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BAHCESEHIR UNIVERSITY
GRADUATE SCHOOL
THE DEPARTMENT OF ARCHITECTURE

A. FAHAD

SUSTAINABLE URBAN DESIGN APPROACHES FOR FLOATING SLUM SETTINGS: THE CASE OF MAKOKO COMMUNITY NIGERIA

MASTER'S THESIS
FAHAD ABDULAHI IBRAHIM

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ABSTRACT

SUSTAINABLE URBAN DESIGN APPROACHES FOR FLOATING SLUM SETTINGS: THE CASE OF MAKOKO COMMUNITY NIGERIA

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The challenge of rapid population growth is evident in developing countries, leading to issues like slums characterized by poor housing and unsanitary conditions. Geographical features, such as floating slums, pose unique challenges, necessitating specific considerations in planning and design. This study focuses on Makoko, a floating slum community in Nigeria. Facing imminent redevelopment, the community grapples with issues like floods, lack of urban planning, and outdated building technology. The study aims to identify and address these challenges by proposing sustainable urban design solutions to accomplish sustainability in Makoko. The Sustainable Development Goals (SDGs) which are a set of global targets and measures that will steer UN member states toward a sustainable city will first be evaluated to meet the context of floating slums since they are made generically. The comprehensive research methodology includes a literature review, expert interviews, and decision-making with multi-criteria methods like Analytic Hierarchy Process (AHP) and Analytic Network Process (ANP). The first phase is the collection of crucial information related to the challenges faced and studies into UN SDGs to create the tailored goals, and the second phase, AHP, and ANP will be used to create the priority list for the tailored goals, this list combines professional perspectives and judgments, providing a clear ranking of the goals based on their significance and possible effect. The research outcomes provide a strategic hierarchy of urban design interventions focused on critical aspects such as social revitalization, adaptation to climate change, and effective urban-scale waste management, contributing to the community's overall sustainability.

Keywords: Slums, Floating Communities, Sustainable Urban Design and Architecture, Sustainable Development Goals, Multi Criteria Decision Making.

ÖZ

YÜZEN ÇÖKÜNTÜ YERLEŞİMLERİ İÇİN SÜRDÜRÜLEBİLİR KENTSEL TASARIM YAKLAŞIMLARI:
MAKOKO TOPLULUĞU ÖRNEĞİ NIJERYA

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Ocak 2024, 130 sayfa

Gelişmekte olan ülkelerdeki kontrolsüz nüfus artışına bağlı olarak, kötü barınma ve sağlıksız koşullara sahip yerleşim alanları ortaya çıkmaktadır. Diğerlerinden farklı olarak su üzerinde yapılaşmış bu tür yerleşimler coğrafi özellikleri bakımından, planlama ve tasarımda özel hususların dikkate alınmasını gerektirmektedir. Bu çalışma, Nijerya'da su üzerinde yapılaşmış Makoko yerleşim alanına odaklanmaktadır. Topluluk, plansız gelişim göstermekte olup zaman zaman sel, taşkın gibi çevresel riskler ile karşı karşıya kalmaktadır. Yüzen yapıların kötü fiziksel koşulları dikkate alındığında ise söz konusu afetler Makoko’nun sürdürülebilir gelişimini engellemektedir. Çalışma, Makoko’nun sürdürülebilir gelişimine yönelik kentsel tasarım ve planlama çözümleri önermeyi hedeflemektedir. Bu hedef doğrultusunda, Birleşmiş Milletler tarafından tanımlanan Sürdürülebilir Kalkınma Hedefleri, yüzen yerleşim bağlamını karşılayacak şekilde değerlendirilecektir. Araştırma metodolojisi, literatür taraması, uzman görüşmelerinin alınması, Analitik Hiyerarşi Süreci (AHP) ve Analitik Ağ Süreci (ANP) gibi çoklu kriterlere sahip sistemler için karar alma süreci gibi yöntemleri içermektedir. İlk aşama, Makoko yerleşimine özgü sürdürülebilir tasarım ve planlama hedeflerinin belirlenmesi için BM Sürdürülebilir Kalkınma Hedefleri'ne ilişkin çalışmaların incelenmesi ve uzman

görüşlerinin alınmasıdır. İkinci aşama, özel hedeflere yönelik öncelik listesinin oluşturulması için AHP ve hedefler arası ilişkiler ağının oluşturulması için ANP süreçlerinin gerçekleştirilmesidir. Hedeflerin önemine ve olası etkilerine göre bir sıralama oluşturulacaktır. Araştırma sonuçları, Makoko toplumunun sürdürülebilirliğine katkıda bulunan, sosyal canlandırma, iklim değişikliğine uyum ve kentsel ölçekte etkili atık yönetimi gibi kritik konulara odaklanan kentsel tasarım müdahalelerinin stratejik bir hiyerarşisini ortaya koymaktadır.

Anahtar Kelimeler: Gecekondular, Yüzen Topluluklar, Sürdürülebilir Kentsel Tasarım ve Mimarlık, Sürdürülebilir Kalkınma Hedefleri, Çok kriterli karar verme.

To My Well-wishers

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LIST OF ABBREVIATIONS

AHP	Analytical Hierarchy Process
ANP	Analytical Network Process
DSS	Decision Support System
DSMIPs	Demand-Side Management Investment Programs
HVAC	Heating Ventilation Air Conditioner
IOT	Internet of Things
SBE	Sustainable Built Environment
SDGs	Sustainable Development Goals
SFDGs	Sustainable Floating Development Goals
SDGs	Sustainable Development Goals
MCDM	Multi-Criteria Decision-Making
MPPUD	Ministry of Physical Planning and Urban Development
NIWA	National Inland Water Authority
UN	United Nations

Chapter 1

Introduction

In recent years, the urban development paradigm has undergone a revolutionary shift, prompting creative ways of decision-making, particularly in marginalised areas confronted with unique constraints. Within this context, the Makoko Community a landmark floating slum, is confronted with the confluence of environmental fragility, limited resources, and the compelling need for long-term solutions. The evolution of decision-making processes, which resulted in the introduction of Analytical Hierarchy Process (AHP) and Analytic Network Process (ANP) methodologies, creates an unparalleled chance in the realm of urban planning and has prompted a reevaluation of community-specific goals tailored to address the complexities of Makoko's unique setting. Through the creation of Sustainable Floating Development Goals (SFDGs) tailored for the Makoko Community, this research aims to navigate this ever-evolving context while adhering to UN sustainable development practices. The importance of this project is underscored by the community's distinct environmental circumstances, where difficulties posed by climate-related disasters meet with stilt and floating structures, creating a unique urban setting that calls for a specialised solution. This research establishes the framework for understanding the complexities and pressing nature of the challenges at hand by delving into the nuances of Makoko's predicament. A range of concerns confront the floating slum, including community engagement, economic well-being, and environmental resilience. This research seeks to shed light on the path toward tailored goals that are consistent with the specific demands of the Makoko Community by contextualising these challenges within the wider discourse of sustainable development. The subsequent sections of this research will examine the integration of past research, expert views, and the application of Analytical Hierarchy Process (AHP) and Analytic Network Process (ANP) methods to create, investigate, and prioritize the tailored SFDGs. This research hopes to provide substantial insights to the greater discourse on sustainable urban development, the findings hold significance not only for the Makoko Community but also for other communities struggling with comparable difficulties.

1.1 Problem Statement and Aim of the Study

Makoko, a floating squatter area that grew informally into a slum, is now renowned for a range of problems such as flooding, poor energy connections, a lack of urban planning, poor waste management, and outdated building technology, which resulted in subpar living conditions and development that was not sustainable, because sustainability is defined as improving the quality of human life while living within the carrying capacity of supporting eco-systems (Moon, 2011). The primary problem with the settlement is a shortage of homes and services, such as safe water, sanitation, and drainage, insufficient solid waste management, access roads, public transport, limited electricity, the health risk of overcrowding, and occupation and natural calamities (Ajayi et al., 2014). The purpose of the research is to customize the Sustainable Development Goals (SDGs) of the United Nations to address the difficulties faced by floating communities such as Makoko and establish the priorities and interrelationships of Sustainable Floating Development Goals (SFDGs). Makoko's unstable living circumstances and the ecological stress brought on by the community's growth make sustainable development essential. By tackling social, economic, and environmental aspects, the SDGs a global framework created to address issues worldwide offer an organized method for reaching sustainability (UN,2022). Nonetheless, the general SDGs' application to diverse regions such as Makoko is limited, hence requiring a customized strategy to address the difficulties encountered by floating slum communities. For the identified SFDGs to be implemented effectively, prioritising and networking them using the Analytic Hierarchy Process (AHP) and Analytic Network Process (ANP) approaches is essential. By addressing the most urgent problems first, the prioritisation maximises the effectiveness of actions and the SFDGs' interdependencies are also essential for holistic and synergistic development as they recognise how advancements in one area may have a beneficial impact on other areas. Through utilizing AHP and ANP approaches, the information gained through standard SDGs is further refined, allowing for a more sophisticated and situation-specific approach to sustainable development in Makoko.

This research intends to explore the numerous concepts surrounding sustainable development goals, slums, and floating architecture in order to alleviate community concerns. To achieve that the following research questions will be answered.

1. What is the existing social, physical, and environmental problems which avoids the sustainable development of Makoko and what is the appropriate approach for sustainable urban design and architecture for Makoko?
2. Which of the Sustainable Development Goals (SDGs) can be tailored to floating slums and which of the goals can be accomplished through architecture?
3. What is the priority in terms of execution to accomplishment of the Sustainable floating development Goals?
4. What is the relationship between the Analytic Hierarchy Process (AHP) and Analytic Network Process (ANP) data results?

1.2 Scope of the Study

This research intends to analyze various concepts to make Makoko a sustainable settlement. Considering this, a variety of issues pertaining to urban growth must be addressed, such as the availability of cheap housing, infrastructure, healthcare, education, gender equality, resources, and economic development. With a focus on Goal no 11 (Make cities and human settlements inclusive, safe, resilient, and sustainable) and several more Sustainable Development Goals will be considered in this research. To achieve that the opening and ending chapters will contain introduction about Makoko and outlining the appropriate design solutions to the community, the second and third chapters will provide the theoretical background on notion of slums, floating communities, sustainable development goals for urban design and architecture, the fourth chapter will be on the urban context of Makoko and it will have a sub chapter for data collection for the interviews conducted through Analytical Hierarchy Process (AHP) to determine the priority list and Analytical Network Process (ANP) to determine the interrelationship between the goals and indicators. During this study the research will satisfy the following aims:

1. Outline the Sustainable Floating Development Goals (SFDG) proposals that are suited for Makoko and meet all sustainability objectives.
2. Provide Makoko with sustainable design techniques that are appropriate for her physical characteristics.

3. Create a priority list for the Sustainable Floating Development Goals (SFDG) approach to Makoko through AHP and ANP.

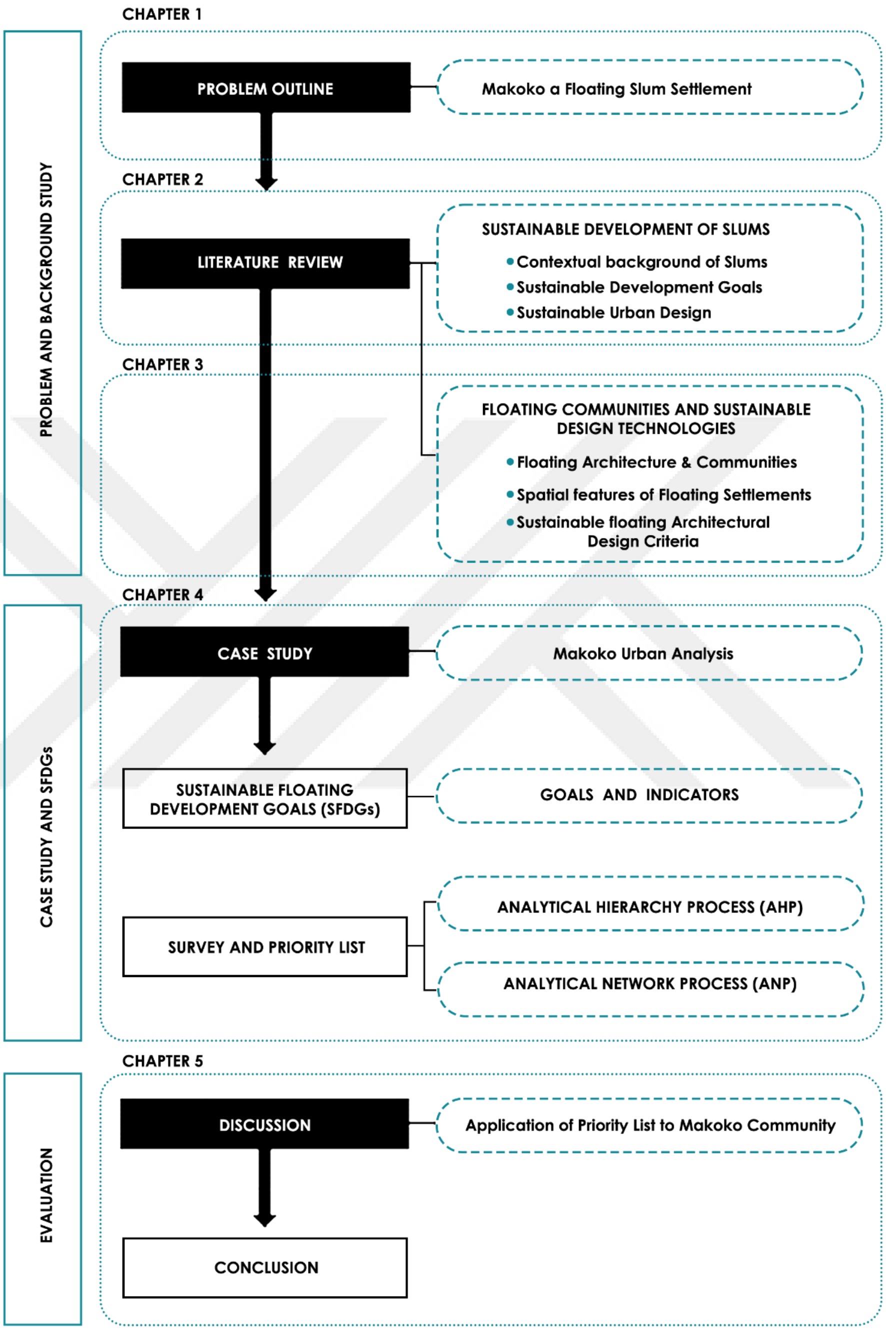

Figure 1. Scope and Context Framework.

1.3 Limitations of the Study

The research has a few limitations, including a paucity of materials on Makoko due to inadequate recording of the area. The inhabitants are not friendly to outsiders, which limits access to specific places. The United Nations Institute, which offered the Sustainable Development Goals (SDGs), did not provide an appropriate framework for implementation. There will be struggles getting in touch with the experts in the field of Architecture and Urban Planners with knowledge of Makoko during the AHP interviews, although expert views are valuable, their evaluations or goal prioritizing may be biased. Backgrounds, experiences, and perspectives of experts may all influence their choices when creating the Priority list for the SFDGs.

1.4 Methods of the Study

The primary purpose of this research is to fill a significant knowledge gap in urban planning for the Makoko Community, a floating slum community. The research methodology adopted for this study is a mixed-method approach, integrating qualitative and quantitative methods to comprehensively explore the unique challenges and opportunities presented by the Makoko community in achieving the Sustainable Floating Development Goals (SFDGs). This study, in accordance with a mixed-method approach, combines both qualitative and quantitative research methods, because it enables the collection of crucial information related to the current conditions, needs, and challenges faced by the Makoko community. The SFDGs and indicators are modeled as a structured network, following a flexible approach, aligned with SDGs guidelines and the theoretical foundation of sustainable development for slums. Then structured questionnaires and prioritization procedures such as the Analytic Hierarchy Process (AHP) and Analytic Network Process (ANP) will be utilized to create data that can be statistically analyzed. AHP and ANP, both proposed by Thomas Saaty, are pairwise comparison measurement theories. It is a widely recognized and approved decision-making process that has been used in a variety of sectors including engineering, business, and social sciences (Saaty,2007). Experts can use the AHP framework to assess and prioritize options based on a set of criteria and sub-criteria. ANP, on the other hand, is a decision-making process and mathematical framework for solving complicated issues containing various criteria, interdependencies, and trade-offs (Burnaz & Topcu, 2006). ANP is intended to assist individuals or organizations in making informed decisions by organizing and analyzing the interactions between various elements within a decision network. ANP recognizes the subtle interplay between elements and accommodates inner and outer dependencies within the network (Valipour et al., 2015). These data sources gotten from AHP and ANP procedures help to establish priorities among several Sustainable Floating Development Goals (SFDGs) and their associated indicators. This list combines professional perspectives and judgements together, providing a clear ranking of the goals based on their significance and possible effect.

This research intends to present data-driven solutions customized to the unique requirements of the Makoko community by merging qualitative and quantitative data. These prioritized aims will therefore serve as the foundation for the construction of a resilient and sustainable Makoko Community, allowing it to thrive despite the particular obstacles given by its floating slum environment.

Chapter 2

Contextualizing Sustainable Development for Slums

2.1 Definition and Characteristics of Slums

The human ecosystem is changing at a rapid pace. Over the previous two centuries, the proportion of people living in cities and towns has risen from 5% to more than 50%. Accelerated urbanization, which began in Europe and North America in the late 18th century with the Industrial Revolution, was followed by the creation of massive slums (Ezeh et al., 2017). Khitrov in Moscow, Russia, the Gorbals in Glasgow, Scotland, and La Chapelle in Paris, France are three well-known examples. Slums already house nearly one billion people, a figure that is anticipated to treble by 2030. In response to the rapid rise of slums, one of the United Nations' Sustainable Development Goals is to alleviate the plight of slums (UN, 2022). According to COLLINS (2012) a slum can be defined as a heavily settled, filthy, and abandoned area of a city that is home to the underprivileged see figure 2. Slums, where living conditions are subpar, have followed the rise of cities in emerging nations. Slums are underserved or sub-service areas of cities where living standards are frequently abhorrently low. Slums are a global problem that affects an estimated one billion people worldwide, particularly in low- and middle-income countries. It is commonly known that slum expansion is primarily a symptom of poverty and that slum settlements cannot be prevented in areas with high levels of poverty and strong urban growth rates. Slums cannot just disappear from emerging nations' cities. Finding practical and effective solutions to this issue is thus a difficulty (Charumitra et al., 2014).

