECTONICS,

In the case studies, all the markets had a specific technical design to them. They had to be designed in a way that makes people feel that the space is accessible.

All the designs mentioned in the case studies had large openings or were an open structure. The most successful designs were those of the Bangladesh Market and the Maputo seafood market, due to the fact that they have some sort of connection to nature and the surroundings. This shows how important it is for a space to have a connection to nature and the use of natural light. When connecting to nature, one wants to be able to at least see the outside world.

8.1.2 MATERIALS

Throughout the document, it was emphasised that when designing a market, the materials are an important aspect of the design. All the case studies show the importance of durable materials and flooring. With a seafood market, it is better to supply already built-in furniture, as this prevents spaces where water can sit and smell. With built-in work stations, the material needs to be non-permeable to prevent the material from soaking up water and potentially rotting. A good material that has been used in the case studies is screed and concrete. The material is low maintenance and easily cleaned.

Materials for the walls and roof need to be insulated. Glass or open walls are also vital in the design to allow the connection between the environment and people when they are in the space. This can be seen in both the Bangladesh and Maputo seafood market.

8.1.3 URBAN REALM.

Understanding the urban context in this research is vital. One needs to take into account what is located around the site, and what networks can be plugged into. One needs to understand the urban and site context and integrate that into the design. Understanding what connections are important can be seen in the Maputo seafood market. The market links with the local industry (i.e., restaurants and hotels). If the market fails to deliver, these industries would be negatively affected. One also needs to understand how the site will be accessed, what transport will be used and how. This is seen in the Warwick Market as there is a direct link to the transport node.

8.1.4 REACHING THE OBJECTIVES AND ANSWERING THE RESEARCH QUESTIONS

This section explores how the objectives of this research document were reached, and the research questions were answered. The first objective was to explore what sustainable systems exist and are currently used in markets. This also ties into the first secondary research question defining the research area: what energy, waste and water systems are currently prevalent in markets? This was achieved through the analysis of three case studies done in Warwick Market, Bangladesh Market and the Maputo Seafood Market. The systems in these markets were analysed in depth and the gap in sustainability of all three markets was explored. The systems that were focused on were that of water, waste, energy and natural systems.

Another objective was to investigate which sustainable systems promote diversity and limit negative ecological impacts. The three case studies explore sustainable systems that are present in the markets. Each market has working infrastructural systems, but effective sustainable systems are lacking and there is little being done to help the environment in most of their systems. This objective was then explored through the lens of the second research question: how can aspects of nature be integrated into the built form? The research explored how nature deals with problems of water waste and energy and then explored how people locally and globally incorporate nature into buildings through infrastructural systems. This was engaged with through the examples of using mussels and mangroves to deal with filtration, or using the sun to generate electricity.

The third objective was to explore ways in which socio-cultural wellbeing is promoted through the creation of space that is integrated with the natural environment. This objective was achieved through understanding how architecture and the natural environment can be integrated. The literature review and precedents helped the researcher achieve this objective. This connection between the architecture and the environment was created through socio-ecological systems. The literature indicates various effective natural systems such as reintroducing mangroves, and integrating natural systems such as mussels and sponges as filtration devices. These filtration devices can purify water in a harbour and make a cleaner space.

The last objective was to explore ways of facilitating a harmonious integration between man-made structures and the natural environment. This objective was achieved in this document

through the case studies, precedent studies and literature. The main precedent that emphasises this objective is the Vancouver Convention Centre. This case study emphasises how architecture and ecological systems can create a symbiotic relationship through architecture and socio-ecological systems.

The research, in its entirety, answers the final research question: how can the built form respond to sustainable systems? This document has explored how architecture and nature can be mutually beneficial through sustainable systems. Architecture and sustainable systems can work together to create a positive environmental response to global problems we are facing every day.

8.2 PROVING HYPOTHESIS AND ASSUMPTIONS

This research proves that people and nature can in fact benefit through socio-ecological and sustainable systems. This research also proves the importance of systems and how sustainable and socio-ecological infrastructural systems can be used to generate a more sustainable approach to infrastructural systems, not only in developing countries but in developed countries as well. Socio-ecological and sustainable systems are more effective systems that are more sustainable, especially when the use of local industries are used as the distance travelled is minimised.

8.3 RECOMMENDATIONS FOR SUSTAINABLE MARKET DESIGN

The following guidelines will provide insight into markets in South Africa. It is important to know both the environmental, social and economic analysis and state of the area. The literature review aimed at giving insight on the background of markets and then further on seafood markets both locally and globally. The concepts and theories were also explored in detail and how they relate to the research at hand. The literature provides insight on both positive approaches countries are taking to achieve sustainability and how sustainability is a far bigger concept and field than just architecture. The following is a list of recommendations when designing or implementing markets:

- Sustainable systems, whether socio-ecological or natural, need to be implemented in order to improve the habitat and environment for both people and nature. These systems must be able to grow and evolve with time.

- Local technologies and experiences need to be utilised to their full extent as they are perfected through generations. Appropriate architecture must be used to connect to human scale and create safe spaces for people to gather and move through comfortably.
- Connection to nature, community and local content is vital when designing a building, especially a market. This building should connect to the community and local people to encourage their involvement. Market squares allow for this connection to happen between people.
- Local resources should be used in the construction of such a market place to minimise transport cost and resources. When exploring the possibility of a seafood market the market should be close to the sea so that the fish doesn't need to be transported far.

8.4 SITE SELECTION GUIDELINES

The site is a vital factor when designing a market. The markets that are located in Durban are under-developed and are in need of sustainable infrastructure and socio-ecological systems. The site selection must be driven by utilising local materials, connecting nature and people through architecture and systems, and generating an effective sustainable seafood market that can potentially benefit both people and nature. Below are some of the guidelines that were used to select an appropriate site. The site must:

1. Be connected to the CBD.
2. Have a connection to the water's edge.
3. Be in close proximity to the harbour and Vetch's pier in order to reintroduce the lost fishing culture.
4. Be in close proximity to transport systems.
5. Reuse and adapt the existing building on the site.
6. Have a direct connection to at least one resource such as the sea.

8.5 CONCLUDING THOUGHTS

This research allows the researcher to conclude that the human race has had a huge negative impact on the environment throughout time. The research has proven that people are destroying the earth's natural environment and the oceans we rely on as a source of food. The research shows that there are ways in which humans and nature can co-exist, with minimal negative

impacts on the environment. This can be done through sustainable or socio-ecological systems. Nature is an unbelievable system that we can mimic by understanding its filtering ability for waste and water to improve our impact on the environment.

In a developing country such as South Africa we need to understand that survival often outweighs the desire to save the environment. There doesn't need to be a dichotomy between self-gain and environmental needs, they can be mutually beneficial. There is a paradigm shift that people in South Africa need to take. This can be seen in the case studies done in South Africa. There are very little to no sustainable systems present in Warwick Market and the Bangladesh Market. There is a vital need to educate people on introducing sustainable systems into their way of living. This will be done in the design of a seafood market that has an educational component that will show people how systems can potentially be used to help both people and the environment.

DESIGN REPORT

THEORIES AND CONCEPTS

SUSTAINABILITY

Sustainability was a response to the concern around environmental degradation and poor resource management (McKenzie, 2004:4). The four main authors that were explored were Joseph Fiksel, Charles Kibert, Mark Doughty, and Stephen Kendall. Fiksel's research explored sustainable systems, and Kibert, Doughty, and Kendall related sustainability to markets, architecture, and the built environment.

Environmental sustainability focuses on the environment or what can be done to reduce environmental impacts, whereas social sustainability explores the building of social capital and improving living conditions in communities in a socially and environmentally just manner (Ralph and Stubbs, 2014:72). Social and environmental sustainability involves enhancing infrastructural systems to improve conditions for people and the environment within a location, in this case a market. This Design report explores infrastructural systems such as water, waste, energy, and natural systems and how they connect with people, the environment, and architecture, and this informs a sustainable architectural response to enhance social and environmental conditions for people in markets.