Figure 2. Dharavi slum in Mumbai, India.

(Julie, 2014).

Slums are usually formed when people migrate to urban areas in search of better economic opportunities but are unable to afford adequate housing. In many cases, these migrants end up living in informal settlements that lack basic amenities such as running water, sanitation, and electricity (Ezeh et al., 2017). In many cases, slums are in areas that are vulnerable to natural disasters such as floods and landslides. This can exacerbate the already poor living conditions and put residents at risk of injury or even death. Slums can have a negative impact on the broader urban environment, with waste and pollution contributing to environmental degradation (UN, 2022). This can have implications for public health, as well as the long-term sustainability of urban areas. Urban slums frequently exhibit poverty, excessive crowding, a lack of amenities, and a lack of infrastructure. Urban service shortages have adversely impacted the urban poor in general and slum dwellers in particular. Due to their proximity to solid waste disposal sites, open drains and sewers, low topography, embankments, and usually railroad tracks, slums have extremely unclean conditions (Chowdhury & Amin, 2006). Poverty is one of the key contextual aspects that enables the continuous existence of slums. Slums usually have high levels of poverty, with individuals earning less than $1 per day. Poor educational attainment, limited access to healthcare, and weak social security systems are only a few of the numerous factors that contribute to poverty. In many cases, disadvantages such as race, ethnicity, gender, and disability are inextricably linked to poverty (Elrayies, 2016).

Figure 3. Aerial view of Floating Community in Ganvie, Benin-Republic.

(Yakubu, 2023).

Slums are a major problem in many African countries, as rapid urbanization and bad urban planning have resulted in the expansion of squatter communities. Slums in Africa today are often characterized by substandard housing, inadequate sanitation, and limited access to basic amenities such as clean water, education, and healthcare. Slum inhabitants have significant economic challenges, such as limited access to formal work and acute poverty (Parienté, 2017). Floating slums are a type of slum that can be prevalent in numerous coastal cities and towns across the world, particularly in Africa. Substandard housing, inadequate sanitation, and limited access to critical facilities are common features of these communities (Cerro, 2016). They are occasionally built on boats or rafts anchored in rivers, lagoons, or harbors. Floating slums are common in Africa in areas where the population has surpassed the local government's ability to provide adequate housing and infrastructure. Fishermen, merchants, and other low-wage workers with few other opportunities can dwell in floating slums. Some well know floating slums include, Makoko in Nigeria, Ganvie in Benin-Republic as shown in figure 3, and Kisenyi in Uganda (Duke, 2018).

Figure 4. Sanjaynagar Slum Redevelopment Project, India (Abdel, 2022).

With the assistance of several donor organizations, the government must carry out many slum rehabilitation efforts to improve the failing socioeconomic and physical environmental conditions of the slums (Charumitra et al., 2014). Improvements to the infrastructure, instruction in nutrition and hygiene, skill-based training, income-generating ventures, and community mobilization and awareness campaigns are some of these projects. For instance, facility rehabilitation initiatives aim to proactively alleviate the risky and unhygienic living conditions in the slums as done in Sanjaynagar slum redevelopment project in figure 4. The construction of drains and sewage lines, walkways, latrines or communal latrines, trash cans, drinking water supply, better housing, flood protection, and street lighting are all included in plans for infrastructure repair. These restoration initiatives directly impact the environment of the slums (Chowdhury & Amin, 2006).

2.2 Approaches to Sustainable Development in Slum Settings

In response to the imminent environmental issues of emissions, resource depletion, global warming, and climate change, worldwide awareness of the need for sustainable development is growing. However, many interventions put out through different slum improvement schemes do not consider long-term sustainability (Smeddle & Roux, 2015). Environmental, economic, and social interventions are all part of interdisciplinary slum rehabilitation programs. These goals are consistent with the goal of sustainable urban development, which is to build livable, socially just, and economically viable urban communities with greater access to services and appropriate urban settings. There are different approaches stakeholders have used for slum redevelopment projects over the years (Elrayies, 2016).

Figure 5. Quinta Monroy Redevelopment Project Iquique, Chile (Aravena, 2016).

The first strategy is community slum upgrading. This strategy comprises supporting slum inhabitants in improving their living conditions. As part of this participatory technique, residents are involved in the development, construction, and maintenance of infrastructure and services (Mehta et al., 2008). The figure 5 depicts the approach's implementation in Quinta Monroy redevelopment project in Iquique, Chile. Quinta Monroy's houses were built with basic infrastructure and services at the forefront, but with the ability for homeowners to extend and upgrade their homes if their demands and financial conditions changed. This strategy is intended to empower inhabitants and foster a sense of belonging and community (Aravena, 2016). The second alternative is to form public-private partnerships. The public and commercial sectors must collaborate to restore slums using this strategy. The commercial sector may contribute money, supplies, and talent to the restoration effort. The authorities can provide regulatory help as well as resources such as land (Charumitra et al., 2014).

Relocating out of a slum is the third strategy. Under this strategy, slum dwellers are transferred to other housing possibilities. This strategy has a number of benefits, including the possibility for bettering slum dwellers' living conditions and producing new housing possibilities. The relocation procedure must be fair and equitable, and uprooting slum dwellers without providing them with acceptable housing choices must be avoided (Mehta et al., 2008). The gradual slum upgrading method is the fourth strategy. This strategy calls for making little, ongoing improvements to slums. It entails identifying priority areas for development with slum dwellers and carrying out focused interventions to enhance living circumstances. This strategy offers a number of benefits, including the opportunity to make changes gradually, making them more controllable and affordable than major redevelopment projects (Charumitra et al., 2014). As previously indicated, the slums have a negative influence on the environment, deteriorating the quality of the water and soil and adversely affecting the communities in which they are located, to tackle the problem the pillars of sustainability must be incorporated into slum rehabilitation programs. As shown in the image below, there are three areas of focus economic, social, and environmental all address various parts of the slum issues that must be resolved throughout the reconstruction (Hannula, 2012).

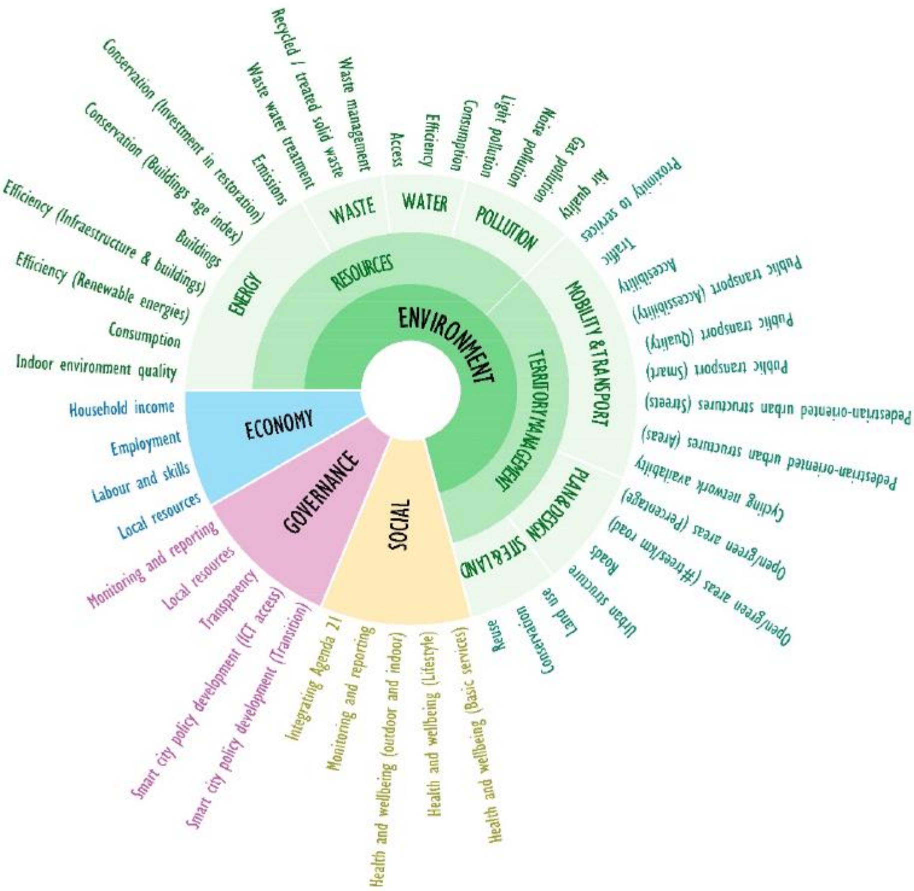

Figure 6. Sustainable Urban Indicators

(UN, 2022)

Economic development aspects are critical to eradicating poverty, slum economies are critical in assisting slum dwellers in developing countries to meet their fundamental needs. It is critical to provide the impoverished with excellent job that provides both empowerment and a stable income as shown in figure 6. The social perspective on slum redevelopment stresses the premise that acquiring appropriate work is the most direct path to socioeconomic improvement, individual well-being, and poverty abolition. Unemployment is the primary cause of poverty (Mehta et al., 2008). Working is sometimes the only way for the poor to improve their level of living. It is critical to establish opportunities for productive employment in order to eliminate poverty and promote long-term social and economic prosperity (Elrayies, 2016).

Figure 7. Mkombozi Primary School, Tanzania
(Caballero, 2017).

The objective of social intervention aspects is for all groups to participate equitably in all stages of development. It is critical to avoid excluding persons with low incomes. This is especially relevant in developing countries because people with low incomes are typically excluded from official planning systems. Social sustainability may be achieved by clarifying four connected and complementary interventions: social inclusion, collaboration, empowerment, and outreach programs

(Mehta et al., 2008). According to a comprehensive online search, these solutions may seem diverse in language, but they are tightly related and consistent in both substance and goal. It might be claimed that people' collaboration in their own improvement initiatives implies social inclusion. Local communities must be educated in order to collaborate in the renovation of informal areas. The empowerment process culminates in community outreach programs, in which residents assume responsibility and dependability even after the upgrading operation is completed (Cappo & Verity, 2014). It is possible to improve social sustainability by giving slum dwellers equitable access to necessities of life such food, clean water, clothes, housing, healthcare, education, transportation, and other public services. For people of informal settlements to live with dignity, social inclusion involves providing for their fundamental necessities. It opposes the stigma attached to informal housing and its people and advocates for equal opportunities for all social groups (Elrayies, 2016). This can be seen in Mkombozi Primary School commissioned by a Tanzanian religious order, where all interventions of social sustainability were the foundation of its conception (Figure 7).

Environmental sustainability is a complicated issue that requires finding a balance between numerous aspects as seen in figure 6. These concerns involve energy-related challenges such as energy conservation in construction, material production and transportation, the use of renewable energy sources, and designing and planning for energy efficiency (Hannula, 2012). In addition to discovering locally available resources, recycling, avoiding pollutants and toxins, collecting rainwater, and appropriately disposing of rubbish are all important. Poverty, as represented in variables such as a lack of access to clean water, inadequate sanitation and waste management, indoor air pollution, and overcrowding, is widely recognized as one of the key factors influencing the environmental health of slum dwellers. Improving the health and living conditions of millions of slum dwellers worldwide is a critical requirement for the current Sustainable Development Goals to reduce poverty (Hák, Janoušková, & Moldan, 2016).

2.3 Overview of Sustainable Development Goals of UN (SDGs)

The Sustainable Development Goals, or SDGs, are a bold step toward sustainable development that includes a significantly broader definition of sustainability than has previously been achievable. As sustainability is intended to accomplish so many distinct tasks, it is challenging to come to an agreement on a definition (Hannula, 2012). The quality of sustainability is perseverance, the capacity for long-term preservation of well-being, which encompasses social, economic, and environmental components, is referred to as people's sustainability. Although vague, the straightforward definition of sustainability as "increasing human well-being while residing within the carrying capacity of supporting ecosystems" suggests that there are quantitative boundaries to sustainability (Moon, 2011). Sustainable development is one that satisfies current needs without endangering the ability of future generations to satisfy their own. Yet there are real problems, including how to bring forth transformation. The concept of sustainable development (SD) has historically grown in the context of environmental concerns, as indicated by its introduction in the World Charter for Nature at a UN summit in 1982. The Sustainable Development Goals (SDGs) are a set of global targets, standards, and measures that will steer UN member states' agendas and actions for the next 15 years (Figure 8) (Hák, Janoušková, & Moldan, 2016).

Figure 8. United Nation's Sustainable Development Goals

(UN, 2022).

A slew of issues is convergent in the world today, presenting a threat to humanity's very existence. The SDGs address all of these concerns, as well as how to avoid and manage them, in a comprehensive manner. The Sustainable Development Goals (SDGs) were presented and agreed upon in 2015 as part of Agenda 2030, the United Nations' strategy to promote global sustainability by 2030. The SDGs are a bold step toward attainable objectives for sustainable development that cover all aspects of sustainability and all socioeconomic sectors. They consist of 17 goals that span all aspects of sustainability (Fleming, Wise, Hansen, & Sams, 2017).

1. Goal 1: No Poverty - To eradicate extreme poverty and reduce inequality among all people and countries.
2. Goal 2: Zero Hunger - To end hunger and malnutrition, improve food security and promote sustainable agriculture.
3. Goal 3: Good Health and Well-being - To ensure healthy lives and promote well-being for all at all ages.
4. Goal 4: Quality Education - To provide inclusive and equitable quality education and promote lifelong learning opportunities for all.
5. Goal 5: Gender Equality - To achieve gender equality and empower all women and girls.
6. Goal 6: Clean Water and Sanitation - To ensure availability and sustainable management of water and sanitation for all.
7. Goal 7: Affordable and Clean Energy - To ensure access to affordable, reliable, sustainable, and modern energy for all.
8. Goal 8: Decent Work and Economic Growth - To promote sustained, inclusive, and sustainable economic growth, full and productive employment and decent work for all.
9. Goal 9: Industry, Innovation and Infrastructure - To build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation.
10. Goal 10: Reduced Inequalities - To reduce inequality within and among countries.
11. Goal 11: Sustainable Cities and Communities - To make cities and human settlements inclusive, safe, resilient and sustainable.

12. Goal 12: Responsible Consumption and Production - To ensure sustainable consumption and production patterns.
13. Goal 13: Climate Action - To take urgent action to combat climate change and its impacts.
14. Goal 14: Life Below Water - To conserve and sustainably use the oceans, seas and marine resources for sustainable development.
15. Goal 15: Life on Land - To protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss.
16. Goal 16: Peace, Justice and Strong Institutions - To promote peaceful and inclusive societies, provide access to justice for all and build effective, accountable and inclusive institutions at all levels.
17. Goal 17: Partnerships for the Goals - To strengthen the means of implementation and revitalize the global partnership for sustainable development.

The SDGs provide a roadmap for countries, organizations, and individuals to work together towards a more sustainable future. Each goal is interconnected, and achieving one goal can positively impact progress towards other goals (UN, 2022). The philosophy that the achievement of one goal may spur improvements in others is emphasized by the synergistic effect created by the SDGs' relations. Since proper nutrition is essential to health, the SDGs of "Zero Hunger" (SDG 2) and "Good Health and Well-Being" (SDG 3) are closely related. 'Quality Education' (SDG 4) empowers people and communities with information and skills, which simultaneously helps to alleviate poverty (SDG 1). These objectives' interconnectedness emphasises how crucial it is to approach sustainable development from a comprehensive and integrated perspective (Fleming, Wise, Hansen, & Sams, 2017).

The research will focus on Goal no 11: Make cities and human settlements inclusive, safe, resilient, and sustainable. To do this, it is required to address a number of urban development-related concerns, including affordable homes, infrastructure, healthcare, education, gender equality, resources, and economic development. To achieve a sustainable city, as outlined by the Sustainable Built Environment Series, this research will take into account a variety of additional Goals. The study seeks to shed light on the intricate interactions between various sustainable development variables in urban settings by taking a comprehensive approach to the SDGs.

2.4 Interconnection of Sustainable Development Goal 11(Sustainable Cities and Communities) In Slums

The growing urbanization of the world and worries about the sustainability of the environment served as the catalyst for the worldwide discussion on environment and development. Urban growth might be both sustainable and inclusive if it is carefully planned and managed (Hannula, 2012). On the other hand, rapid and poorly planned urbanization results in a number of problems, such as a lack of affordable housing, inadequate infrastructure (such as public transportation and essential services), a lack of open spaces, unhealthy air pollution levels, and a higher risk of natural disasters (Simon & Arfvidsson, 2015). SDG 11 seeks to make cities and human settlements more resilient, safe, and inclusive. Promoting small, walkable communities that encourage active transportation and reduce reliance on automobiles, funding publicly accessible and reasonably priced public transportation systems, and creating green spaces that provide ecosystem services such as air purification and stormwater management are all critical components of a global development strategy (UN, 2022). According to United Nations, the SDG 11 has several key targets, including:

1. Safe and Affordable Housing: By 2030, it is hoped that everyone would have access to vital utilities and safe, inexpensive, and acceptable housing, as well as that slums will be modernized.
2. Sustainable Urban Transport: It aims to enhance road safety by boosting public transit and ensuring that everyone has access to safe, affordable, accessible, and sustainable transportation systems by 2030.
3. Inclusive and Sustainable Urbanization: By 2030, it is aimed to dramatically reduce the number of fatalities, persons impacted, and direct economic losses

caused by catastrophes, especially those connected to water, compared to global GDP, with an emphasis on protecting the vulnerable and disadvantaged.

4. Cultural Conservation: The objective is to step up efforts to protect and preserve the world's cultural and natural heritage by 2030.
5. Social Inclusion: Everyone, notably women, children, the elderly, and people with disabilities, is expected to have access to green places that are secure, pleasant, and accessible by 2030.
6. Sustainable urbanization management: Policies for sustainable urbanization and land-use planning, as well as better national and regional development planning, are expected to have been put into place by 2030.
7. Environmental Sustainability: By 2030, it is hoped that cities would have fewer adverse environmental effects per capita, in part by giving waste management and air quality special attention.

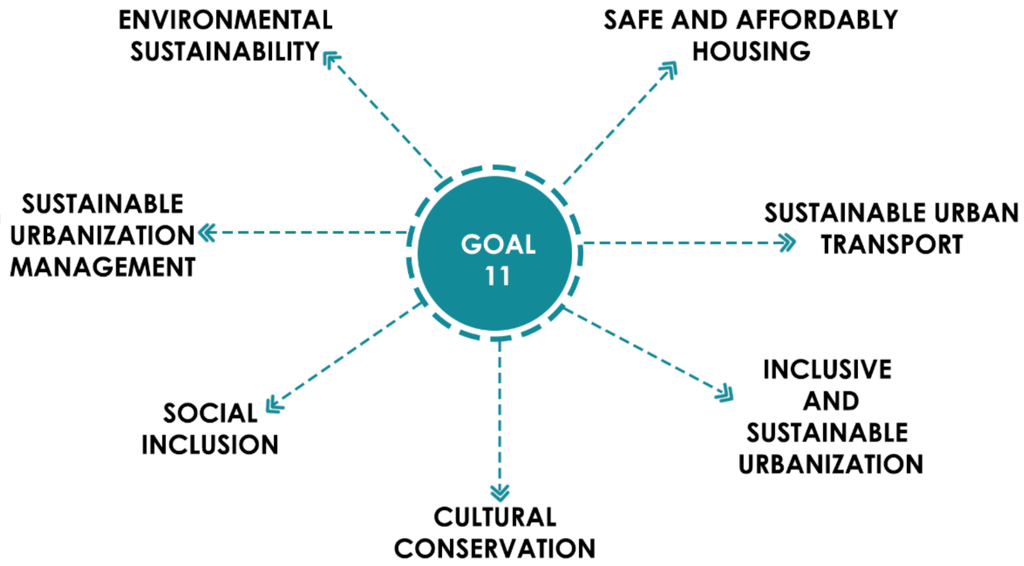

Figure 9. SDGs 11 key targets

(UN, 2022).

Although the targets described above are important indicators of SDGs Goal no 11, they require a clear framework for achieving a sustainable built environment. The impact of Sustainable Development Goal 11 is apparent in its emphasis on the need for inclusive, resilient, and well-managed cities as a response to the problems posed by urbanization. Unplanned urban expansion that happens quickly presents risks including poor infrastructure, a shortage of accommodation, and heightened susceptibility to natural disasters. SDG 11 tackles these problems by aiming to create ecologically sustainable, inclusive, and safe cities. The indicators are goals outlined by the United Nations for 2030 for the countries trying to incorporate Goal no 11, in order to achieve a sustainable urban design, the procedure, systematic or orderly arrangement together with the idea of a clearly defined goal as an end product should be outlined.

2.5 Overview of Sustainable Built Environment Series

Environmentally conscious architectural design methods are referred to as "sustainable architecture." The broader conversation about sustainability and the most important global economic and political issues characterizes the sustainable design. By improving efficiency and moderation in the use of materials, energy, and development space, the sustainable design aims to reduce the harmful environmental effects of buildings (Moon, 2011). An established international forum for conferences devoted to promoting sustainable practices in the built environment is the Sustainable Built Environment (SBE) series. Since its launch in 2000, the SBE series has been instrumental in influencing the conversation about sustainable development in the fields of urban planning and building (SBE, 2022). Sustainable built environment (SBE) refers to the study of techniques for organizing, planning, constructing, and sustaining the structures and built environments that will be necessary as a part of a more sustainable society (Hannula, 2012). SBE aims to construct structures that consume less energy, water, and trash while also considering the health and welfare of residents and the surrounding community. SBE's guiding values include using renewable resources, reducing greenhouse gas emissions, limiting waste and pollution, safeguarding natural resources, and furthering social justice. SBE is increasingly important as the world grapples with concerns like urbanization, resource depletion, and climate change. It is possible to develop infrastructure and buildings that are not only environmentally friendly but also more durable and cost-effective in the long term by employing sustainable design approaches. The Sustainable Development Goals

(SDGs) of the United Nations (UN) can be connected to numerous aspects of the sustainable built environment (SBE), including the eight SDGs that surround Goal 11 (Sustainable Cities and Communities) to achieve a sustainable environment that are most pertinent to the built environment for the SBE series as seen in figure 10 (SBE, 2022). A sustainable built environment is a critical component of achieving the United Nations' Sustainable Development Goal 11, which aims to create inclusive, safe, resilient, and sustainable cities and human settlements. Achieving this goal requires addressing a range of social, economic, and environmental issues, including poverty, health, sanitation, energy, economic growth, innovation, consumption patterns, and climate change.

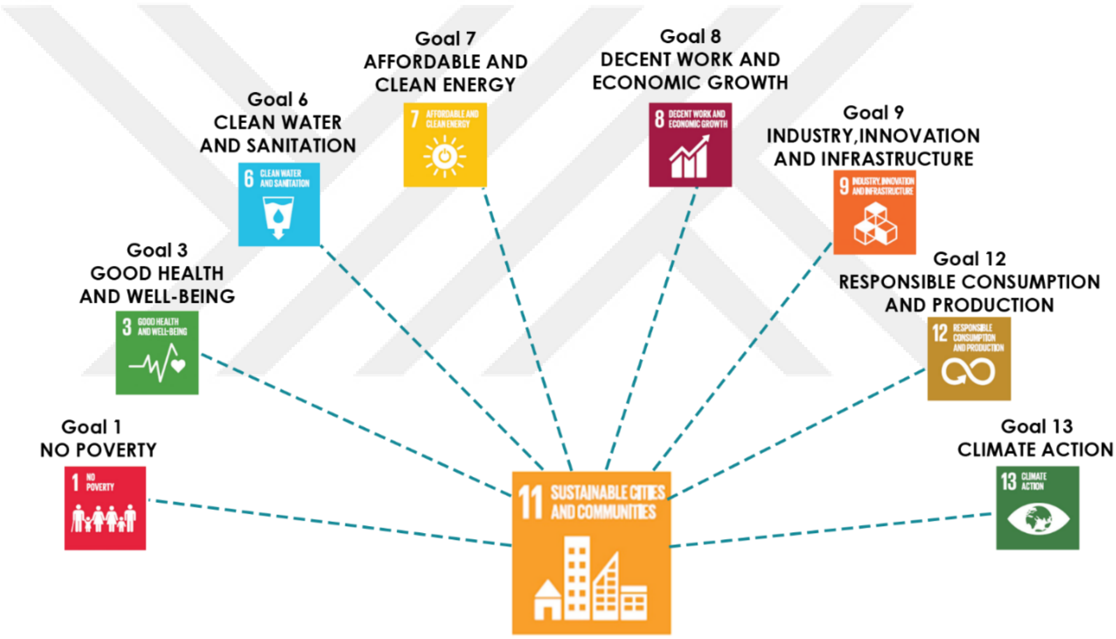

Figure 10. SDG 11 Connection Network as presented by SBE Series (SBE, 2022).

The fulfillment of this target, however, is highly contingent on the accomplishment of other Sustainable Development Goals such as Goal 1, 3, 6, 7, 8, 9, 12, and 13 must all work together to develop a sustainable built environment. These objectives range from eradicating poverty and reducing inequality to promoting health and well-being, ensuring access to safe drinking water and sanitation, providing affordable and clean energy, promoting economic growth and innovation, encouraging responsible consumption and production, and taking immediate action to combat climate change. It is attainable to construct sustainable built environments that support the health and well-being of all people and promote a vibrant, resilient, and equitable society by concentrating on these linked aims. A coordinated effort from governments, corporations, civil society, and individuals is required to achieve these goals, with a focus on collaboration and partnership. Architects and planners cannot create a sustainable built environment solely through design; as previously stated, only SDGs 3, 6, 7, 9, and 13 may be affected through architecture. Encouraging well-being and healthy lifestyles, assuring sustainable water collection, usage, and disposal, and promoting the use of green energy in the building and community Supporting ecologically sustainable infrastructure, which encourages innovation, and, lastly, battling climate change. Designers and planners can manage all of these, but the remainder of the goals will need action from the government and other stakeholders. Goals 1, 8, and 12 address poverty eradication, providing decent work for everyone in order to promote inclusive and sustainable economic growth, and ensuring sustainable consumption and production patterns. Only by collaborating a sustainable built environment that is resilient, vibrant, and equitable for all could be created.

2.6 Projection of Sustainable Urban Design Criteria for Slum Settings

Urban design, or the art of designing cities, is the process by which man creates a physical environment that meets his needs and represents his values. The three fundamental goals of urban design are to produce aesthetically appealing urban developments that are also structurally and operationally sound (Fleming, Wise, Hansen, & Sams, 2017). Urban design is defined by these three characteristics: practicality, durability, and the ability to offer the user with a sense of well-being and emotional fulfillment. The basic approach to urban planning and the tools used within it have been devised to achieve these connected goals (Moughtin et al., 1999). The Sustainable Development Goals (SDGs) provide nations, organizations, and individuals with a road map for proceeding in the direction of a more sustainable future. All facets of sustainability, including sustainable urban design, are covered under the 17 SDGs (UN, 2022). Urban inclusiveness, safety, resilience, and sustainability are the goals of Goal 11: Sustainable Cities and Communities. Addressing a variety of urban development-related issues, including affordable housing, infrastructure, healthcare, education, gender equality, resources, and economic development, is necessary to achieve this aim (Larco, 2015). Based on the research conducted for this study, the criteria for a sustainable urban design are listed below (UN, 2022, Larco, 2015, Moughtin et al., 1999, Fleming, Wise, Hansen, & Sams, 2017, Michael, Isaac, & Olusola, 2017).

Table 1

Sustainable Urban Design Criteria

Criteria	**UN SDGs Satisfied**	**References**
Compact and Mixed-usage Development	Goal 3 (Good Health and Well-being) Goal 8 (Decent Work and Economic Growth) Goal 9 (Industry, Innovation, and Infrastructure) Goal 12 (Responsible Consumption and Production)	(UN, 2022) (Larco, 2015) (Moughtin et al., 1999) (Fleming, Wise, Hansen, & Sams, 2017) (Michael, Isaac, & Olusola, 2017)
Green and open spaces	Goal 3 (Good Health and Well-being) Goal 13 (Climate Action)	(Michael, Isaac, & Olusola, 2017) (SBE, 2022) (UN, 2022) (López Chao, Casares Gallego, Lopez-Chao, & Alvarellos, 2020)
Energy Efficiency and Renewable Energy	Goal 7 (Affordable and Clean Energy)	(Mersal, 2016)

	Goal 12 (Responsible Consumption and Production)	(Carmona, 2009) (UN, 2022) (SBE, 2022)
Sustainable Transportation	Goal 3 (Good Health and Well-being) Goal 12 (Responsible Consumption and Production), Goal 13 (Climate Action)	(Carmona, 2009) (Zivkovic, Jovanovic, & Kondic, 2014) (UN, 2022)
Access to Basic Services	Goal 3 (Good Health and Well-being) Goal 6 (Clean Water and Sanitation) Goal 13 (Climate Action)	(Carmona, 2009) (Mersal, 2016) (López Chao, Casares Gallego, Lopez-Chao, & Alvarellos, 2020)
Social Equity	Goal 1 (No Poverty) Goal 3 (Good Health and Well-being)	(Zivkovic, Jovanovic, & Kondic, 2014) (UN, 2022) (Mersal, 2016)

1. Compact and Mixed-usage Development: This design strategy incorporates compact building designs that limit land usage while including a mix of residential, commercial, and public areas within a community. This reduces reliance on vehicles and increases walkability, lowering carbon emissions and increasing air quality (Moughtin et al., 1999). This strategy is congruent with the concept of a '15-minute neighborhood,' where everything you need is a short walk away, making life more pleasant and sustainable for everyone (Larco, 2015). Goal 3 (Good Health and Well-being), Goal 8 (Decent Work and Economic Growth), Goal 9 (Industry, Innovation, and Infrastructure), and Goal 12 (Responsible Consumption and Production) will be met by adopting this and accordingly the

criteria have been decided (UN, 2022, Larco, 2015, Moughtin et al., 1999, Fleming, Wise, Hansen, & Sams, 2017, Michael, Isaac, & Olusola, 2017).

2. Green and open spaces: Integrating green and open spaces in urban configurations may be beneficial to elevate the quality of the air, offer recreational space, reduce urban heat island effects, and enhance biodiversity. Public parks, green roofs, and urban forests are examples of such settings (Michael, Isaac, & Olusola, 2017). The SDGs: Goal 3 (Good Health and Well-being) and Goal 13 (Climate Action) will be achieved by adopting this and accordingly the criteria have been decided (UN, 2022, SBE, 2022, Michael, Isaac, & Olusola, 2017, López Chao, Casares Gallego, Lopez-Chao, & Alvarellos, 2020).
3. Energy Efficiency and Renewable Energy: Creating energy-efficient buildings and encouraging the use of renewable energy sources can assist to reduce carbon emissions and expenses for energy. This may be accomplished by using sustainable construction materials, passive solar design, and renewable energy sources such as solar, wind, and geothermal (Mersal, 2016). Goal 7 (Affordable and Clean Energy) and Goal 12 (Responsible Consumption and Production) will be fulfilled by adopting this and accordingly the criteria have been decided (UN, 2022, Mersal, 2016, Carmona, 2009, SBE, 2022).
4. Sustainable Transportation: Promoting ecologically friendly means of transportation such as walking, biking, and public transportation can help reduce reliance on automobiles and improve air quality. This may be accomplished by providing pedestrian and bike infrastructure as well as investing in public transit networks (Hannula, 2012). By successfully doing so, the SDGs: Goal 3 (Good Health and Well-being), Goal 12 (Responsible Consumption and Production), and Goal 13 (Climate Action) will be attained and accordingly the criteria have been decided (UN, 2022, Zivkovic, Jovanovic, & Kondic, 2014, Mersal, 2016, Carmona, 2009, SBE, 2022).
5. Access to Basic Services: It is critical to ensure that basic services are available to all inhabitants such as water, sanitation, and healthcare, in order to build inclusive and sustainable communities. This may be accomplished through providing public services and promoting community-based initiatives (Fleming, Wise, Hansen, & Sams, 2017). The SDGs: Goal 3 (Good Health and Well-being), Goal 6 (Clean

Water and Sanitation), and Goal 13 (Climate Action) will be adhered to by adopting this and accordingly the criteria have been decided (UN, 2022, Zivkovic, Jovanovic, & Kondic, 2014, Mersal, 2016, Carmona, 2009, SBE, 2022, López Chao, Casares Gallego, Lopez-Chao, & Alvarellos, 2020).

6. Social Equity: Ensuring that sustainable urban design serves all members of the community, particularly underprivileged and disadvantaged groups, by providing cheap housing, fair access to transportation, and encouraging social inclusion (Zivkovic, Jovanovic, & Kondic, 2014). The SDGs: Goal 1 (No Poverty) and Goal 3 (Good Health and Well-being) will be achieved by adopting this and accordingly the criteria have been decided (UN, 2022, Zivkovic, Jovanovic, & Kondic, 2014, Mersal, 2016, Zivkovic, Jovanovic, & Kondic, 2014, SBE, 2022, López Chao, Casares Gallego, Lopez-Chao, & Alvarellos, 2020).

Based on the specific requirements offered, it is clear that sustainable urban design entails a multidimensional approach to designing cities that are both practical and environmentally friendly. These criteria offer a base framework for developing living conditions that are both sustainable and beneficial to human well-being. They are consistent with the United Nations' Sustainable Development Goals (SDGs), notably Goal 11 (Sustainable Cities and Communities), and provide a blueprint for constructing cities that can flourish in the face of environmental and social problems.

Chapter 3

Floating Communities, Floating Architecture and Sustainable Design Technologies

3.1 Definition and Aspects of Floating Communities

As humanity grapples with the difficulties caused by global warming, the number of proposals for improving the planet's ability to adapt to natural disasters grows. As a result of the rising river and sea levels caused by climate change, seaside settlements confront several challenges (Cerro, 2016). To solve these difficulties, architects and designers must first recognize the need for typological breakthroughs in floating and amphibious architecture. Floating architecture refers to any structure that is designed to float on water, and it can include anything from single-family homes to multi-story office buildings (Moon, 2011). The floating architecture consists of structures that either permanently float on the surface of the water or only float during a flood, both of which make them safe from changing water levels. In order to qualify as floating architecture, a building must be permanently anchored, float on water using a flotation device, exclude boats needed for mobility, and have a facilities service (electricity, water/sewage, gas) system (Penning-Rowsell, 2019).

Figure 11. Floating vernacular Architecture in Ganvie, Benin-Republic.