Design solutions

Fish farms

Mangroves

Coral farms

SOCIO-ECOLOGICAL SYSTEMS

Socio-ecological systems can be defined as a set of social and ecological components that are constantly evolving interdependently to create balance (Berkes et al., 2000:171). In terms of socio-ecological systems thinking, the following author's views were explored: Paul Sillitoe, Fikret Berkes, and Elinor Ostrom. Paul Sillitoe and Fikret Berkes explore socio-ecological systems, and Elinor Ostrom explores creating a socio-ecological systems framework, to achieve sustainability as explained below.

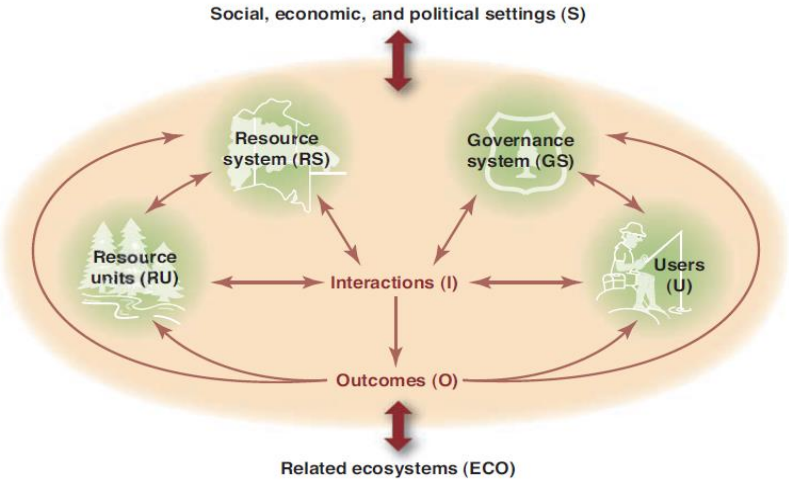


Figure 142: Indicating the interactions and relationships between the social and ecological actors within her socio-ecological systems thinking
Source: Ostrom.2009:402

The diagram above indicates that people and society are the users, whereas the resource units and systems are the ecological actors, in the form of natural resources or ecosystems from which we, as people, benefit (Ostrom, 2009:420). This research explores places where there are interactions between people and nature and utilise the opportunities through architecture, to create a sustainable space and systems that will benefit both the environment and local communities.

Design solutions

Design solutions include:

- Filtration ponds
- Small scale fish farms
- Sewerage ponds
- Recycling waste
- Solar panels
- Wind turbines

CRITICAL REGIONALISM

Critical regionalism explores the potential of introducing cultural characteristics into a building or system to show cultural identity in a rapidly changing technically driven age. Kenneth Frampton talks about including local culture, knowledge, experiences and technologies into each design as each site is different (Frampton, 1981:26). The seafood market will increase the connections people have with both nature and local communities. The main authors explored were Renzo Piano and Kenneth Frampton. Both explore critical regionalism that relates back to local context, technology and local culture.

The reason for using critical regionalism is because it takes into account the technology and experiences behind the systems, the culture of the community, and nature. This research explores how a seafood

market can be used to aid local communities thriving in Durban harbour. The research will bring local cultures and nature together by encouraging sustainability that will potentially improve the link between community and nature, as well as bring back a lost local culture.

Design solutions

Design solutions include:

- Experience
- Connection to nature
- Connection to culture
- Materials and tactile
- Connection to site
- Connection to topography

LOCAL DESIGN PRECEDENTS

The site is an important aspect of the research, as is making the building communicate with the site and surrounding context. Two buildings – one located on the site and one in the surrounds – were influences in the design.

Site 1: Café Fish

Café Fish is located on the site. The building has a strong roof architecture component that is followed through the design. The plan below shows how the roof of Café Fish builds up to the main market building, which ties the building to the site and its surroundings.

Figure 143: Café Fish located on site.
Source:http://www.greenwoodguides.com

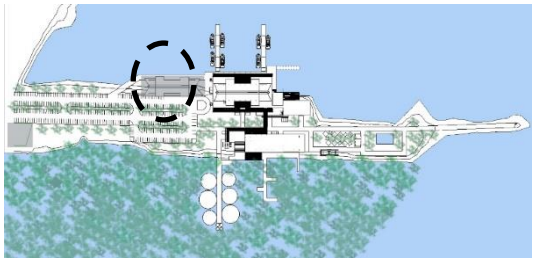


Figure 144: Café Fish location plan
Source: Author

Figure 145: Revit image of the seafood market
Source: Author

Site 2: Royal Natal Yacht Club

The Royal Natal Yacht Club is also located on the outskirts of the site. This architecture is brought through the market with a barrel vault roof that will be used in the pavilion thus making linear lines of build-up on both sides of the site.

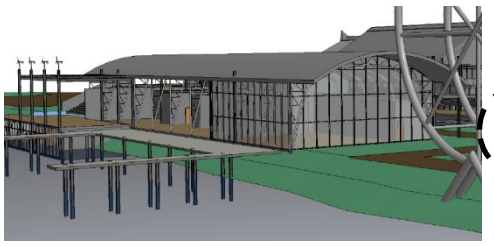


Figure 146: Revit image of the pavilion
Source: Author

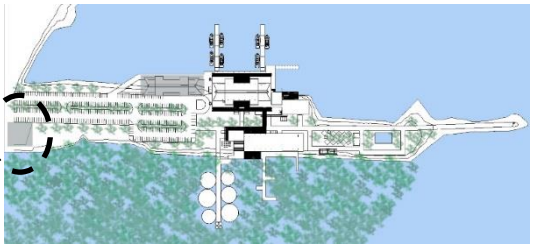


Figure 147: Location Plan of the Royal Natal Yacht Club
Source: Author

Figure 148: Royal Natal Yacht Club located on site.
Source: https://justalittlefurther.com

INTERNAL

DESIGNPRECEDENT

With the site being located in the Durban harbour area the context and surrounding communities are vital to the style of building. Figure 152 below indicates a building located in the Sydney waterfront. This shows a connection with the boats in the harbour. The structure of the building ties into the context in which it is built. Durban harbour has both yachts and industry which ties into this style of architecture. Sydney and Durban also experience very similar climate and vegetation, making it a perfect example of waterfront architecture that will fit into the context of Durban. Figure 151 and 153 shows an image of the yachts and cranes in the Durban harbour that have become iconic landmarks for the harbour. These will be incorporated into the design as indicated below.

Figure 149: Image of the Yachts in the Durban harbour.
Source: https://www.nightjartravel.com

Figure 150: Building by Cox Architects located in the Sydney Waterfront
Source:https://inheritanceorg.wordpress.com

RESEARCH PRECEDENTS

Site 1: Bamboo Sports Hall For Panyaden International School

Figure 152: Image of an Aerial view of the hall showing the organic lotus flower design.
Source: https://www.archdaily.com

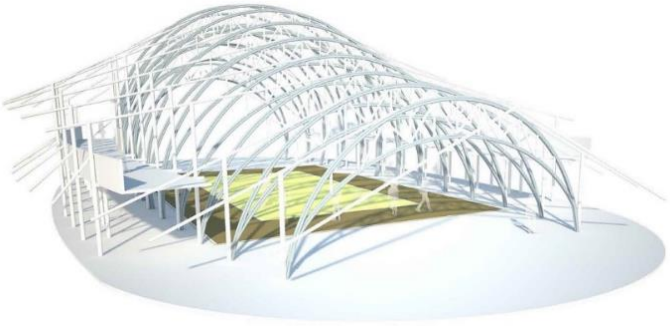


Figure 153: Image showing the structure, roof and floor of the building in different colours.
Source: https://www.archdaily.com

Figure 154: Image showing the magnificent bamboo structure that spans over 18m.
Source: https://www.archdaily.com

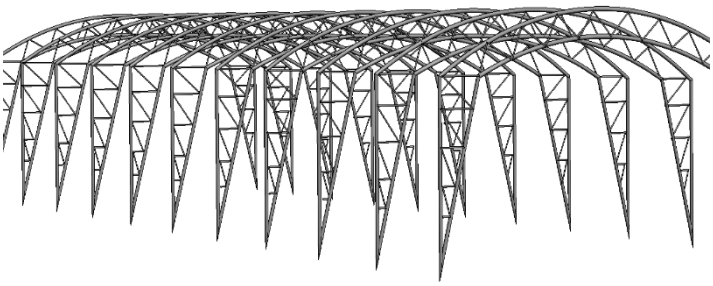


Figure 155: Section of the supporting trusses in the informal trading, food court and events area.
Source: Author

The researcher used this precedent to understand the structure and building techniques used to construct this building. The materials that were used creates a positive experience aesthetically when one is in the building. The same structure, trusses and techniques were used to design the pavilion. This hall has no walls and therefore ties into the pavilion design. The image above shows a section through the food court and events area indicating the connection between the precedent and final design.