(Yakubu, 2023)

The idea of floating architecture is not a new one, and humans have been building structures that float on water for centuries. However, recent advancements in technology and materials have made it possible to create more complex and sustainable floating structures. One of the main benefits of floating architecture is that it can be used to create additional living or working space in areas where land is scarce just like Ganvie in Benin-Republic showing vernacular floating architecture in figure 11 (Yakubu, 2023). For example, in densely populated cities where there is limited space for new construction, floating architecture can be used to create additional housing or office space without taking up valuable land. Additionally, floating structures can be designed to be mobile, which allows them to be easily relocated to different locations as needed. Floating architecture also offers several benefits in terms of sustainability (Lin et al., 2018). Floating structures can be designed to be energy-efficient by incorporating features such as solar panels, wind turbines, and water recycling systems as seen in Nle's Makoko floating school. Additionally, as floating structures are not attached to the ground, they are less susceptible to damage from floods or earthquakes

(Moon, 2014). And as for Floating communities, they're clusters of floating structures that are designed to form self-contained communities. These communities can include everything from residential neighborhoods to commercial centers and can be created in a variety of locations, including coastal areas, rivers, and lakes. As sea levels continue to rise, many coastal communities are facing the prospect of being displaced. However, by creating floating communities, these communities can be relocated to the water while still maintaining their way of life (Trang & Vukorep, 2021).

Figure 12. Phnom Penh Floating Slum, Cambodia

(Reuters, 2021).

Floating settlements have thrived throughout history in a variety of configurations and on a range of water bodies. They have been spotted in a variety of locations around the world, including lakes in Cambodia where large communities practice aquaculture and fishing, the reliance on water bodies for livelihoods and sustenance led to the development of the floating settlement centered around aquatic activities see figure 12 (Roshko, 2011). Ganvie in Benin, Africa figure 11, where the

Tofinu tribe adopted the shape of a floating village as a deterrent to slave trading as early as the 16th century showcasing how the community was shaped by historical circumstances. Floating settlements have previously existed in Vietnam, Indonesia, Thailand, China, Peru, and Bolivia, in addition to these two examples, the diversity in locations underscores the universal challenges these communities addressed, such as land scarcity and the need for innovative housing solutions (Lin, Spijkers, & van der Plank, 2021). The floating villages could take the form of houseboats or normal houses and cottages. The roots of modern floating homes may be traced back to the 1980s and can be linked to a lack of land and budgetary constraints. International Marine Floatation System Inc. created a revolutionary technology for creating land on the ocean at the time. This strategy generated a structure that was intrinsically buoyant and "unsinkable" by combining a concrete shell with a polystyrene foam core. This technology enabled the creation of large floating housing developments in Vancouver (Bhatt, 2020). Moving forward, the ensuing discussion will delve into an examination of spatial characteristics and technological dimensions.

3.2 Spatial Characteristics of Floating Settlements

Spatial features are the physical properties and configuration of objects or buildings inside a certain space. In the context of urban planning or architecture, spatial aspects include the location of public spaces and services, the use of land and resources, and the overall organization and design of a given area or community. The geographic attributes of a site can be used to improve social interaction, economic development, and long-term prosperity. These factors can have a considerable impact on a location's usefulness, accessibility, and overall visual appeal (Smith, 2007). In some coastal cities, the prospect of floods and sea level rise along with rapid urbanization led to the construction of floating villages, which are communities built on water. The geographical characteristics of floating cities are influenced by their water environment, unlike typical land-based towns. Spatial features in the context of floating settlements can include a variety of elements related to the physical layout and organization of the community (Lin, Chih Lin, & Tan, 2018). While examining the geographic characteristics of a floating village, the important factors listed below should be taken into account:

1. Layout and configuration: This includes the physical layout of the buildings and public spaces inside the neighborhood, as well as the overall size and shape of the community. The layout, together with the visual and social elements of the community, can influence how successfully and functionally the region works (Ko, 2015). Narrow canals or highly inhabited buildings might impede navigation and restrict available areas for outdoor activities. A well-planned and spacious layout, on the other hand, may promote ease of mobility and create pleasant public places (Penning-Rowsell, 2019). Thus, deciding on the shape and arrangement of a floating village, designers and planners should consider the wants and needs of the community members as well as the environmental features of the region. This may ensure that the settlement is practical, functional, and aesthetically engaging. Given that the community is built on water and is subject to fluctuating water levels and conditions, the layout and placement of the structures inside it must be adaptive and flexible in terms of design. It should be resilient as well. Resilience in the built environment is the capacity to adapt to changing conditions and maintain or restore functioning and vitality in the face of stress or disturbance (Moon, 2015).
2. Access and circulation: Roads, canals, and other modes of transportation are utilized to transport people both within and outside of the village. Access and circulation may have a substantial impact on a community's functionality and viability. A well-planned network of canals and walkways for pedestrians may provide swift and efficient travel across the neighborhood. Poorly designed or overcrowded pathways, on the other hand, may affect traffic and provide a safety risk (Putro & Zain, 2021). In the transportation chain, sustainability is commonly used to define a community's commitment to the long-term growth of a circulation system that it owns and uses. Historically, transportation infrastructure has been built using principles that emphasize traffic mobility, lower early running costs, and take social and environmental demands into account. To enable sustainable mobility in floating cities, a mix of electric-shared and networked transportation systems might be deployed. Several city circles may be equipped to accommodate multiple modes of transit (Umar, 2020).

3. Resource distribution: The availability and distribution of resources including food, energy, and water are the subject focus. The accessibility and use of these resources by community members, as well as their overall quality and sustainability, may be impacted by the physical aspects of the settlement. The location of water sources and sewage treatment facilities can have an impact on the quantity and quality of water available in a community. The sustainability and resilience of the settlement may also be impacted by the availability of renewable energy sources like solar or wind energy (Abubakar & Dano, 2019). While building and organizing the spatial elements of a floating town, planners and designers should take resource distribution and availability into account. This might help guarantee that resources are used efficiently and sustainably, and that locals have access to what they need (Bhatt, 2020). To ensure the sustainability of the floating cities, waste management in the settlement should incorporate recycling and reuse of plastic waste in affiliation to waste creation and disposal. To grow food, it will be essential to employ techniques like indoor and outdoor farming, three-dimensional (3D) ocean farming, aquaponics, and aeroponics. In terms of energy, two things will be crucial. Using renewable energy is one example, while energy efficiency is another. There are several environmental and global challenges as a result of the unsustainable nature of current energy production and consumption practices. Renewable energy sources such as biomass, the solar, wind, and geothermal energy are accessible all over the world. Yet, the oceans may supply renewable energy in the form of waves and tidal currents, which may be employed immediately for floating communities (Nguyen, 2021).
4. Social organization: This involves the creation of social networks, the establishment of rules and standards, and how community members gather and interact. The physical components of the settlement can have an impact on the social dynamics of the neighborhood as well as the togetherness and resilience of the community. This includes concerns such as the architecture of public spaces and the proximity of residential and business areas. A well-designed public space may foster social interaction and make residents feel more connected to one another. The proximity of residential and commercial sectors may also have an

influence on the community's liveliness and accessibility (Naing, Santosa, & Soemarno, 2011). While planning and organizing the physical elements of a floating town, it is important to consider the social dynamics of the neighborhood. This might contribute to the development of a strong, resilient community that fosters interpersonal relationships and supports the welfare of its residents (Abubakar & Dano, 2019).

5. Environmental Sustainability: The geographical qualities of a floating community may influence how adaptable and sustainable its ecology is. Among the considerations is the use of green infrastructure, the impact on biodiversity and other natural resources, and the likelihood of environmental dangers such as erosion or flooding. The floating community architecture must deliver the highest level of sustainability conceivable (Penning-Rowsell, 2019). The consequences of urbanization on natural ecosystems might be mitigated, for example, by constructing green walls, floating wetlands, or artificial reefs. Furthermore, the environmental effect of the settlement might be lowered by employing sustainable building materials and practices (Lin, Chih Lin, & Tan, 2018). Building materials should be prioritized, and only locally available, low-carbon-footprint materials should be used. To save project costs, floating communities should preferably be built on land and then transported to their final position (Umar, 2020). Designers and planners should consider the consequences of the settlement on the environment while constructing and structuring the spatial components of the settlement. This can ensure that the settlement has a low environmental effect, is robust to environmental change, and is long-term.

3.3 Sustainable Architectural Solutions for Floating Communities

Floating architectural structures may be built using a wide range of design technology. The proprietor's financial situation affects the floating building technology selection since it determines the amount of funding that can be allocated to the adoption of sustainable design principles. Several design criteria must be satisfied to guarantee long-term viability, resource efficiency, and environmental resilience while constructing a sustainable floating building (Penning-Rowsell, 2019). These goals include using innovative materials that are resistant to exposure to water, putting energy-efficient power generation technologies into practice, and using building techniques that have the least negative environmental effects. Adaptability to shifting climatic circumstances should also be given top priority in the design, as this will lay the groundwork for durable and environmentally conscious floating architectural constructions (Cerro, 2016). To build a sustainable floating structure, the following design objectives must be met:

1. Buoyancy Technologies: The key technical component of a floating structure is buoyancy. The buoyancy necessary to keep the structure floating can be provided by hollow pontoons, air-filled chambers, and other buoyancy technologies (Bhatt, 2020). Contemporary buoyancy solutions are typically made of composite materials like as fiberglass, carbon fiber, or reinforced polymers, and are designed to endure harsh sea conditions while being sturdy and light. To reduce drafts and the possibility of tilting, the structure should abide by the following components: The positioning of building components should be equal and symmetrical to lessen the structure's consequent heeling moment. The use of lightweight materials will minimize the overall weight of the building (Endangsih, 2020). The floating structure approach is influenced by the owner's financial status. Underprivileged communities can build floating platforms from repurposed drums, barrels (such as empty oil drums), steel drums, airtight plastic cylinders, and other materials, see figure 13 for the application of empty barrels as a floating platform for a slum dwelling design. Drums can also be built with steel or wood frames, this would help to strengthen and stabilize the floating platform (Trang, 2016). Architects may employ modern floating materials like concrete and polystyrene EPS in more affluent areas. Each floating foundation requires a mooring system that is robust and rigid enough to prevent the structure from shifting owing to external pressures such as wind, waves, and currents. There are a variety of permanent and temporary belay systems available. These belays hold the structures in place and prevent them from moving (Ko, 2015).
2. Modular Design: Modular design is a popular way for creating floating architectural structures. A floating structure is built herein utilizing prefabricated sections that are simply assembled on-site. Modular architecture allows for greater

design and construction flexibility, as well as easier transport and installation (Wawryniuk & Piątek, 2020). The design of a floating town's should consider local architecture as well as the social, cultural, and economic contexts. Architectural spaces should be flexible and open to increase ventilation and minimize humidity. Moreover, the modular design if employed properly provides flexibility in determining the utilization of the many activities that take place in the vicinity (Cerro, 2016).

3. Sustainable Materials: In order to avoid harming the environment and the nearby ecosystems, ecologically friendly materials were explored for this project. Due to their lightweight, toughness, and corrosion resistance, sustainable composite materials are a preferred option in floating architecture design (Moon,2015). Fiber-reinforced composites, lightweight concrete, and expanded polystyrene are typical composite materials used to build floating structures (Endangsih, 2020). Simple and fragile materials are employed to construct floating shelter. Water dwellers build inexpensive floating homes using locally accessible lightweight materials that are climate adaptable. The majority of the materials used in floating are natural, eco-friendly and light-weighted materials such as wood, bamboo, steel, polystyrene EPS (Bhatt, 2020).
4. Building Services Technologies: The systems and resources used in the management and maintenance of buildings to give occupants a cozy, safe, and practical interior environment are known as building services technology. Building services technology includes things like lighting, plumbing, fire prevention, and security in addition to heating, ventilation, and air conditioning (HVAC) (Rehman, 2020). The requirement to take the effects of the aquatic environment into consideration while creating building services technology for floating structures presents another difficulty. Exposure to seawater, powerful winds, and large waves are all potential hazards in the aquatic environment, see figure 13 for the use of green façade to break powerful winds and filter the air coming into the building. Building services technology needs to be created to endure various environmental factors and be water-resistant (Umar,2020).
5. Energy-Efficient Technologies: Floating Architecture should include elements like passive solar design, high-efficiency insulation, and the utilization of renewable

energy sources like solar, wind, or hydropower, architectural constructions may be made to be energy-efficient. Energy-efficient technology can assist save energy bills and operational expenses while also lowering the structure's environmental effect (Penning-Rowsell, 2019).

6. Water treatment technology: They can be integrated into floating architectural constructions to provide a steady supply of drinkable, clean water. This can involve installing desalination systems, filtration systems, and rainwater collection systems, see figure 13 for the use of barrels for rainwater collection system. The application of water treatment technology in buildings can lessen the need for outside water sources (Lin, Chih Lin, & Tan, 2018).
7. Sanitation Technology: To prevent the pollution of the water and surroundings due to incorrect waste disposal, a local waste management chain should be developed. Designers should propose technology and solutions that are dependable, cheap, environmentally friendly, and culturally suitable for floating community sewage management. Depending on the area, septic tanks, sewage systems, and floating toilets can all be considered (Trang, 2016).
8. Smart Technologies: Floating architectural constructions may be made more useful and efficient by integrating smart technologies like Internet of Things (IoT) sensors and automation systems. Smart technologies may be used to track and manage a number of systems, including lighting, heating, ventilation, and security, and they can also serve to enhance the building's overall user experience (Rehman, 2020).

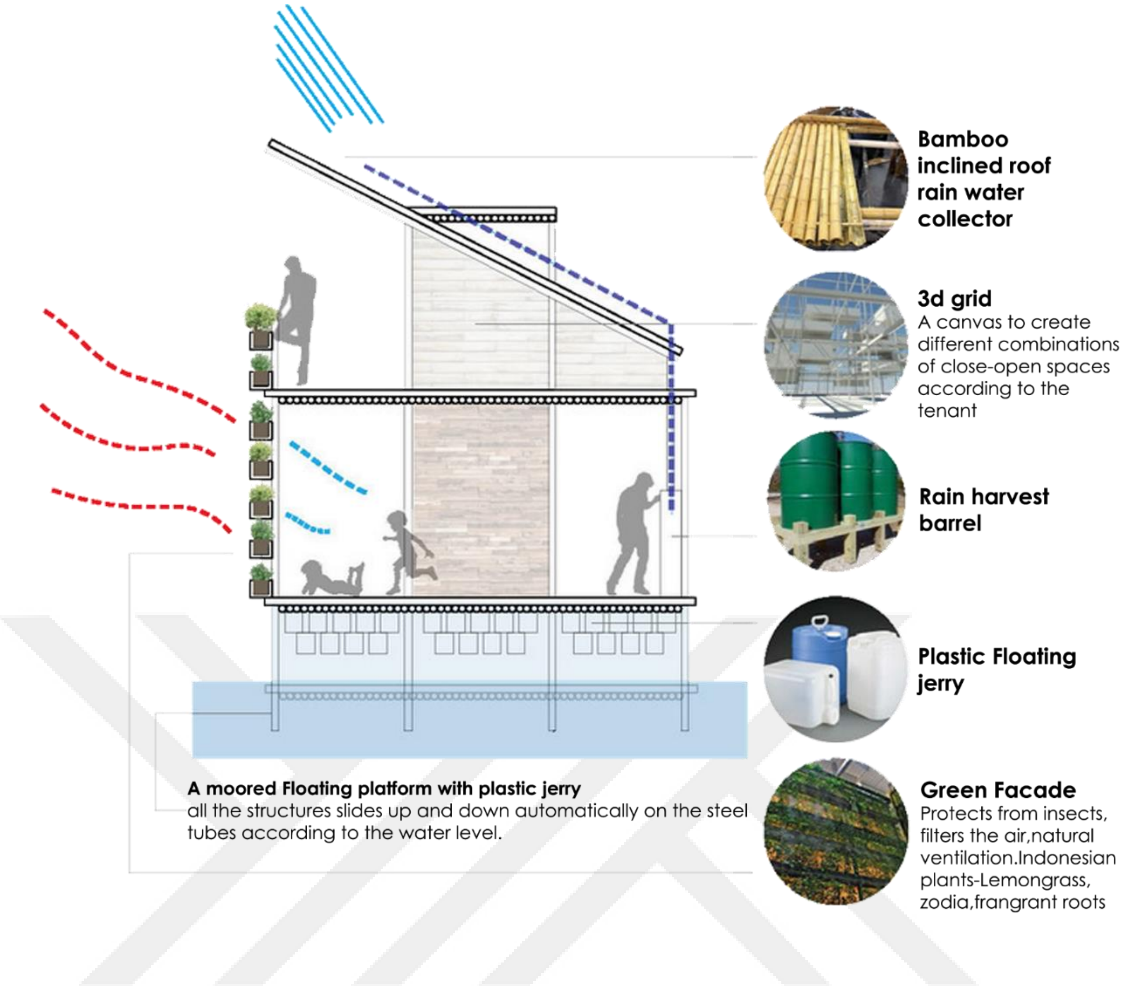

Figure 13. Design Technology for Slum Dwellings in Jakarta.

(Foka & Tsaparoglou, 2014).

3.3.1 Case Studies of Architectural Solutions

1. **Makoko Floating School, Nigeria**

The 220 square meter Makoko Floating School developed by NLÉ Architects a prototype floating structure, is located in the historic water settlement of Makoko, Lagos, Nigeria. The social and physical needs of the community must be fulfilled in unique ways, considering the consequences of climate change and the region's rapid urbanization (Duke, 2018). The Makoko Floating School is designed with a triangular A-Frame part with a 10x10 meter base and a height of 10 meters (Figure 14). The playground is located below, while the classrooms are located on the second level. They are partially enclosed by louvered slats that move, and the roof also serves as an outdoor classroom (Figure 15). In response to the Makoko community's needs, NLÉ developed the prototype floating building that can function as a school while also expanding and changing to take on new roles as a community hub, health clinic, market, entertainment center, or home (Moon, 2014).

Figure 14. Makoko floating school

(Adeyemi, 2012).