Site 2: Vancouver Convention Centre

Figure 156: Urban plan of the site
Source: https://www.archdaily.com

Figure 157: Image of the green roof
Source: https://www.archdaily.com

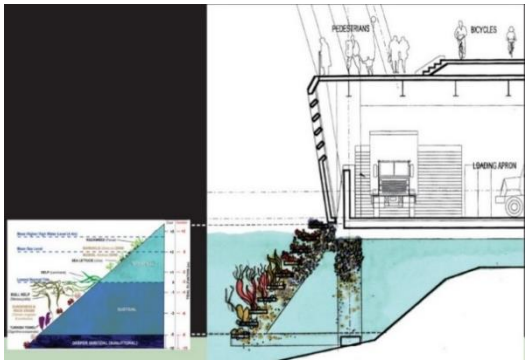


Figure 158: Eco system growing on the buildings foundation
Source: https://www.archdaily.com

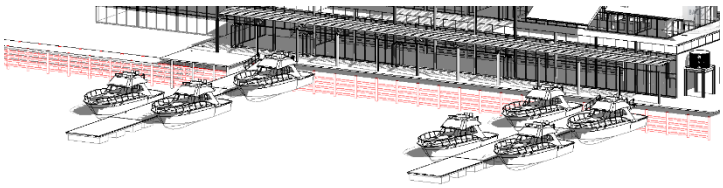


Figure 159: Image indicating the coral farm layouts under the piers.
Source: Author

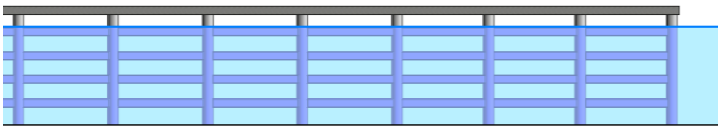


Figure 160: Pier section with coral shelves below the water line
Source: Author

The Vancouver Convention Centre helped with understanding the surrounding context and how to incorporate this into the design and architecture. The Vancouver convention centre has won many awards for the sustainable systems that are incorporated in the design, and how it complements its surroundings. This precedent shows how one can bring nature into a building and connect people to nature through architecture. Figure 160 will be discussed further, later in the document.

CASE STUDIES

The three case studies the researcher explored guided her to one frightening conclusion: all were lacking sustainable and ecological aspects in their systems. The Maputo market is the only market that sustainably filters its sewer and grey water before it is pumped back into the sea. This emphasises the importance of introducing sustainable systems into markets. The precedent studies prove it is possible to introduce another ecological and sustainable dimension to markets.

The three case studies that were explored were:

1. The Maputo Seafood Market in Maputo, Mozambique.
2. The Bangladesh Market in Chatsworth, South Africa.
3. The Warwick Meat and Fish Market in Durban, South Africa.

Below is a summary of the markets, and include energy, waste and water, along with experiences at the market.

Maputo Seafood Market

Energy	Municipality - not sustainable
Waste	Filters sewerage before entering the sea
Water	Filters water before entering the sea
Experience	Well maintained and no bad smells

Figure 161: Maputo Seafood Market observation sheet finding
Source: Author

Warwick Meat and Seafood Market

Energy	Municipality – not sustainable
Waste	Municipality – not sustainable
Water	Municipality – not sustainable
Experience	Not well maintained and smells unpleasant

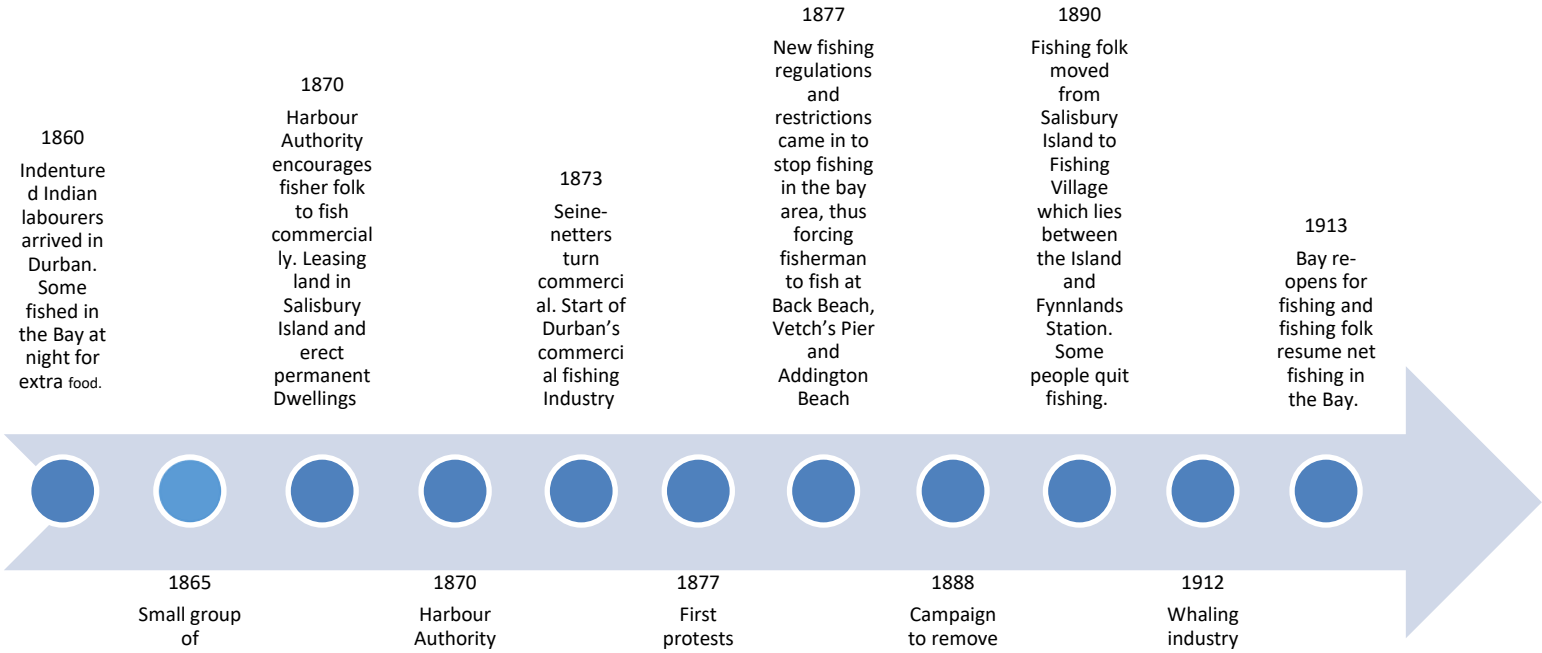
Figure 162: Warwick Meat and Seafood Market observation sheet finding
Source: Author