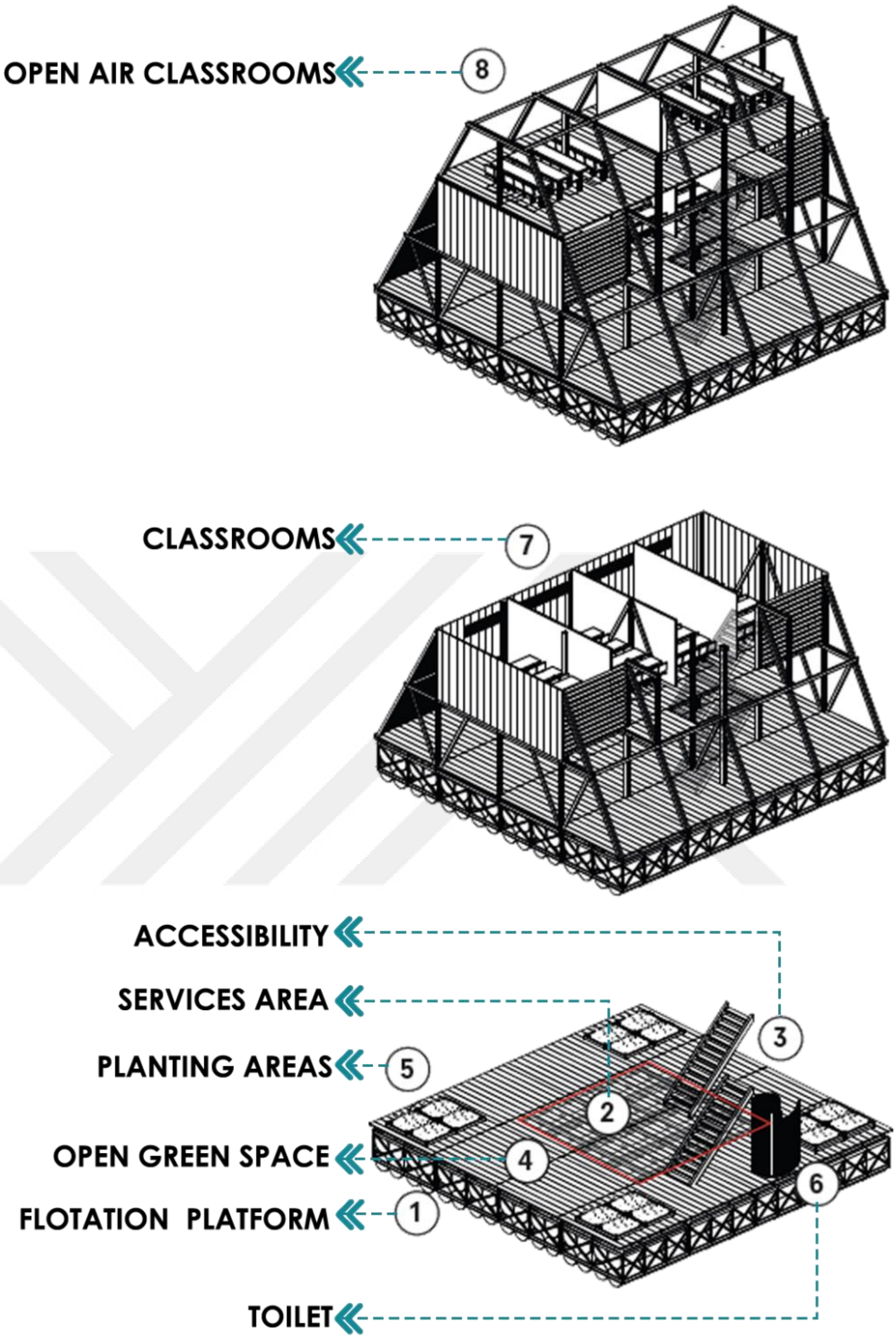

Figure 15. Space Breakdown Makoko Floating School

(Adeyemi, 2012).

The Makoko Floating School has ecologically friendly features such as rooftop solar panels to produce power, natural ventilation to keep children cool, biodegradable waste recycling, and rainwater catchment for sanitary facilities. The major building materials for the school's structure, support, and finishing were bamboo and wood from the community (Riise & Adeyemi, 2015). The buoyancy system for the structure, which is made up of 16 wood modules with 16 barrels each making a total of 256 barrels, was constructed from recycled empty plastic barrels that were commonly accessible in Lagos which were causing pollution to the environment. The polypropylene barrels placed at the structure's foundation support the whole structure, and the barrels around the perimeter may also be utilized to store excess rainwater collected by the rainfall harvesting system. Finally, the Makoko Floating School exhibits an environmentally friendly and creative strategy for architecture and construction by incorporating the community's social and natural surroundings (Adeyemi, 2012).

2. Land On Water, Norway

The "Land on Water" project was developed by Danish Maritime Architecture Studio MAST, which aims to create adaptable and sustainable floating structures for various purposes. The project addresses the challenges of rising sea levels and urban flooding by proposing a flexible and sustainable solution using flat-pack floating foundations made from recycled plastic filled with upcycled floatation materials (Florian, 2022). The "Land on Water" project exemplifies sustainable practices through its use of recycled and upcycled materials. The flat-pack floating foundations are made from reinforced, recycled plastic, reducing the demand for new materials and promoting the circular economy. Additionally, the floatation materials used are locally sourced and upcycled, further reducing the environmental impact. The project also prioritizes biodiversity enhancement by designing the foundations to provide a habitat for marine life, including fish, crustaceans, Mollusca, and seaweed, contributing to the enrichment of the local ecosystem (Maarbjerg & Blecher, 2021).

Figure 16. Land on Water designed by MAST

(Blecher & Maarbjerg, 2021).

Figure 17. Land on Water Floating Foundation

(Blecher & Maarbjerg, 2021)

Furthermore, the "Land on Water" project avoids the use of toxic materials, such as anti-fouling paints commonly used in steel and concrete foundations, reducing the release of harmful chemicals into the surrounding water and promoting a healthier environment for marine life. The modular and adaptable nature of the system promotes organic community growth that can be responsive to changing needs and conditions, avoiding unsustainable development patterns often seen in large-scale master-planned floating cities (Florian, 2022). In addition to these sustainable practices, the "Land on Water" project has the potential to incorporate renewable energy sources, such as solar panels or hydrokinetic turbines, further promoting energy efficiency and reducing reliance on fossil fuels. Overall, the project demonstrates a commitment to sustainability through its use of recycled and upcycled materials, promotion of biodiversity, avoidance of toxic materials, adaptable growth, and potential for incorporating renewable energy sources. These sustainable aspects make the "Land on Water" project a promising solution for building on water in an environmentally friendly manner (Maarbjerg & Blecher, 2021).

3.4 Summary of Sustainable Floating Architectural Design Criteria

The concepts and rules used to develop floating structures that are environmentally benign, economically practical, and socially inclusive are referred to as sustainable floating design criteria. Foundation, configuration design, sustainable materials, building services technologies, energy-efficient technologies, water treatment technology, and sanitation technology are all featured (Trang, 2016).

1. Foundation Structure: This is the most important aspect of Floating Architecture; the structure must be created with enough buoyancy to keep it aloft. This is accomplished through the use of lightweight materials and symmetrical component arrangement (Endangsih, 2020).
2. Configuration Design: planning the layout of a structure or the organization of spaces in terms of urban design can assert sustainability, as the use of modular design allows for flexibility in design and construction and generates open areas that promote ventilation and reduce humidity (Wawryniuk & Piątek, 2020).

3. Sustainable Materials: The materials employed in the structure's construction contribute to its long-term viability. Using locally available materials such as bamboo and lumber, as well as environmentally friendly materials like fiber-reinforced composites, lightweight concrete, and expanded polystyrene, helps to protect the environment and local ecosystems (Moon, 2015). In the construction of makoko floating school (figure 18), locally available materials such as bamboo and lumber were recycled and used in construction (Adeyemi, 2012).
4. Building Services Technologies: The generation, management, and usage of services should be taken into consideration, all building services technology should be designed to withstand environmental factors and be water-resistant (Rehman, 2020).
5. Energy-Efficient Technologies: Floating architecture should use passive solar design, high-efficiency insulation, and renewable energy sources to be energy-efficient and reduce environmental impact (Penning-Rowsell, 2019). In figure 18 makoko floating school operates PV cells for generation of power for the school.
6. Water Treatment Technology: Water treatment technology can provide a steady supply of clean water through desalination, filtration, and rainwater collection systems. In figure 18, makoko floating school utilizes the empty barrels along the edge for rainwater collection.
7. Sanitation Technology: Dependable, cheap, and environmentally friendly solutions for floating community sewage management should be developed to prevent pollution due to incorrect waste disposal (Lin, Chih Lin, & Tan, 2018).

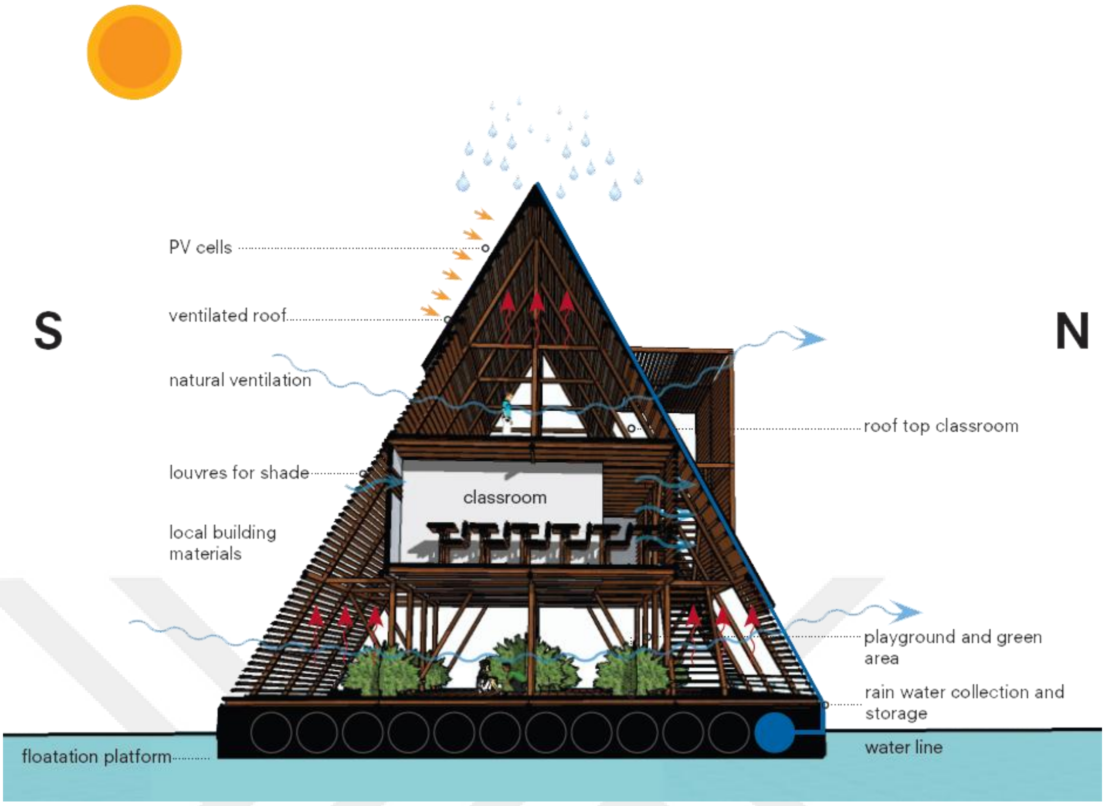

Figure 18. Makoko floating school architectural design and technology (Adeyemi, 2012).

In conclusion, these design principles attempt to reduce environmental harm while also creating a more sustainable built environment that provides people with a sense of well-being and fulfillment in their lives. In figure 18, NLE architects has employed the use of these principles in the design of Makoko Floating School.

Chapter 4

A Case Study: Makoko Floating Community

4.1 Overview of Makoko Community

4.1.1 Urban Context of the floating slum in Makoko. As Makoko is a unique urban community located in the southwestern part of Lagos, Nigeria. It is situated on the edge of the Lagos Lagoon, the so-called squatter community in the state, evolved informally along the water coast during the previous century, and it is characterized by its stilted architecture, water-based lifestyle, and vibrant culture (Riise & Adeyemi, 2015). The community of Makoko is a prime example of disproportionate growth amid rapid urbanization in the developing world. Historically a fishing community predating the establishment of Lagos State, Makoko has devolved into an urban slum over the years due to rural-urban migration and poorly governed development (Michael et al., 2017). The community is accessible by boat, and it is surrounded by mangrove forests that provide important ecosystem services. However, the community's location also poses challenges related to urban planning and environmental sustainability (Oduwaye et al., 2011). Makoko is vulnerable to flooding and waterborne diseases, and the community is threatened by deforestation and land use changes that are driven by urbanization and population growth.

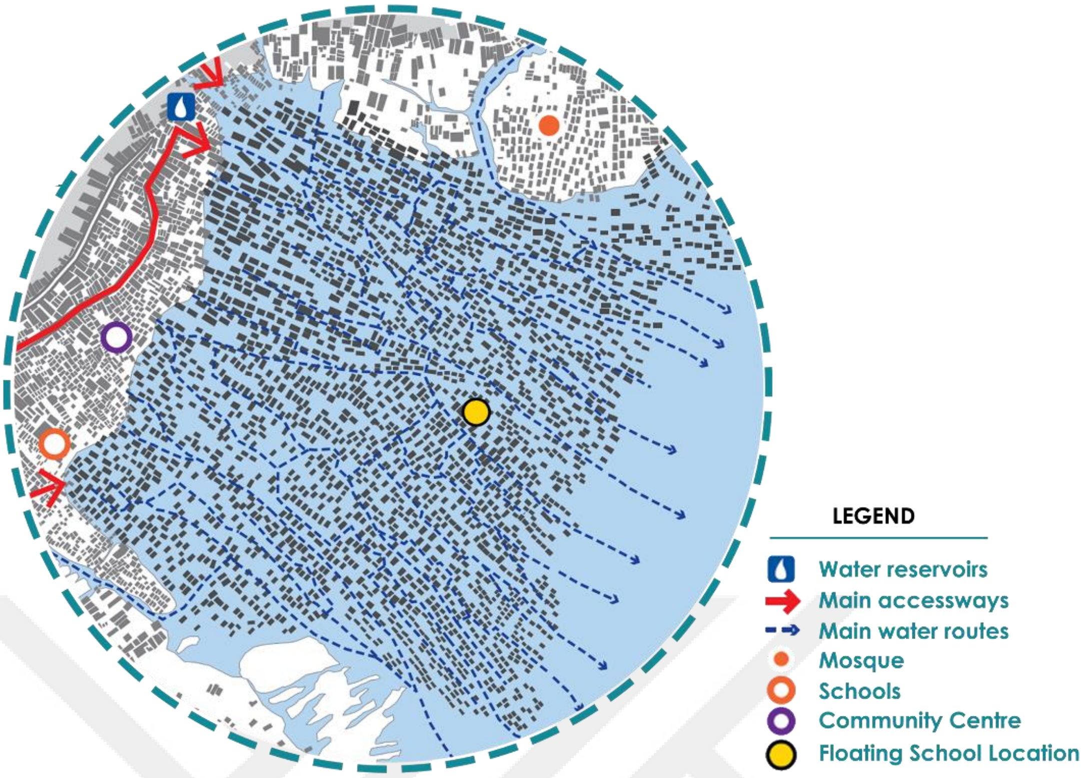

Figure 19. Map of Makoko

(Adeyemi, 2012).

Makoko is home to an estimated 100,000 residents, most of whom are fishermen or work in the informal economy (Agbola & Agunbiade, 2009). The community is ethnically diverse, with people from many different ethnic groups living together. The community is also young, with a high percentage of the population under the age of 18. The community's demographics pose both challenges and opportunities. The community faces challenges related to poverty, unemployment, and a lack of access to basic amenities such as clean water, sanitation, and healthcare. However, the community's young population also represents a potential source of innovation and entrepreneurship, and there is a growing interest in the community's vibrant culture and creative industries (Duke, 2018).

Figure 20. Aerial view of Makoko Community

(Adeyemi, 2012).

The physical environment of Makoko is shaped by its unique location and water-based lifestyle. The community is built on stilts that rise above the water, and many of the homes are constructed from wood, bamboo, and other locally sourced materials. The water is a prominent physical feature of the community, and it is used for transportation, fishing, and other activities (Olafimihan, 2009). The community's reliance on the water poses both opportunities and challenges. On the one hand, the water provides a source of livelihood and cultural identity. On the other hand, the water is also a source of pollution and health risks, as sewage and waste are often dumped directly into the lagoon. In addition to the water, Makoko is surrounded by mangrove forests that provide important ecosystem services, including erosion control, carbon sequestration, and habitat for marine life. However, the mangroves in Makoko are under threat from deforestation and land use changes that are driven by urbanization and population growth (Lawanson et al., 2022).

4.1.2 Urban and Infrastructural challenges. Makoko community is characterized by its stilted architecture, water-based lifestyle, and vibrant culture. However, the community also faces a range of urban and infrastructural issues that impact the lives and livelihoods of its residents (Riise & Adeyemi, 2015). One of the key urban issues facing Makoko is the lack of basic infrastructure. The community has limited access to basic amenities such as clean water, sanitation, and healthcare, which are critical for maintaining health and well-being. Many residents of Makoko rely on the lagoon for water, which is often contaminated with sewage and other pollutants. The lack of clean water and sanitation facilities is a significant health risk, and it contributes to high rates of waterborne diseases such as cholera and typhoid fever (Duke, 2018). In addition to the lack of basic infrastructure, Makoko also faces challenges related to its physical environment. The community is located on the edge of the Lagos Lagoon, which is prone to flooding during periods of heavy rainfall. Flooding poses a significant threat to the community's homes and livelihoods, Major flooding occurs 3 to 4 times per year and last up to 4 days, and it can also exacerbate health risks by spreading sewage and other pollutants. The building technology employed in the construction of structures is completely obsolete and provides no protection against floods that destroy homes or sewage and water that seeps into homes (Oduwaye et al., 2011). The community also faces challenges related to deforestation and land use changes that are driven by urbanization and population growth. These changes threaten the ecosystem services provided by the mangrove forests that surround Makoko, including erosion control, carbon sequestration, and habitat for marine life (Olafimihan, 2009). Another major infrastructural issue facing Makoko is the lack of access to education and other services. Many children in Makoko do not attend school due to a lack of resources and facilities. The community also lacks access to other important services such as healthcare, electricity, and transportation. These infrastructural challenges contribute to a cycle of poverty and lack of opportunities for the community's residents (Michael et al., 2017). Furthermore, the community's water-based lifestyle poses challenges for transportation and mobility. The lack of proper water network infrastructure and transportation systems in Makoko makes it difficult for residents to access other parts of Lagos, limiting their access to employment opportunities and essential services. The community relies heavily on boats for transportation, which can be unsafe and unreliable, particularly during periods of inclement weather (Lawanson et al., 2022).

Figure 21. A view of Makoko

(Adeyemi, 2012).

In conclusion, Makoko faces a range of urban and infrastructural issues that impact the lives and livelihoods of its residents. These challenges include the lack of basic infrastructure such as clean water, sanitation, and healthcare, as well as the physical environmental challenges posed by flooding, deforestation, and land use changes (Olafimihan, 2009). The community is currently developing in a non-sustainable way, exacerbating these challenges and hindering the potential for long-term resilience and well-being. The challenges Makoko faces in achieving sustainable development are made worse by limitations with access to basic necessities including power, transportation, education, and other services. The unplanned and fast expansion of a community has resulted in an overload of resources and inadequate urban planning, making the challenges faced by its citizens even more severe. It will need a comprehensive and sustainable strategy that takes into account Makoko's particular social and environmental setting to address these complex issues. Prioritizing investments in healthcare, education, and basic infrastructure is essential for both long-term growth and immediate alleviation. The physical environmental issues facing the community, such as deforestation and floods, must be addressed with sustainable solutions. By employing an appropriate strategy that blends short-term fixes with a long-term sustainable plan, Makoko could become a resilient and prosperous community that maintains its vibrant and distinct culture while raising the standard of living for its citizens.

Figure 22. A View of Makoko Bad Waste Management

(Adeyemi, 2012)

4.1.3 Social and Cultural needs of Makoko Residents. Makoko is a unique community with a vibrant culture and rich social history. The community is known for its stilted architecture, water-based lifestyle, and close-knit community. Despite substantial urban and infrastructure constraints, the people of Makoko have formed a strong social and cultural identity that is an important component of the community's fabric (Adeyemi, 2012). One of Makoko's most pressing social and cultural demands is the preservation of its cultural legacy. The rich history and traditions of this community are inextricably linked to its water-based lifestyle and distinctive building style. Oral histories, songs, and performances are used to pass along these traditions from generation to generation. However, Lagos's fast urbanization and population increase threaten to undermine its traditional legacy. As development demands rise, it is critical to safeguard Makoko's cultural traditions and identity (Olafimihan, 2009).

Figure 23. A view of Makoko Fishermen

(Adeyemi, 2012).

Makoko also has a crucial social and cultural need for the creation of opportunities for social and economic empowerment. Despite considerable obstacles in education, healthcare, and infrastructure, Makoko's population has established a dynamic and enterprising spirit. Many locals run small enterprises including fish farming, weaving, and boat construction, which are vital to the community's economic and social well-being (Duke, 2018). These enterprises, however, are frequently informal and have substantial obstacles in terms of funding, markets, and infrastructure. Supporting the development of established and sustainable economic possibilities in Makoko is critical for unleashing the community's potential and increasing inhabitants' quality of life.

Furthermore, Makoko's access to education is a critical social necessity. Many Makoko children do not attend school and those who do have limited access to an excellent education. Dropped-out young lads establish small gangs, abuse drugs, and alcohol, and generate societal conflicts. This lack of access to education hinders young people in the community's capacity for social and economic mobility (Riise & Adeyemi, 2015). Access to high-quality education is crucial for breaking the cycle of poverty and promoting upward mobility. Makoko has major infrastructure requirements for basic services such as water and sanitation. Many Makoko families lack access to clean water and basic sanitation, resulting in the spread of avoidable illnesses. Furthermore, due to the community's water-based culture and lack of infrastructure, there is a lack of access to sufficient healthcare services. As a result, many inhabitants suffer from treatable illnesses and injuries that could have been avoided. Access to healthcare is critical for enhancing Makoko inhabitants' well-being and minimizing the burden of avoidable diseases (Oduwaye et al.,2011).

Figure 24. A view of Makoko marketplace

(Adeyemi, 2012).

Makoko's social and cultural requirements also involve addressing the community's distinct gender dynamics. Women in Makoko play an important part in the social and economic fabric of the town, yet their efforts are sometimes devalued and unrecognized (Lawanson et al., 2022). Many Makoko women confront considerable barriers to education, healthcare, and economic possibilities. Addressing these issues demands a gender-sensitive strategy that acknowledges and honors women's contributions to the social and economic well-being of the community. Makoko's social and cultural requirements also include facilitating the creation of community-led activities that promote social harmony and community development. The community's distinct aquatic lifestyle and tight-knit social fabric provide fertile ground for the growth of community-led projects. These efforts may include the creation of social programs that encourage education, health, and well-being, and the creation of cultural activities that honor Makoko's distinct tradition and identity (Okeke et al., 2019).

Figure 25. A view of Makoko
(Riise & Adeyemi, 2015).

Ultimately Makoko's social and cultural demands are vital to the well-being and growth of the community. Among these demands are the preservation of the community's cultural legacy, the creation of opportunities for social and economic empowerment, the resolution of gender dynamics, and the support of community-led projects that promote social cohesion and communal development. Addressing these issues necessitates a collaborative and community-led approach that recognizes and respects the Makoko people's opinions and efforts.

4.1.4 Physical Conditions of built entities in Makoko.

Makoko is a unique and densely populated community, with a distinctive feature in its stilted structures that line the banks of the Lagos Lagoon. These structures are the primary housing units for the community's estimated 100,000 residents. As such, the condition of these built entities is of great importance to the community's overall well-being and quality of life (Riise & Adeyemi, 2015). The physical condition and quality of Makoko's built entities are typically deplorable. Most of the buildings are made of low-quality materials, they are acquired locally, such as bamboo, wooden boards, and corrugated metal sheets. These materials are not long-lasting and are prone to rotting decay and other types of damage from use. As a result, many of Makoko's buildings are in ruin, with evident indicators of deterioration such as cracks, holes, and water damage (Olafimihan, 2009). Regular maintenance and repairs are required to preserve the buildings' longevity and safety. Unfortunately, many structures in Makoko are in ruin owing to a lack of resources, with some even collapsing because of neglect (Figure 26).

Figure 26. A view of damaged structures in Makoko (Olafimihan, 2009).

In terms of design and layout, the stilted structures in Makoko are generally small and cramped, with limited space for movement or storage. The structures are lightweight and flexible to withstand the region's periodic floods. However, because of their design, the buildings are prone to destruction from severe rains and high winds. Furthermore, a lack of proper ventilation and natural light can have a substantial influence on the occupants' health and well-being (Figure 26). The closely packed buildings, along with a lack of sufficient ventilation and natural light, create a damp and stuffy atmosphere that encourages mold and other harmful bacteria to develop (Michael et al., 2017). The lack of natural light also makes it difficult for people to carry out their daily tasks and has an impact on their mental and emotional well-being. The resilience and safety of Makoko's structures are also major concerns. Many of the structures lack basic safety measures like fire escapes and smoke alarms. The use of combustible materials in construction raises the risk of fires, which can be disastrous in such a highly populated location. Furthermore, the constructions are not designed to resist earthquakes, which are uncommon in Nigeria but have occurred. The structures' lack of structural integrity and stability also endangers the community's safety, especially during big storms or floods (Agbola & Agunbiade, 2009).

Figure 27. A view of Makoko Structures

(Adeyemi, 2012).

The substandard condition of the construction materials and design confine the functioning and utility of the structures in Makoko. Many of the buildings lack basic utilities like power, running water, and decent sanitation (Figure 27). This has a substantial influence on the community's members' quality of life, notably in terms of health and hygiene (Duke, 2018). The small living quarters and lack of privacy can have social and psychological consequences, such as tension and anxiety.

To summarize, the state of the constructed entities in Makoko poses a serious challenge to the settlement and its citizens. The use of low-quality materials, poor design and layout, and a lack of basic utilities all contribute to the construction's poor state and quality. The structures' longevity and safety are also key problems since they endanger the community's general well-being and safety (Adeyemi, 2012). Tackling these issues would need a comprehensive and coordinated effort that includes not just physical renovations but also tackling the social and economic causes that contribute to their poor status.

4.2 Methodology

This study proposes an approach to decision-making on sustainable floating development goals to fill a significant knowledge gap in urban planning for the Makoko Community, a floating slum community. To achieve the purpose of the research, the study is framed in two phases. First phase is the formulation of the tailored Sustainable Floating Development Goals (SFDGs) from the deep literature studies and analysis of Makoko Community, and second phase includes Multiple Criteria Decision-Making (MCDM) survey with the experts with the knowledge of the area to analyze and prioritize the goals.

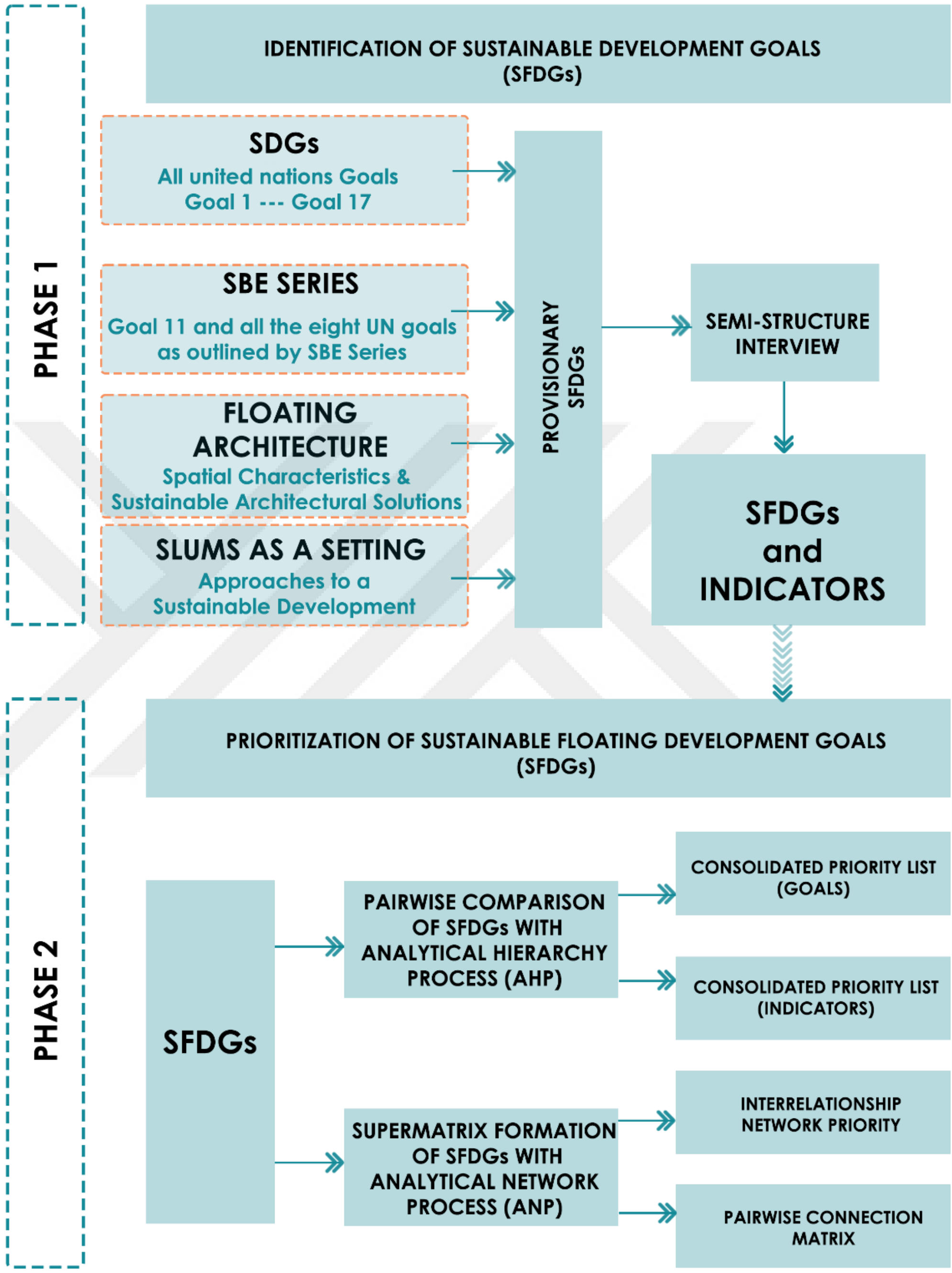

Figure 28. Methodology Diagram

In Phase one (1) which is the ‘Development of the Structure of the Decision-Making Process’, this is the qualitative aspect of the survey which enables the collection of crucial information related to the current conditions, needs, and challenges faced by the community and a deep study into United Nation Sustainable Development Goals (SDGs) to create a tailored Sustainable Floating Development Goals (SFDGs) for Makoko. This research is founded on a careful examination of the most recent and relevant literature, which includes books, journal articles, conference papers, and papers from other fields of study relevant to sustainable community development. The thorough literature review provides the foundational knowledge needed to guide the study's subsequent stages. The establishment of specific targets for sustainable floating development in Makoko is the main result of the literature study and field investigation. These aims are not meant to be a one-size-fits-all answer, but rather a carefully selected set of goals that take into account the unique conditions and requirements of this floating slum community. These specific goals serve as the template for Makoko's transformation and growth, directing the study's succeeding phases. The essential subsequent phase in this research is to engage professionals in urban design, planning, and architecture, particularly those with firsthand experience working on Makoko projects. These specialists are critical in refining and validating the defined goals. Their distinct perspectives and practical expertise are invaluable in analyzing the feasibility and relevance of the suggested goals. As for Phase two (II) ‘Prioritization of Goals and Networking Analysis’ of the tailored goals, the essential part of this phase in this research for prioritization is to engage professionals in urban design, planning, and architecture, particularly those with firsthand experience working on Makoko projects. These specialists are critical in refining and validating the defined goals, their distinct perspectives and practical expertise are invaluable in analyzing the feasibility and relevance of the suggested goals. After finalizing the (SFDGs) the quantitative aspect of the survey will be carried out, where experts will take the AHP and ANP survey online to give their priority rating to the set of goals and their indicators. Thus, for this phase of the survey, 5 participants each will be selected based on their profession and knowledge of the area.

4.2.1 The Analytical Hierarchy Process (AHP). A rigorous decision-making process will be used throughout the current phase of the study, AHP uses pairwise comparisons to systematically guide the goal prioritization process. AHP quantifies judgments about the relative importance of each goal. This approach makes use of an absolute judgement scale to assess how much one factor dominates another in terms of certain traits. The application of AHP within this research is multi-faceted. Initially, it involves constructing a structured set of criteria and sub-criteria that reflect the various dimensions of sustainable floating development in Makoko. The main formula in the Analytic Hierarchy Process (AHP) used to calculate the weights of criteria and alternatives based on the pairwise comparisons made by decision-makers are listed below (Saaty, 1987). For Criteria used for the Goals:

$$w_i = \frac{\sum_{j=1}^{n} a_{ij}}{n} \qquad (4.1)$$

w_i is the weight of criterion i, a_{ij} is the element in the pairwise comparison matrix representing the preference of criterion i over criterion j, n is the number of criteria. For Alternatives used for the indicators:

$$w_{ij} = \frac{\sum_{k=1}^{m} b_{ijk}}{m} \qquad (4.2)$$

w_{ij} is the weight of alternative j for criterion i, b_{ijk} is the element in the pairwise comparison matrix representing the preference of alternative i over alternative k for criterion i, m is the number of alternatives.

These weights are derived from the pairwise comparison matrices, where decision-makers express their preferences. Once the weights are calculated, they are used to score and prioritize the criteria and alternatives, facilitating the decision-making process. Although AHP calculations can be done using electronic spreadsheets, the appearance of software packages such as Expert Choice, Super Decisions and Decision Lens later on has made AHP mathematical calculations very easy to deal with (Burnaz & Topcu, 2006). It's important to note that consistency checks, such as calculating the Consistency Ratio (CR), are often performed to ensure the reliability of the pairwise comparisons and, consequently, the derived weights. If the CR is below a predefined threshold (commonly 10%), the pairwise comparisons are considered consistent (Saaty,2006).

Verbal judgment	Numeric value
Extremely important	9
	8
Very Strongly more important	7
	6
Strongly more important	5
	4
Moderately more important	3
	2
Equally important	1

Figure 29. Saaty's pairwise comparison scale

(Saaty, 2006).

Buying a car	Cost	Comfort	Safety
Cost	1	7	3
Comfort	1/7	1	1/3
Safety	1/3	3	1

Figure 30. Matrix Template

(Mu & Pereyra-Rojas, 2016).

These criteria may encompass factors such as environmental sustainability, social equity, economic viability, adaptability to the unique floating conditions, and community well-being. Following the development of criteria, experts will conduct a series of interviews. The platform for the pairwise comparison procedure will be these interviews. Experts will carefully compare personalized goals against each other as criteria, delivering their judgements of how well each objective corresponds with community needs. Each goal will be granted a number score based on these comparing judgements (Figure 29), reflecting its priority appropriateness within the framework (Figure 30).