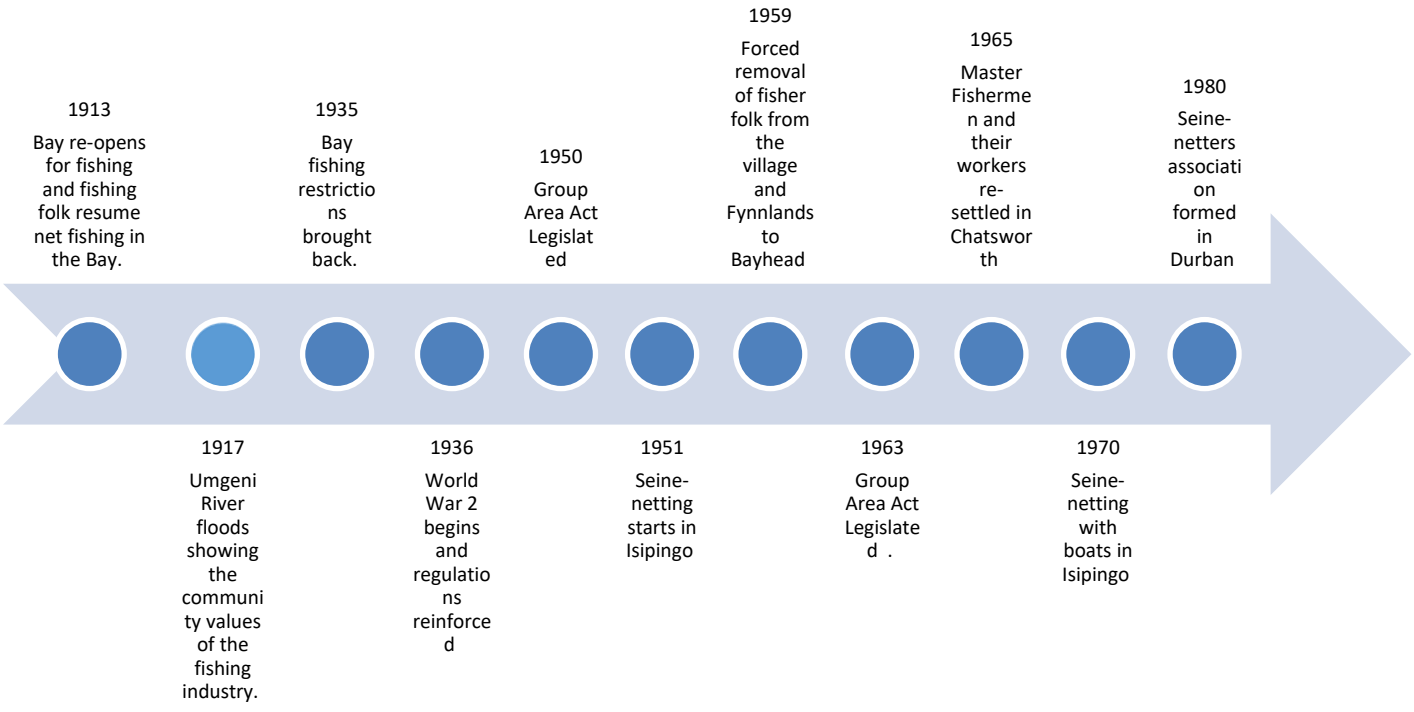
Bangladesh Market

Energy	Municipality – not sustainable
Waste	Municipality – not sustainable
Water	Municipality – not sustainable
Experience	Not well maintained; slaughter house and fish section smell unpleasant

Figure 163: Bangladesh Markets observation sheet finding
Source: Author

HISTORY OF THE NATAL HARBOUR (taken from legends of the tide.)





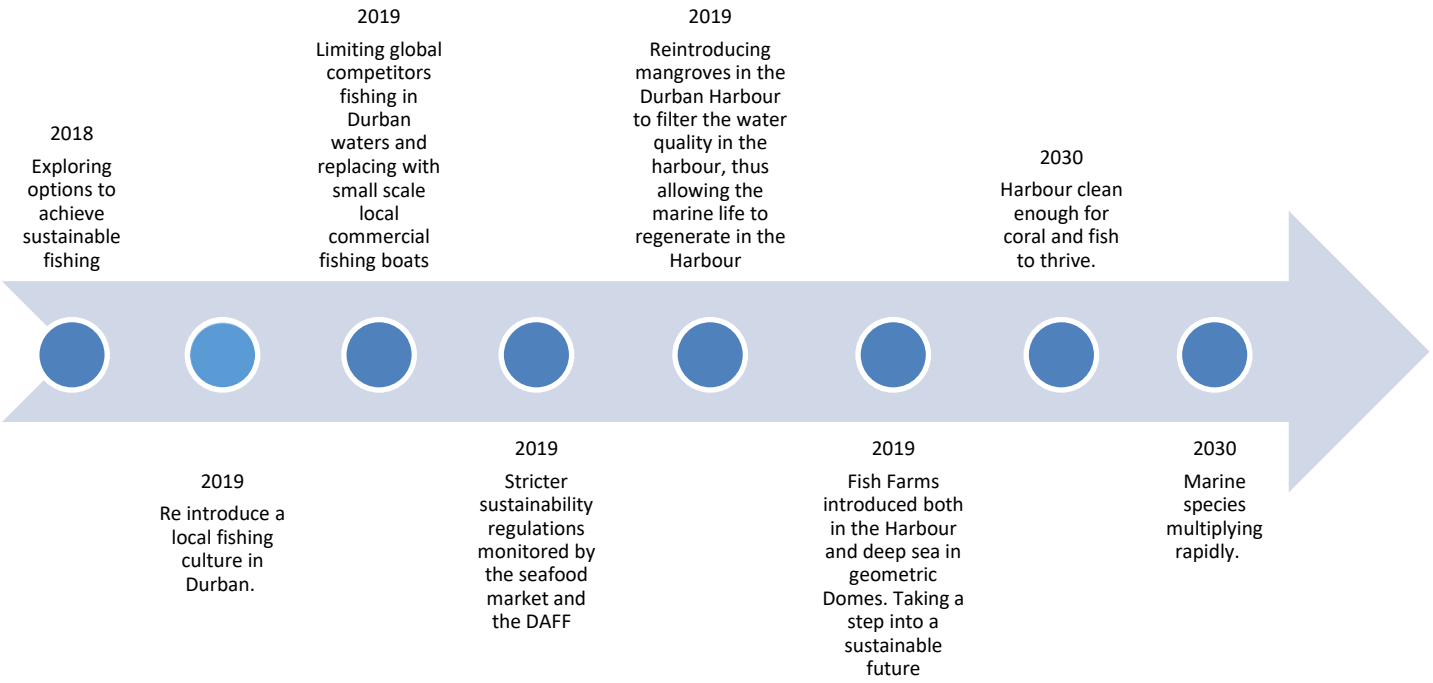


Figure 163: Time Line of the Durban Harbour
Source: Author

SITE DEVELOPMENT

Figure 164: The Bay of Natal Connectivity plan
Source: GoogleEarth.com

1 Train: Trains are currently used mostly for the car terminal in the harbour however, with the new framework, the car terminal will be moved to the west side of the bay. This will allow the train to be transformed into a passenger train or tram connecting the city in a more sustainable way.

2 Ferry Boats: A ferry boat terminal will be introduced in the harbour area with 6 main points being established. These ferry boats will be used to move people from different parts of the harbour as well as connect the seafood market with the Point area, the new cruise ship terminal, and the Bluff area.

3 Pedestrians: There is a proposed pedestrian bridge that will connect the CDB to the site through Albert Park. This point of access is due to the height difference and will make it easier to cross the road and rail. There is also a direct pedestrian connection to the yachts that are berthed next to the site as well as the potential to connect to the new promenade and cruise terminal, making the area a waterfront.

4 Vehicular: The site is along Victoria embankment where the three main roads connect the North Coast, the South Coast and the N3 inland.

5 Sea: The most important connection is the direct connection the site has to the sea and marine species.

SUSTAINABILITY AND SOCIO-ECOLOGICAL DESIGN INFLUENCES AND DEVELOPMENT

CORAL FARM

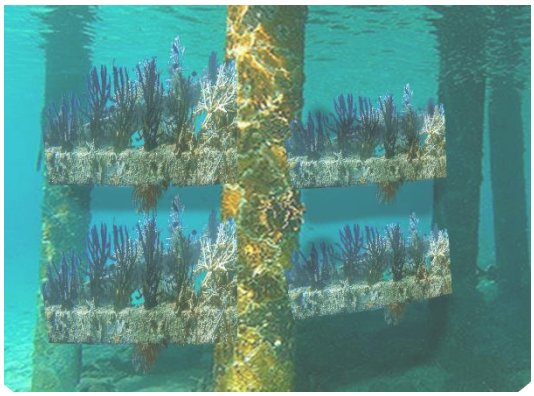


Figure 166: Coral farms
Source: Author

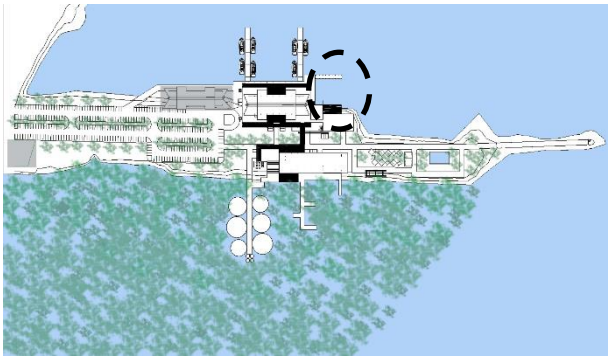


Figure 167: Location of coral farms
Source: Author

The underwater columns are concrete with concrete beams creating shelves for artificial coral growth. Once the coral has reached maximum capacity it is moved and reintroduced into the sea where the coral reefs have been damaged. The coral farm is located below the piers and deck spaces on the north side of the building. This area makes a good space for a viewing window in the aquarium below to look at and understand the importance of coral and how it grows in the ocean.

FISH FARMS

Awareness fish farm the site has a small scale fish farm that is located below, in the mangroves. These fish farms are creating awareness and an educational tool for sustainable fishing. These are to educate people on the positives and negatives of aquaculture. These farms are also generating fish that will be released when they reach maturity. The layout of the fish farm can be seen below.

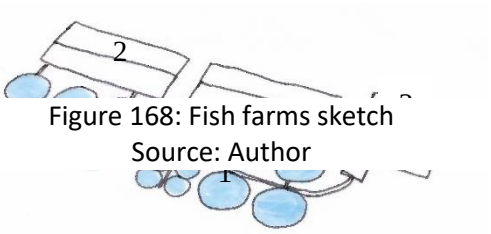


Figure 168: Fish farms sketch
Source: Author

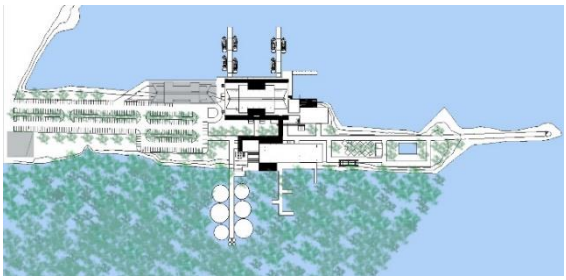


Figure 169: Location of fish farms
Source: Author

1) Fish tanks

2) Filtration areas

3) Monitoring and quarantine area

DEEP SEA FISH FARMS

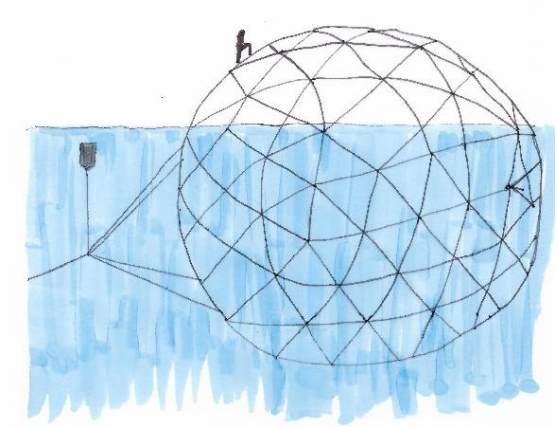


Figure 170: Deep sea fish farms sketch
Source: Author

Figure 171: Location of fish farms
Source: GoogleEarth.com

The deep sea pods are located in deep water just off shore. These domes are created to allow fish to grow in deep sea where the water is a lot cleaner due to currents that clean the water and waste away from the dome making the quality of life better for the fish.

The sketch above indicates where these pods will be located and what they will potentially look like. With time these domes can be used as a transportation system for the fish. They will start at a specific point with juvenile fish and with the help of a GPS and motor, the domes will eventually deliver full grown fish.

SANITATION SYSTEMS AND FILTRATION PONDS

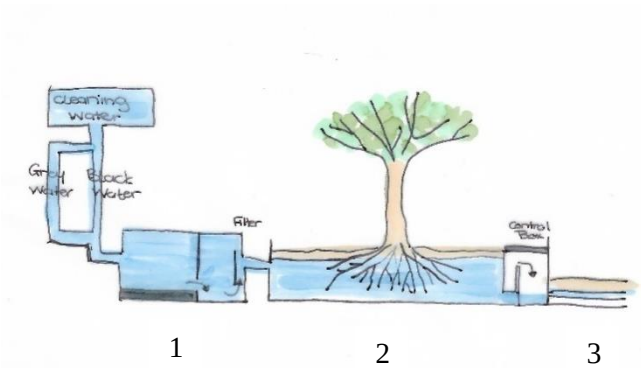


Figure 172: Filtrations ponds
Source Author

The water in the market is collected and filtered in filtration ponds as indicated below. These ponds clean the water neutralising any harmful chemicals through natural means. Both the grey water and black water is filtered through these ponds. The black water has another compartment that is a septic tank where the sewerage is stored for a couple of days. These filtration ponds are located throughout the site.

1) Septic tank
2) Wetland filtration tank
3) Treated water

RECYCLING SPACE

Figure 173: Recycle netting
Source: http://stormwatersystems.com

Figure 174: Recycle nettings location
Source: Author

On the site there is a major storm water pipe from the CBD that deposits waste into the harbour. It can be seen in the image below. This causes pollution to the harbour. Being aware of this creates the potential to solve a problem before it pollutes the ocean. This will be done by introducing a net system as indicated above to collect foreign objects. The plan above indicates the location, with a deck where waste pickers can sort through the waste and use it or dispose of it responsibly. The plastic can be used throughout the site to make furniture or to do landscaping with eco bricks that are made up of the recycled plastic. All the fish waste on site will be recycled and either used as fish food or sold as bait in the bait shop located on the east side of the site.

CONNECTING TO HISTORY

Figure 175: Vasco Da Gama Clock
Source: https://www.fad.co.za

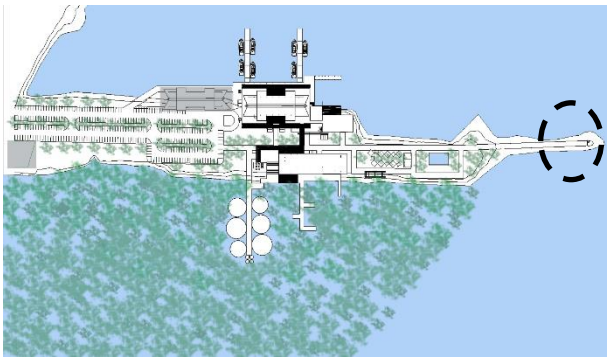


Figure 176: location of the Vasco Da Goma clock
Source: Author

This monument has been located along Victoria Embankment for many years. The monument has been extensively vandalized over time. The city is refurbishing the clock and it will be moved to the end of the site making it a feature visible from the entrance. This clock creates an end point on the site, as seen in the plan above

EXPERIENCES DESIGN DEVELOPMENT

SMELL

Figure 177: Strelitzia flower
Source:www.gardenshop.co.za/

Figure 178: Bruguiera Gymnorrhiza or more commonly known as Black mangroves
Source: http://www.madeinnys.com

Figure 179: Avicennia Marina or more commonly known as Grey mangroves
Source:https://www.researchgate.net

Figure 180 : Fig tree located along the Umgeni river mouth Durban, South Africa.
Source: Author

The use of glazing and vegetation will neutralise the smell of the seafood market. Vegetation also breaks down odours. Vegetation will be used throughout the site as a natural system. A few of the plants that break down odours as indicated above