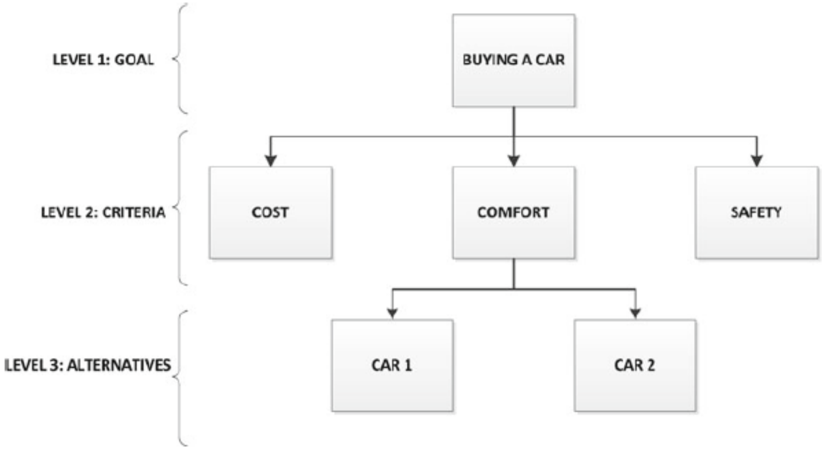

Figure 31. A Decision hierarchy for Buying a Car.

(Mu & Pereyra-Rojas, 2016).

To understand how AHP has been used by other researchers here is an example of AHP decision-making used to purchase a car by a client. As shown in figure 31, there are two alternatives Car 1 and Car 2, and three judgement criteria used in the pairwise comparison matrix: cost, comfort, and safety.

Buying a car	Cost	Comfort	Safety	Priority
Cost	1.000	7.000	3.000	**0.669**
Comfort	0.143	1.000	0.333	**0.088**
Safety	0.333	3.000	1.000	**0.243**

Figure 32. Table Presenting Criteria Priorities.

(Mu & Pereyra-Rojas, 2016).

In the initial phase of the Analytic Hierarchy Process (AHP) analysis, criteria judgments were conducted to ascertain the relative importance of each factor influencing the client's preferences (Figure 32). Based on the survey data, the cost criterion emerged as the foremost priority, receiving a value of 0.669 (66.9%). This underscores the significance placed by the client on the financial aspect when making decisions about the type of vehicle to acquire. Following closely, the safety criterion attained a value of 0.243 (24.3%), indicating the client's substantial consideration for passenger safety. Lastly, the comfort criterion garnered a rating of 0.088 (8.8%). Although it occupies the lowest position among the identified factors, it does not imply insignificance rather, it signifies a comparatively lower priority in the decision-making process when weighed against the other criteria.

	Cost	Comfort	Safety	Overall priority
Criteria Weights ->	*0.669*	*0.088*	*0.243*	
Car 1	0.875	0.167	0.100	0.624
Car 2	0.125	0.833	0.900	0.376

Figure 33. Synthesis of the Model Priorities

(Mu & Pereyra-Rojas, 2016).

Subsequently, the analysis progressed to the comparison phase, wherein the hierarchy of the car alternatives was established. Through a meticulous evaluation against the defined criteria, each car was systematically weighed to ascertain its priority (Figure 33). The outcome, as depicted in the accompanying image, reveals that Car 1 emerged as the superior choice with a priority value of 0.624 (62.4%). This indicates that Car 1 aligned more closely with the specified criteria, thus garnering a higher priority. In contrast, Car 2 received a priority rating of 0.376 (37.6%), signifying a relatively lower alignment with the criteria when compared to its counterpart.

In recent years, researchers and scientists have intensively explored Multiple Criteria Decision-Making (MCDM) methodologies, discovering many applications in management, engineering, science, and business. These techniques assist decision-makers in evaluating, choosing, rating, and sorting alternatives in order to make informed decisions. In the architectural field, there have been several applications of AHP, Jung & Awad (2023) for instance applied AHP in prioritizing approaches to urban planning components in Sharjah Sustainable City (SSC) where 118 urban planning experts in the UAE participated in the study. The study stands apart from other studies on the subject of urban planning and sustainability because it uses AHP analysis to assess the relative importance of specific planning elements and considering it focuses on the process of producing findings vital for design. The analysis revealed that the transportation system sector followed by the energy/building sector had the highest importance score, implying that these outcomes must be the focal point of the Sharjah Sustainable City's design. In a different architectural context, Harputlugil (2018) employed AHP in the study titled "Analytic Hierarchy Process (AHP) as an Assessment Approach for Architectural Design: Case Study of Architectural Design Studio". The primary objective of the research was to innovate the assessment of architectural design through the application of the Analytic Hierarchy Process (AHP) – a Multi-Criteria Decision-Making (MCDM) method. The AHP-based method produced results that are not only comparable, quantifiable, gradable, and consistent, but also reportable distinctly for each evaluator. Additionally, because of its versatility, this technique may be used as a checklist to ensure compliance with the requirements specified by regulated outcomes. Finally, Harputlugil (2018) concluded that the AHP-based method shows substantial promise for improving competence and progressing the appraisal of architectural projects, including their alternatives. This potential is especially notable in architectural design education and competitions, demonstrating the method's adaptability and application in a variety of situations. Furthermore, Wang, (2021) applied AHP in the study titled Research on Design Factors of Urban Public Space Safety Based on ISM and AHP. The study examines and evaluates the urban design perspective and the elements that influence public space safety design in the commercial area of Jiefangbei, Chongqing. The study looked at fifteen major factors that have an impact on public space safety in commercial districts. The findings outline the design focus of the urban public safety design, establish the important degree and hierarchical relationship of the main factors, and serve as a basis and reference for the urban commercial intensive area's public space safety design. Additionally, Lifang, Yichuan, & Wei, (2008) employed AHP in their study titled “Evaluation of Urban River Landscape Design Rationality based on AHP”. Their objective was to establish a basis for modernizing the urban river landscape design. Using this assessment approach to assess the Weihe River's landscape design rationale in Xinxiang City, Henan Province, demonstrated the feasibility of the model. The findings highlight the most important elements that ought to serve as the foundation for assessing the logic of urban river landscape design.

4.2.2 The Analytic Network Process (ANP). A decision-making process and mathematical framework for solving complicated issues containing various criteria, interdependencies, and trade-offs (Figure 34). ANP is intended to assist individuals or organizations in making informed decisions by organizing and analyzing the interactions between various elements within a decision network. ANP recognizes the subtle interplay between elements and accommodates inner and outer dependencies within the network (Saaty,2006). An extension of the Analytic Hierarchy Process (AHP) that considers the dependencies within the hierarchy is the Analytic Network Process (ANP). Since many choice difficulties include interactions and dependencies between higher- and lower-level components, they are often unsuited to hierarchical structure. Consequently, a network is used to depict ANP as opposed to a hierarchy (Aragonés-Beltrán et al., 2010).

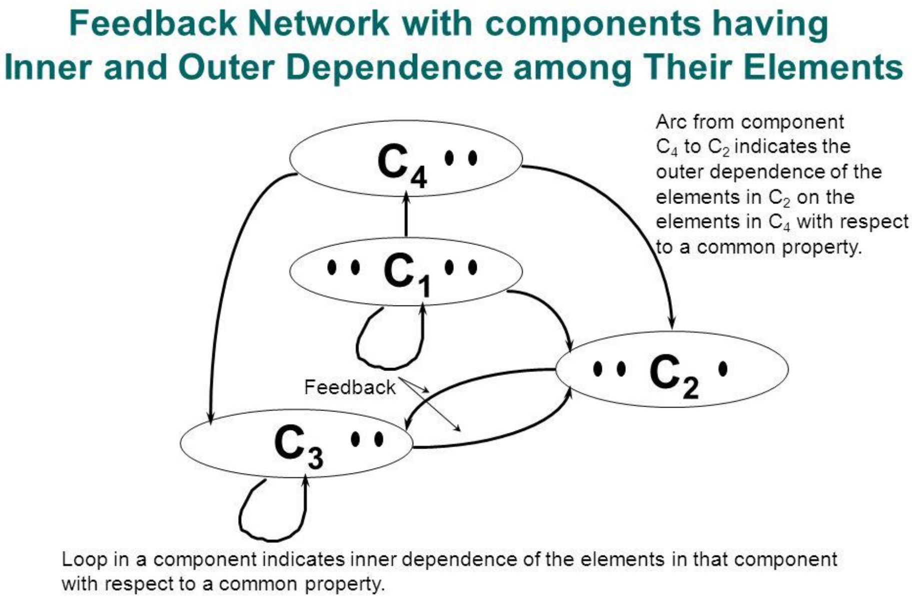

Figure 34. Feedback Network

(Saaty,2006).

The Analytic Network Process (ANP) is an extension of the Analytic Hierarchy Process (AHP) that deals with more complex decision-making situations involving interdependencies and feedback. The main formula for ANP is based on the supermatrix approach and for the priority vector W of the network elements (e.g., criteria, sub-criteria, and alternatives), the formula is given by $[W = (I - A)^{-1} \cdot B]$, where W is the priority vector of the network elements, I is the identity matrix (Figure 35), A is the principal supermatrix representing the dependencies and feedback in the network, B is the supermatrix containing the priority vectors derived from local decision-making within each cluster of the network.

$$
\begin{array}{cc}
 & \begin{array}{cccc} \overset{C_1}{e_{11}e_{12}\cdots e_{1n_1}} & \overset{C_2}{e_{21}e_{22}\cdots e_{2n_2}} & \cdots & \overset{C_N}{e_{N1}e_{N2}\cdots e_{Nn_N}} \end{array} \\
W = \begin{array}{cc} C_1 & \begin{array}{c} e_{11}\\ e_{12}\\ \vdots\\ e_{1n_1}\end{array} \\ C_2 & \begin{array}{c} e_{21}\\ e_{22}\\ \vdots\\ e_{2n_2}\end{array} \\ \vdots & \\ C_N & \begin{array}{c} e_{N1}\\ e_{N2}\\ \vdots\\ e_{NnN}\end{array} \end{array} & \begin{bmatrix} W_{11} & W_{12} & \cdots & W_{1N} \\ W_{21} & W_{22} & \cdots & W_{2N} \\ \vdots & \vdots & \cdots & \vdots \\ W_{N1} & W_{N2} & \cdots & W_{NN} \end{bmatrix}
\end{array}
$$

Figure 35. Identity Matrix

(Saaty,2006).

The formula captures the interrelationships and feedback within the network, making ANP suitable for decision problems with complex and interrelated elements. The inversion of the matrix $(I - A)$ ensures that the feedback loops are appropriately considered in determining the overall priorities. Although the appearance of software packages such as Expert Choice, Super Decisions and Decision Lens later on has made ANP mathematical calculations very easy to deal with (Valipour et al., 2015). While the development of software programmes like Expert Choice, Super Decisions, and Decision Lens has since made handling ANP mathematical computations simpler.

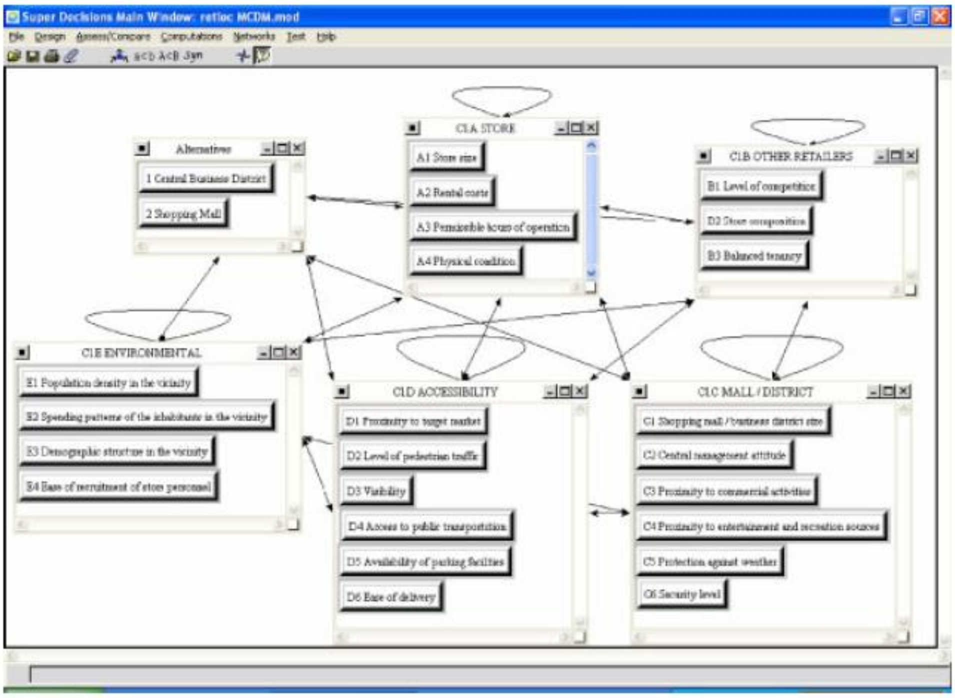

Figure 36. An example for the Analytic Network Model

(Burnaz & Topcu,2006).

Exploring the practical application of Analytic Network Process (ANP) in organizational evaluations, a pertinent illustration involves the assessment of retail locations for apparel stores as presented by Burnaz & Topcu (2006). In this case, district managers served as experts in a survey aimed at optimizing the selection of suitable locations. The methodological approach encompassed several key stages, providing a comprehensive insight into the ANP process. Initiating the evaluation, the first crucial step involved the deliberation and determination of clusters and criteria essential for deciding the optimal location. This foundational phase laid the groundwork for subsequent analyses and ensured the relevance of the factors considered. Subsequently, a pairwise relationship matrix was meticulously established among the participating district managers, consolidating their expert perspectives. This matrix, integral to the ANP methodology, served as the basis for the subsequent analysis. The data generated from the expert inputs was then seamlessly transferred to the SuperDecision Software, a specialized tool designed for ANP analyses (Figure 36). Within this software, the ANP analysis unfolded, producing an Analytical Network

Model that visualized the intricate web of feedback, inner, and outer dependency loops among the identified clusters and criteria. The network model image, portraying the interconnections within the evaluative framework added a layer of complexity to the analysis, providing a nuanced understanding of the relationships between the various factors.

Clusters and criteria	Limiting priorities (%)	Normalized by cluster (%)
A store-related criteria		
A2 Rental costs	4.01	34.03
A1 Store size	3.00	25.42
A4 Physical condition/physical facilities	2.77	23.47
A3 Permissible hours of operation	2.01	17.07
B Criteria related with other retailers nearby		
B1 Level of competition	5.20	40.83
B2 Store composition	3.93	30.83
B3 Balanced tenancy	3.61	28.34
C Criteria related with shopping mall/business district		
C3 Proximity to commercial activities	4.24	22.13
C1 Shopping mall/business district size	3.87	20.23
C6 Security level	3.33	17.42
C2 Central management attitude	3.28	17.14
C4 Proximity to entertainment and recreation sources	3.28	17.11
C5 Protection against weather	1.14	5.96
D Criteria related with accessibility		
D4 Access to public transportation	5.01	30.79
D2 Level of pedestrian traffic	3.57	21.92
D5 Availability of parking facilities	2.83	17.37
D1 Proximity to target market	2.53	15.53
D3 Visibility	1.21	7.43
D6 Ease of delivery	1.13	6.96
E Environmental criteria		
E3 Demographic profile in the vicinity	5.59	34.08
E2 Spending patterns of the residents in the vicinity	4.80	29.27
E1 Population density in the vicinity	4.39	26.75
E4 Ease of recruitment of store personnel	1.62	9.91

Figure 37. Tabulation Table for the Importance of the Criteria (Burnaz & Topcu,2006).

Moreover, the survey findings, presented in a tabulated format, offered valuable insights into the priorities assigned to different clusters and criteria (Figure 37). Notably, the normalized priorities revealed that renting prices held the highest significance among store-related criteria, accounting for 34.03%. The level of competition emerged as a key consideration, surpassing both balanced tenancy and store composition with priorities of 40.83% and 30.83%, respectively. Beyond store-specific factors, the study emphasized the importance of a shopping center or business district's proximity to commercial firms (22.13%) and the size of the center (20.23%) as crucial determinants (Burnaz & Topcu, 2006). Ultimately, the survey questionnaire served as the final step, providing a quantitative measure of the priorities identified through the ANP analysis. In conclusion, the presented example underscores the practical utility of ANP in organizational decision-making, showcasing how this methodology can offer nuanced insights into complex evaluations and guide strategic choices for gaining a competitive advantage in retail operations.

In the architectural field, there have been several applications of ANP, one instance Navarro, Melón, Martín, & Dutra (2008) applied ANP in the evaluation of urban development proposals for La Carlota airport in Caracas (Venezuela). The study provides a rigorous technique with a suitable degree of complexity for ranking urban development concepts based on environmental pressure. There were three options: a Health Club, a Residential Area, and a Theme Park. The experts who participated agreed that the method suggested in this research is beneficial and an improvement over existing methodologies such as environmental impact assessments, lifecycle analysis, etc. They found the acquired findings to be cohesive, the procedure to be rigorous and exact, and the utilisation of resources to be much less than in other techniques. In a different application, Napoli & Schilleci (2014) employed ANP in the study titled An Application of Analytic Network Process in the Planning Process: The Case of an Urban Transformation in Palermo (Italy). The fundamental goal of this research is to put the multicriteria analysis application to the test in favor of a selection process among possible transformations of an urban area in Palermo. The use of multicriteria analysis methodologies, such as the Analytic Network Process (ANP), is owing to the necessity to depict the complexity of the decision issue, which is characterized by interrelationships between multiple variables defined by several indicators at various levels. Furthermore, Salehi, Zabihi, & Zarabadi, (2014) applied ANP in the paper titled Evaluation of the Most influential Criteria of Desirability of High-rise Buildings in Urban Landscape Using ANP. The article's goal is to identify the most effective criteria of suitability for tall structures, such as their ability to influence strategic views, how the skyline is defined, etc. The study's findings demonstrate that performance measures, particularly the indicator "impact on strategic views," which creates the best possible urban viewpoint, are the most useful standards for tall structures. Additionally, Pazzini, Corticelli, Lantieri, & Mazzoli, (2022) employed ANP in the study titled Multi-Criteria Analysis and Decision-Making Approach for the Urban Regeneration: The Application to the Rimini Canal Port (Italy). They were of the opinion because globalization, climate change, and economic uncertainty have a significant impact on urban settlements, these factors ought to be considered when planning cities. When making decisions in this kind of situation, evaluation techniques are necessary to identify the best course of action for city redevelopment while taking into account many social, economic, and environmental factors.