DURBAN CLIMATE

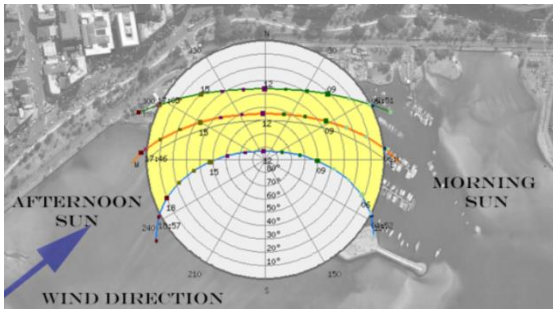


Figure 182: Pergolas as shading devices
Source: Author

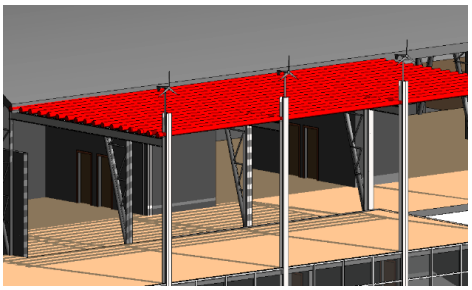


Figure 181: Sun Path
Source: GoogleEarth.com and Author

Durban's climate consists of extremely hot summers with cool winters. The figure above indicates the sun's path over the site. The morning sun is utilised within the fish market. Seafood and ski boats often come in at early hours of the morning making the east side perfect for the market. The use of pergolas is visible throughout the site. These pergolas connect to the building structure, making them part of the building and not just something that has been added as an afterthought

WIND TURBINES

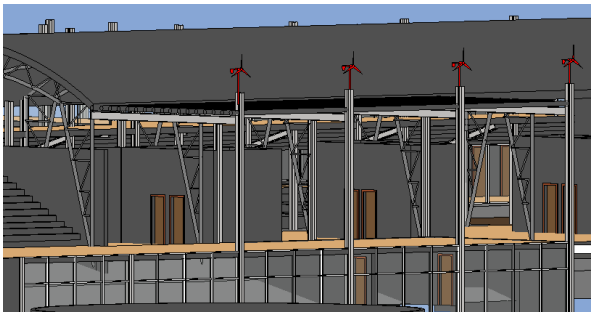


Figure 183: Wind turbines generating wind power on site.
Source: Author

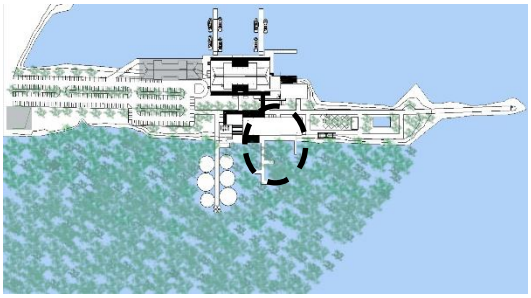


Figure 184: Location of Wind turbines
Source: Author

Figure 185: Image of wind turbines located throughout the design
Source: Revit City.com

The wind turbines and solar panels are a source of energy that is generated on site. The wind turbines are located on masts around the building, similar to ocean yachts as indicated to the right. There are strong north easterly winds in the harbour.

DESIGN INFLUENCES

TOPOGRAPHY

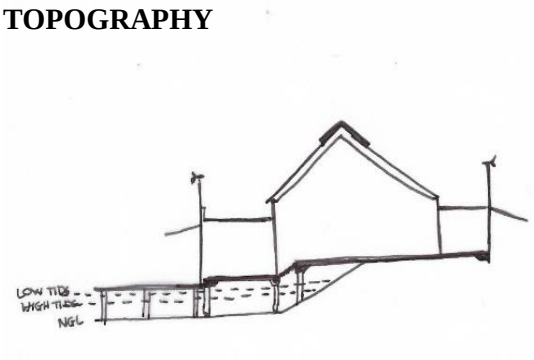


Figure 186: Building designed above the site to allow the natural tides to occur
Source: Author

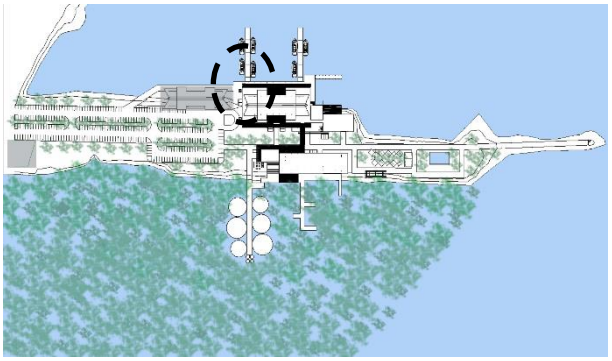


Figure 187: Location of the detail
Source: Author

The site is relatively flat with very little to no vegetation. The design takes into account the topography. The figure above indicates how the building takes into account the flat site with the water's edge connecting to the building.

CONNECTION TO NATURE

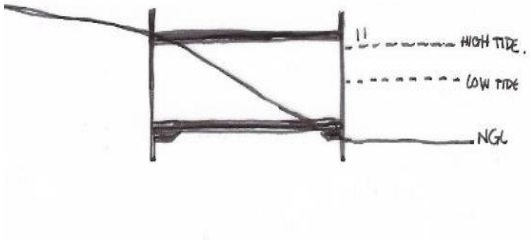


Figure 188: Building has underwater viewing windows as an educational and awareness space.
Source: Author

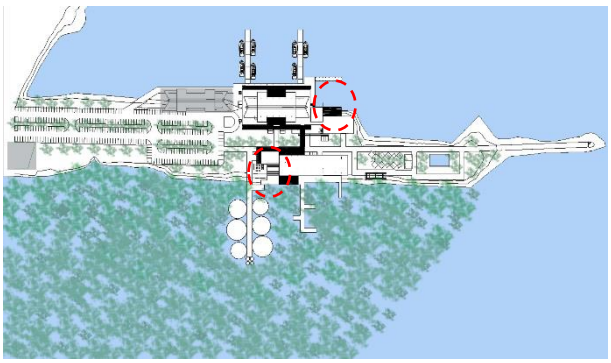


Figure 189: Location of the detail
Source: Author

The building and the water share a close connection. This can be seen in the section above here the building connects to the sea through a display window that shows both the mangrove area and the coral farm on either side. These two windows can be seen in the location plan above. These windows show not only the beauty of nature but the importance of nature and how it functions.

LEARNING COMPONENTS

VIEWING SPACE

The viewing space shows how mangroves function and the importance of mangroves. On the south side of the building there is a viewing deck that looks into the mangroves. During low tide the mangroves will be completely out of the water and during high tide they will be slightly covered with water. These viewing spaces are for educational purposes. On the north side the viewing window is exposed to a sea view that looks onto a coral farm. This space educates people on the growth of corals and how important they are.

EXPOSED SYSTEMS AND TECH ROOMS

All systems and tech rooms are exposed to the public. Most of the tech rooms are located in the aquarium space. These systems are exposed to help people understand how important and simple solutions can create an environmental difference. The filtration ponds are located on the main walkways of the building. The wind turbines are located above the sheltered pergolas. Cleaning and recycling of fish is done in plain sight in the market. The buildings structural elements are exposed and create an aesthetic feel to the site

CONTROL PANEL

When entering the aquarium space there is a control panel that has all the measurements displayed. The control panel has measurements on:

1. Water used and stored by the building
2. Energy used and energy generated
3. Information on the amount of fish sold compared to the fish grown and released.
4. Amount of waste that is recycled
5. Amount of urban farming used on site.
6. Amount of goods brought in compared to amount of goods that leave the site.

FISH FARMS AND CORAL FARMS

The fish farm located in the mangroves will be used for educational purposes (as discussed above). This is due to the large amount of waste that is released when there is minimal filtration, causing the degradation of the water quality in which the fish live. The deep sea fish farms are far more effective and create a healthier catch. The mangrove fish farm will show both the positives and negatives of fish farming. Once the fish reach a certain size they will be released into the harbour to build up the fish count within the harbour area. The coral farms similarly will be used to protect coral and educate people on it.

FISH POND

There is a fish pond located on site that will be used by the youth to learn about sustainable fishing. In this pond children will be taught to catch and release, learn what size fish are allowed to be removed from the sea and which fish don't meet regulations. This pond will have regulations that require all hooks and barbs to be removed therefore easing the pain for the fish, as everything that is caught will need to be released. Once these fish meet maximum capacity they will be sold as live bait to the local fisherman or released into the harbour.

ECO-BRICK WALL

Eco bricks will be used to construct the infill panels throughout the building. There will be a section of the building that has an infill panel that is not plastered to show how the construction of eco bricks is done. In the aquarium, children and people will be educated on how to make both standard eco bricks and ocean eco bricks.

MATERIALS

WATERPROOFING

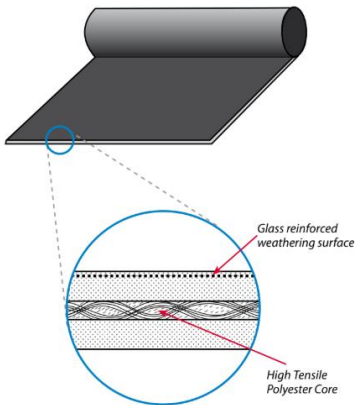


Figure 190: Detail of waterproofing
Source: http://www.derbigum.co.za

The waterproofing that is used on the flat roofs and below the roof structure is Derbigum CG product line. The roof structure is protected with Derbigum CG3 whereas the flat roofs and green roofs will have Derbigum CG4H. CG4H is designed for vegetation as long as the plant types have non-aggressive roots. The figure to the right shows a detail and section of the waterproofing from Derbigum. The company is local therefore saving on transport costs for the material.

INFILL

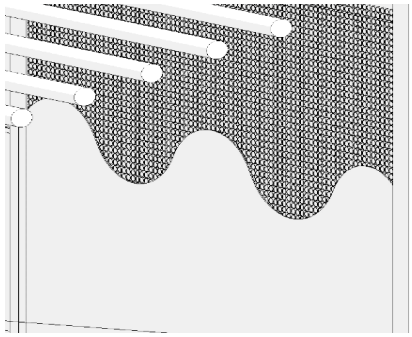


Figure 191: How an ecobrick wall is constructed
Source: Author

The building is constructed using both concrete and steel structural supports. The infill panels will be made from eco bricks, made from the recycled plastic collected at the recycling deck. Ocean eco bricks will be used to make outside furniture and landscaping and the infill panels will be made of eco bricks that are stacked and then plastered over.

STEEL

All steel will be galvanised and maintained when needed. The steel, if not galvanised, will cause the building to deteriorate and lose its structural integrity relatively quickly, due to the close proximity to the sea. During the construction, all steel down to the nuts and bolts need to be inspected for galvanising.

ROOF MATERIAL

The roof materials used will match what currently exists on site. Both the Royal Natal Yacht Club and Café Fish have corrugated iron roofs. This will be carried through the site. The flat roofs have urban farming and, to a degree, vegetation.

SITE PLAN

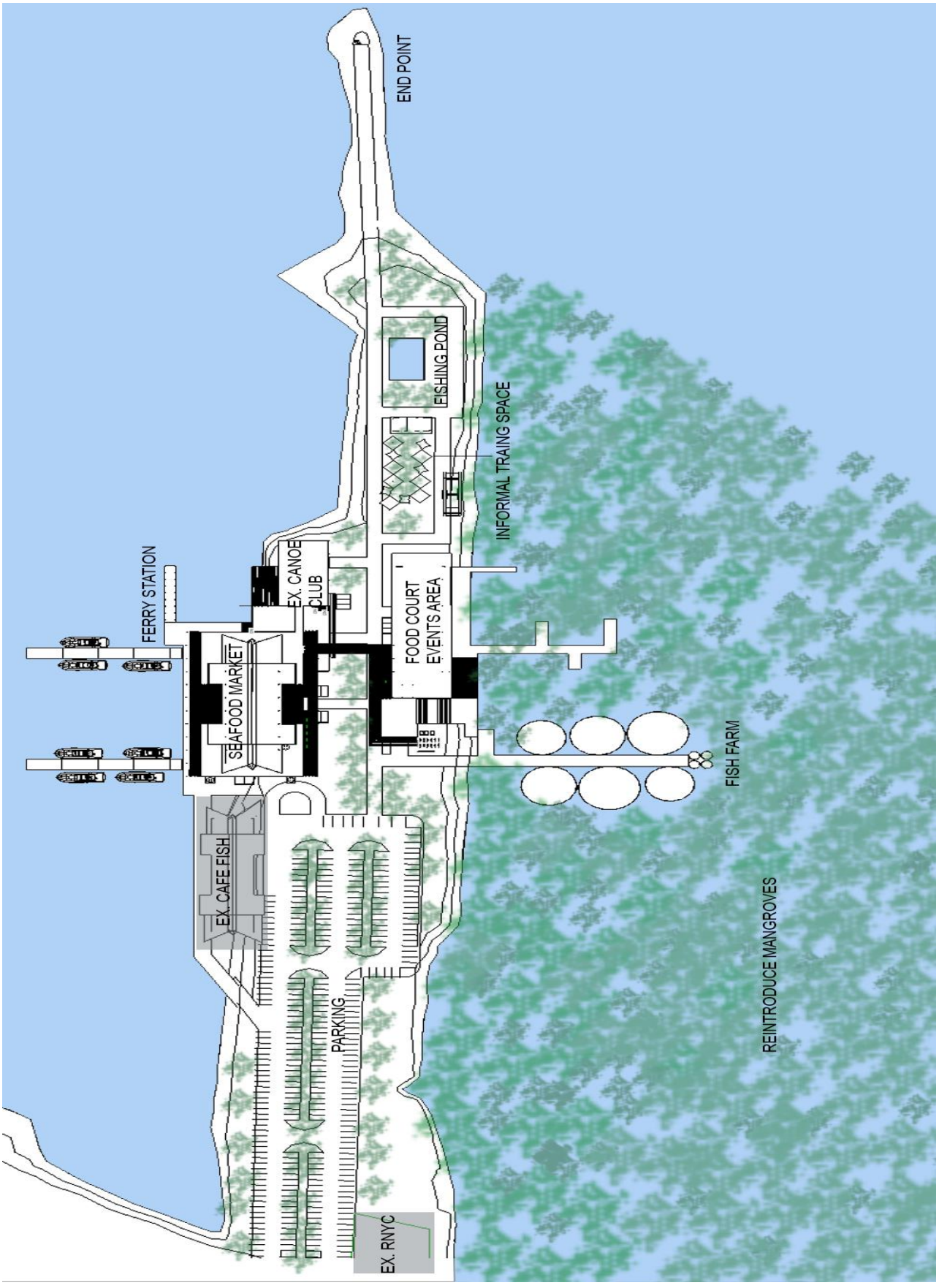


Figure 192: Design Site Plan
Source: Author

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APPENDIX A:

Consent form

RESEARCH ETHICS: CONSENT FORM

Project title: Exploring the integration of sustainable systems within market architecture: towards the design of a market for Durban.

Researcher: Jane Pascoe

Purpose of the Study: This research document will look at exploring sustainable systems in architecture to inform a building. This will be done through the integration of sustainable systems to inform an architectural response to global warming and local environmental degradation.

Procedure: I am asking you to participate in an interview session. The session will be up to 1 - 1.5 hours (maximum) in length. You will be discussing specific questions regarding the different experiences you have had when using a market or sustainable systems.

Confidentiality: Any information derived from your participation in the study will be kept confidential by the researcher. There will be no identifying information given during the interview. The audio taped sessions will be stored anonymously and confidentially. Only anonymous quotes will be presented on my report.

Ethics Approval: This project was approved by the School Research Ethics Board of the University of KwaZulu-Natal. If you have any questions or concerns about your rights or treatment as a research participant, you may contact the Chair of the Research Ethics Board: Mr Premlall Mohun, 031 2604557. Mohunp@ukzn.ac.za

Please Initial Box

1. I confirm that I have read and understand the information sheet for the above study and have had the opportunity to ask questions. ☐
2. I understand that my participation is voluntary and that I am free to withdraw at any time, without giving reason. ☐
2. I agree to take part in the above study. ☐
3. I agree to the interview consultation being audio recorded ☐

Name of Participant:	Date	Signature
Jane Pascoe		
Name of Researcher:	Date	Signature

APPENDIX B:

Questionnaires

Questionnaires:

1. **Where do you live?**

   _____

2. **How do you get to work?**

   _____

3. **How do you get the seafood you sell?**

   _____

   _____

4. **How long can you keep the seafood/produce fresh?**

   _____

   _____

5. **Can anyone sell seafood/produce at the market?**

   _____

   _____

6. **Why do you have a shop at this market over other potential markets?**

   _____

   _____

7. **What do you feel this market is lacking?**

   _____

   _____

8. **Why do people come to this market?**

   _____

   _____

9. **Are there other markets in close proximity to this one?**

   _____

   _____

10. **Who maintains the market?**

APPENDIX C:

Interviews

Interview 1

In- Depth Interview: Jane Flood

Maputo Fish market

Location: Maputo Mozambique

Jane Flood is the founder of the Maputo a Pe (Maputo on Foot) Walking Tours. She has been doing tours through the Maputo markets for many years. I will be doing an in depth interview with her.

Reason for interview: Flood will be interviewed on the sustainable systems that are used in Mozambique markets and how the Japanese influence has affected the design of these sustainable systems.

Basic question

1) Please can you define a sustainable market?
2) What water, energy and waste systems are present in the market and if so are they sustainable?
3) Who is responsible for establishing and maintaining the water, energy and waste systems?
4) What consequences/impacts do the water, energy and waste systems have on the environment?
5) What could be done to improve the relations between the water, energy and waste systems in the market and the environment?

Interview 2

In- Depth Interview: Richard Dobson

Warwick English and Early morning Market

Location: Durban CBD, South Africa

Asiye eTafuleni is a non-profit organization that collaborates between informal traders in Warwick and allied professionals. I will be interviewing Richard Dobson who is the project manager of the organization.

Reason for interview: Richard Dobson has vast knowledge on how Warwick works. Dobson will be interviewed on the sustainable systems in two of Warwick's markets, one being the English Market and the other the Early Morning Markets. The main focus of this is to explore the sustainable systems that are located in the Warwick Market.

Basic question

1. What systems are present in the market and if so are they sustainable?
2. What consequences do the systems have on the environment?
3. Who is responsible for maintaining the systems?
4. How do these systems create an architectural response to global warming and local environmental degradation?

Interview 3

In- Depth Interview: Rodney Harber

ArchUrban Plan

Location: Durban, South Africa

Background: Rodney Harber is a well renowned architect in Durban. He has designed many markets through his architectural career.

Reason for interview: Harber will give an architectural response on the design of markets as well as the sustainable systems that make up the market. Harber will be interviewed on his past experiences in designing markets.

Basic question

1. What environmentally sustainable systems have you used in previous designs?
2. What environmentally sustainable systems worked well?
3. What common problems have you seen with environmentally sustainable systems?
4. What is the most important advice when designing a market with environmentally sustainable systems?
5. How have you previously used environmentally sustainable systems to create an architectural response to global warming and local environmental degradation?

FOCUSED INTERVIEWS 1: RICHARD DOBSON

Ice Breaker: Was to have an informal conversation of about 5 minutes introducing myself and my dissertation topic. This time was used to help him understand the goals of my research and show how he could help me achieve this by understanding what was needed from him.

The first question was how do you define a sustainable market?

- Looks at reaching an equilibrium of inputs and outputs, that need to balance out.
- Cannot isolate one system, we need to explore at a macro scale.

Please can you provide evidence of where a socio-ecological systems approach has been applied in the markets you are familiar with?

What water, energy and waste systems are present in Warwick?

- People recycle and use what is available on the streets.
- Making use of biofuels for cooking however it's expensive
- Some people use wood that is salvaged
- Waste pickers

Who is responsible for establishing and maintaining the water, energy and waste systems?

- Municipality and people who work in the area.

What consequences/impacts do the water, energy and waste systems have on the environment?

- Landfill due to waste not being recycled.
- Food waste and cooking fats end up in the storm water and sewer points.
- Smoke pollution
- Water is being polluted as cars are washed in the street

What could be done to improve the relations between the water, energy and waste systems in the market and the environment?

- Harvest more water.
- Grade water due to activity needed as water is highly purified in South Africa
- Managing resources is vital

- Salvage wood to cook
- Make use of wood cutting throughout the city
- Solar cookers
- Make use of green waste
- Skins and bones can be recycled.

How could the water, energy, waste systems create an architectural response to reducing global warming and local environmental degradation?

- Effective management infrastructural systems within a building.

END OF INTERVIEW

FOCUSED INTERVIEW 2: RODNEY HARBER

Ice Breaker: Was to have an informal conversation for about 5 minutes introducing myself and what I was doing in my dissertation. This time was used to help him understand the goals of my research and show how he could help me achieve them by understanding what was needed from him.

What environmentally sustainable systems have you used in previous designs?

- Solar panels need a lot of maintenance and security as they are expensive
- Sewerage used Freon gas to filter and kill pathogens or reuse water to flush toilets.
- Use people as a security system

What environmentally sustainable systems worked well?

- Simple systems work the best with the least amount of maintenance.
- Anything with pumps need maintenance and don’t work well.
- Systems need to be fool proof

What common problems have you seen with environmentally sustainable systems?

- Mechanical and electrical systems need a lot of maintenance.
- Pumps.

What is the most important advice when designing a market with environmentally sustainable systems?

- Maintenance and simple systems

How have you previously used environmentally sustainable systems to create an architectural response to global warming and local environmental degradation?

- Hammarsdale market. Disposal and hygiene needed to be contained and prevented from going into the stream that is in close proximity to the market

END OF INTERVIEW

FOCUSED INTERVIEW 3: EDILSON MANJATE

Ice Breaker: Was to have an informal conversation for about 5 minutes introducing myself and what I was doing in my dissertation. This time was used to help him understand the goals of my research and show how he could help me achieve this by understanding what was needed from him.

The first question was how does he define a sustainable market?

- A market where people feel safe
- A market that creates enough income to sustain the market.
- A market that creates enough space for traders and vendors.

What water, energy and waste systems are present in the market in Maputo?

- No recycling
- People live in close proximity to the landfills
- Electricity comes from the government at big markets
- Smaller informal markets have limited electricity.
- There is a new solar panel factory in Maputo that has started supplying houses with solar panels.
- No recycling of water in most of the markets.
- Most of the water is supplied by a public company
- Informal markets need to arrange their own water.
- This is a problem as markets that don't have access to water are not well cleaned.

Who is responsible for establishing and maintaining the water, energy and waste systems?

- In the large markets the municipality or people from the markets establish and maintain the market.

- In informal markets it is the responsibility of the people.
- People complain about the municipality when it comes to things like cleaning the streets.

What consequences/impacts do the water, energy and waste systems have on the environment?

- Waste and landfills are a big problem in Maputo. Recently 17 people died in a landfill collapse.
- No recycling so this contributes to landfills and sea pollution.

What could be done to improve the relations between the water, energy and waste systems in the market and the environment?

- Infrastructure in general

END OF INTERVIEW

APPENDIX

Observation sheet

Case study_____

Observe	Systems	Environmental consequences	Social connections to the systems	Social or environmental benefits.	Comments
Energy systems					
Waste systems					
Sanitation systems					
Water systems					

Observe	What systems can be used?	What are the social benefits?	What are the ecological benefits?	Consequences of these systems on people and environment	Comments
Spacing of stores					
Slope					
Surface					
Roof layout					
Movement paths					
Place to expand					
Site					