Similarly in this research for (SFDGs) the techniques and procedures as highlighted above with AHP and ANP application will be used to create the priority list, the formulation of a priority list for the tailored goals is the final step of this AHP and ANP procedures. This list combines professional perspectives and judgements together, providing a clear ranking of the goals based on their significance and possible effect. These prioritized aims will therefore serve as the foundation for the construction of a resilient and sustainable Makoko Community, allowing it to thrive despite the particular obstacles given by its floating slum environment.

4.3 Data Collection and Analysis

4.3.1 Identification of Sustainable Floating Development Goals (SFDGs) and Indicators

and Indicators. A solution to rapid urbanization that has emerged in recent years is the development of floating communities, which can provide a unique and sustainable way of living. However, it is essential that these communities are designed with sustainability in mind to ensure their long-term viability and reduce their environmental impact (Hák, Janoušková, & Moldan, 2016). Sustainable floating communities can offer a range of benefits, including increased resilience and adaptation to changing environmental conditions, efficient use of resources, social inclusion, economic sustainability, cultural preservation, improved health, and well-being, and reduced disaster risk (Hannula, 2012). In this chapter, the specific Sustainable floating development goals (SFDGs) that can guide the design and development of Makoko floating community will be highlighted, each of the goals is related to one or more united nations SDGs. The goals and indicators are based and derived from a series of studies into previous papers with the aim of making Makoko Community a sustainable place by solving its unique problems and conditions, thereby uplifting the way of life of the people living in that area. In order to make the (SFDGs) more reliable and applicable semi-structure interviews were made and Expert sampling is used to be the subject of the purposive sampling. Purposive sampling, also known as judgement sampling, is the deliberate selection of an interviewee based on the candidate's expertise (Etikan,2016). For the purpose of this research five experts were selected, given the Makoko community's unique circumstances, key urban planning professionals, architects, and lecturers were recruited. These individuals were chosen for their experience and personal knowledge of the community's difficulties and possibilities. Purposive sampling was employed to ensure that the final data findings represented a diverse range of opinions and thoughts, resulting in a well-rounded understanding of the issues at hand. Among the list of experts sought were Urban Planners from ministry of physical planning and urban development (MPPUD), Architects from National Inland Water Authority (NIWA) or Architectural studios in Makoko. Their expertise and experiences are crucial for developing successful long-term plans and recommendations for floating communities, particularly in light of the Sustainable Development Goals (SDGs). Furthermore, having these experts involved makes it easier to conduct a thorough evaluation of the viability of the suggested goals. Their comprehensive knowledge of the pragmatic obstacles present in urban initiatives enables a refined assessment, guaranteeing that the objectives are not only soundly conceptually but also practically achievable within the distinct confines of Makoko's urban environment. Professional involvement also helps to identify any problems that might not be immediately obvious from a theoretical perspective. Their input is crucial for identifying any errors, omissions, or difficulties that can prevent the objectives from being carried out successfully, which helps to build a stronger and more thorough research framework. Finally, the experts were shown the SFDGs in order to obtain their professional feedback. By providing their opinions on the goals and indicators, the experts added a layer of assurance, emphasized the validity and reliability of the suggested objectives, and strengthened confidence in the research endeavor as a whole.

Table Below is the breakdown of the Tailored Goals stating information regarding its formulation and sources.

Table 2

Sustainable Floating Development Goals and Indicators for Makoko Community

Tailored SFDGs	**UN SDGs Satisfied**	**Indicators**	**References**
Goal No 1: Resilience and Adaptation	• Goal 11: Sustainable Cities and Communities • Goal 13: Climate Action	• The number of stilt/ floating structures built to withstand flooding. • Reduction in Frequency and severity of climate-related disasters in the community over time. • Percentage of community members reporting feeling more secure and prepared for climate-related hazards.	• (UN, 2022) • (Hák, Janoušková, & Moldan, 2016) • (SBE, 2022) • (Adeyemi, 2012) • (Okeke et al., 2019) • (Olafimihan, 2009) • (Lawanson et al., 2022)
Goal No 2: Resource Efficiency	• Goal 7: Affordable and Clean Energy • Goal 12: Responsible Consumption and Production • Goal 13: Climate Action	• Energy consumption per capita in the community. • Percentage of households using energy-efficient appliances. • Amount of waste generated per capita in the community. • Percentage of households engaged in recycling and waste separation practices. • Percentage of community-owned buildings equipped with rainwater harvesting systems.	• (Agbola & Agunbiade, 2009) • (UN, 2022) • (Michael et al., 2017) • (Hák, Janoušková, & Moldan, 2016) • (Oduwaye et al., 2011) • (SBE, 2022)

Goal No 3: Social Inclusion	• Goal 1: No Poverty • Goal 4: Quality Education • Goal 5: Gender Equality • Goal 10: Reduced Inequalities • Goal 11: Sustainable Cities and Communities	• Percentage of women in decision-making positions. • Percentage of children and youth attending school. • Percentage of residents participating in community development programs. • Number of community-owned spaces for social, recreational and cultural activities.	• (Agbola & Agunbiade, 2009) • (UN, 2022) • (Hoelzel & Akinsete, 2015) • (Hák, Janoušková , & Moldan, 2016) • (Oduwaye et al., 2011)
Goal No 4: Economic Sustainability	• Goal 1: No Poverty • Goal 8: Decent Work and Economic Growth • Goal 9: Industry, Innovation, and Infrastructure	• Average household income. • The number of micro and small enterprises. • Percentage of residents with access to financial services. • Percentage of residents employed in the formal sector. • The number of community-led economic development projects.	• (UN, 2022) • (Hák, Janoušková , & Moldan, 2016) • (Oduwaye et al.,2011) • (Agbola & Agunbiade, 2009) • (Michael et al., 2017)
Goal No 5: Cultural Preservation	• Goal 11: Sustainable Cities and Communities • Goal 16: Peace, Justice, and Strong Institutions	• The number of cultural heritage sites identified and protected. • Percentage of residents engaged in cultural preservation activities. • The number of cultural events and festivals organized annually. • The number of traditional building techniques and materials used in construction.	• (Oduwaye et al.,2011) • (UN, 2022) • (Hák, Janoušková , & Moldan, 2016) • (Michael et al., 2017)
Goal No 6: Health and	• Goal 3: Good Health and Well-being	• The number of healthcare facilities. • Percentage of households	• (UN, 2022) • (Hák, Janoušková

Well-being	• Goal 6: Clean Water and Sanitation • Goal 11: Sustainable Cities and Communities	with access to improved sanitation facilities. • Percentage of households with access to clean water. • The number of health and hygiene education programs. • Percentage of residents vaccinated against preventable diseases.	, & Moldan, 2016) • (Oduwaye et al.,2011) • (Olafimihan, 2009) • (Lawanson et al., 2022)
Goal No 7: Sustainable Transportation	• Goal 7: Affordable and Clean Energy • Goal 11: Sustainable Cities and Communities • Goal 13: Climate Action	• The number of public boat transportation options available. • Percentage of households with access to non-motorized transportation. • Average commute time.	• (Hoelzel & Akinsete, 2015) • (SBE, 2022) • (UN, 2022) • (Hák, Janoušková, & Moldan, 2016) • (Oduwaye et al.,2011) • (Olafimihan, 2009) • (Lawanson et al., 2022)
Goal No 8: Biodiversity and Ecosystem Protection	• Goal 14: Life Below Water • Goal 15: Life on Land	• Implementation of sustainable waste management systems to reduce pollution in the water bodies. • Improved Air and water quality. • Promotion of local biodiversity through conservation and restoration efforts. • Integration of the community's traditional fishing practices into sustainable fishing practices to ensure the protection of aquatic life.	• (Riise & Adeyemi, 2015) • (UN, 2022) • (Hák, Janoušková, & Moldan, 2016) • (Olafimihan, 2009) • (Okeke et al., 2019)

Goal No 9: Disaster Risk Reduction	• Goal 9: Industry, Innovation, and Infrastructure • Goal 11: Sustainable Cities and Communities • Goal 13: Climate Action	• The number of households with access to early warning systems. • The number of emergency shelters. • Percentage of residents trained in disaster response. • The number of community-led disaster risk management initiatives. • Percentage of critical infrastructure resilient to disasters.	• (UN, 2022) • (Hák, Janoušková, & Moldan, 2016) • (Olafimihan, 2009) • (Lawanson et al., 2022) • (Michael et al., 2017) • (Hoelzel & Akinsete, 2015)
Goal No 10: Innovation and Creativity	• Goal 9: Industry, Innovation, and Infrastructure • Goal 11: Sustainable Cities and Communities • Goal 12: Responsible Consumption and Production	• The number of training and capacity-building programs. • Implementation of innovative and sustainable building materials and techniques in the design of floating structures. • Promotion of sustainable livelihood options such as eco-tourism, artisanal fishing, and aquaculture. • Incorporation of renewable energy sources such as solar and wind power in the community's energy mix.	• (UN, 2022) • (Hák, Janoušková, & Moldan, 2016) • (Olafimihan, 2009) • (Lawanson et al., 2022) • (Hoelzel & Akinsete, 2015)

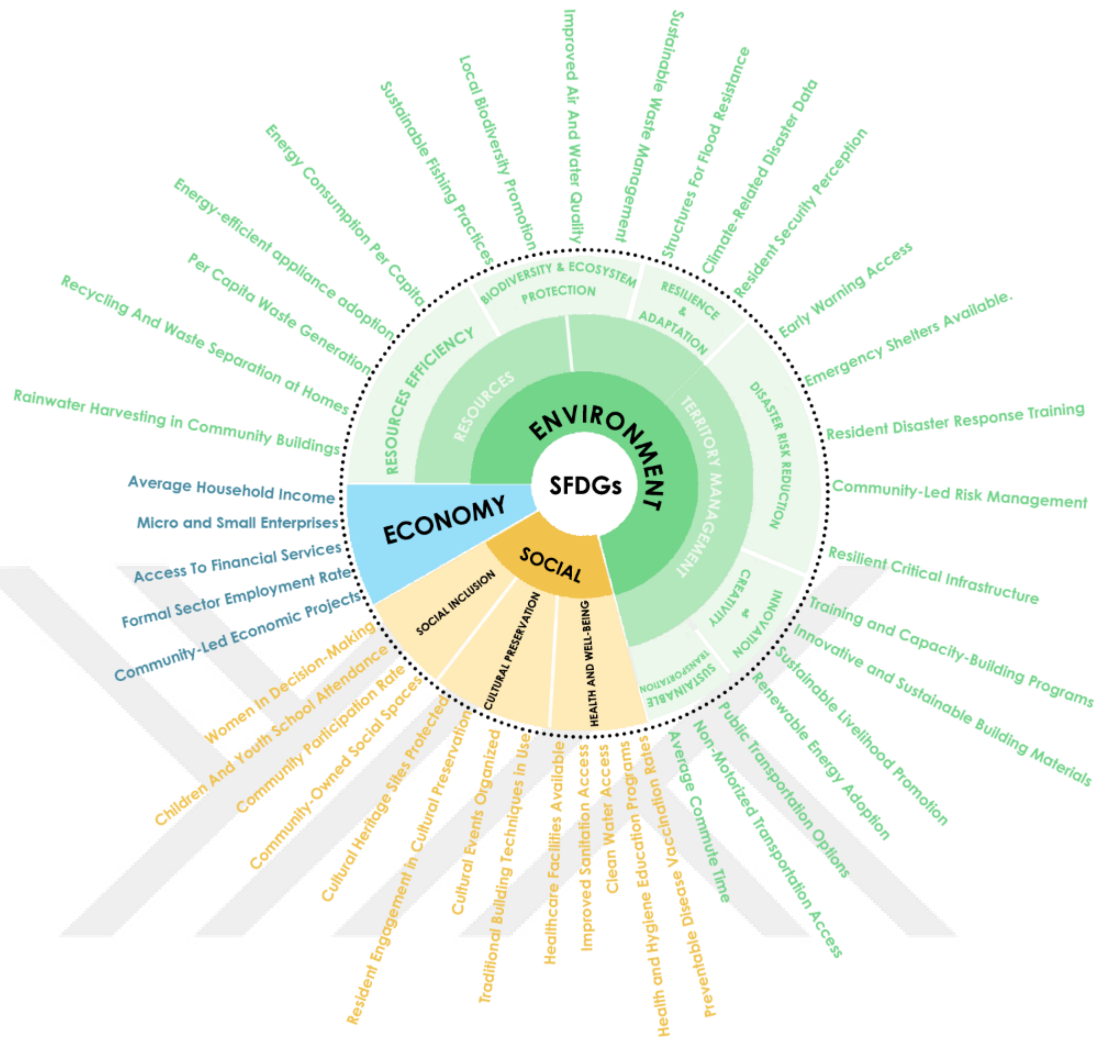

Figure 38. SFDGs and indicators for Makoko Community

1. Goal no 1: Resilience and Adaptation

The Makoko community, being a floating community, is particularly vulnerable to the impacts of climate change such as sea level rise, storms, and other climate-related hazards. Therefore, it is crucial to design and develop the community in a resilient way that can adapt to changing environmental conditions. This can include measures such as designing floating structures that can withstand strong winds and floods, creating evacuation plans for extreme weather events, and ensuring that essential infrastructure such as water and sanitation systems are resilient to climate impacts. This goal would satisfy UN SDGs 11,13, and accordingly the indicators have been tailored to Makoko Community (UN, 2022, Hák, Janoušková, & Moldan, 2016, SBE, 2022, Adeyemi, 2012, Okeke et al., 2019, Olafimihan, 2009, Lawanson et al., 2022).

Indicators:

a) The number of stilt/ floating structures built to withstand flooding: This Indicator represents the number of robust floating and stilt structures built in the Makoko neighborhood. Flooding, a common problem in this floating location, is considered when developing these structures. The higher the number, the stronger the community's resilience to flood disasters and ability to recover from them. It exemplifies how physical infrastructure has been altered to meet climate-related concerns.

b) Frequency and severity of climate-related disasters in the community over time: This indicator tracks the incidence of climate-related catastrophes in the Makoko community in the past. It gives critical insights into the shifting risk environment by evaluating the frequency and severity of these events over time. A decrease in frequency or intensity might indicate high adaptation and resilience.

c) Percentage of community members reporting feeling more secure and prepared for climate-related hazards: This indicator assesses community members' individual experiences. It depicts the proportion of residents who say resilience and adaptation measures have made them feel safer and more prepared to deal with climate-related hazards. This statistic gives a human-centered assessment of a community's preparedness and is critical for determining its citizens' general optimism and well-being in the face of environmental concerns.

2. Goal no 2: Resource Efficiency

Makoko community, like many other informal settlements in developing countries, faces challenges related to access to basic resources such as water, energy, and materials. Therefore, the design and development of a sustainable floating community in Makoko should prioritize the efficient use of these resources to ensure that they are used in a sustainable manner. This can include measures such as implementing rainwater harvesting systems to provide a reliable source of water, using renewable energy sources such as solar or wind to power homes and public facilities, and promoting recycling and waste reduction to minimize waste. This goal would satisfy UN SDGs 7,12,13 and accordingly, the indicators have been tailored to Makoko Community (UN, 2022, Hák, Janoušková, & Moldan, 2016, SBE, 2022, Agbola & Agunbiade, 2009, Michael et al., 2017, Oduwaye et al., 2011).

Indicators:

a) Energy consumption per capita in the community: This indicator offers information on how Makoko residents utilize energy. Less energy is utilized per person, implying that people are making better use of energy resources. This not only reduces energy expenses but also helps to create a greener, more sustainable planet.

b) Percentage of households using energy-efficient appliances: A key indicator of the community's adoption of sustainable energy practices is provided by this indicator. It additionally sheds light on locals' knowledge of and acceptance of environmentally friendly technology, which is important for putting certain steps into place to improve the community's overall sustainability.

c) Amount of waste generated per capita in the community: Calculating the amount of rubbish created per person provides a comprehensive picture of waste generation in the community. A reduction in the quantity of garbage produced per capita demonstrates a dedication to waste reduction. It demonstrates that the community encourages environmentally friendly activities such as recycling and rubbish minimization.

d) Percentage of households engaged in recycling and waste separation practices: This metric examines how the local community engages in garbage and recycling separation. More households using these strategies reflects a social commitment to minimising waste and managing resources effectively. It emphasises the importance of recycling in Makoko's resource-conservation plan.

e) Percentage of community-owned buildings equipped with rainwater harvesting systems: This indicator assesses the effectiveness with which rainwater collection systems are integrated into publicly owned structures. A larger proportion indicates greater support for sustainable water supply. Rainwater collection promotes resource efficiency and conserves water by minimising the community's reliance on outside water sources.

3. Goal no 3: Social Inclusion

Makoko is home to a diverse community, including people from different ethnic and socio-economic backgrounds. Therefore, the design and development of a sustainable floating community in Makoko should prioritize social inclusion and equal access to opportunities for all residents. This can include measures such as ensuring that public facilities and services such as schools, healthcare facilities, and markets are accessible to all, regardless of income or social status. Additionally, community-based participatory approaches should be used to involve residents in decision-making processes and to ensure that their voices are heard in the development of the community. This includes addressing the challenges faced by marginalized and vulnerable groups such as women, children, and the elderly. This goal would satisfy UN SDGs 1,5,10,11 and accordingly the indicators have been tailored to Makoko Community (UN, 2022, SBE, 2022, Agbola & Agunbiade, 2009, Hoelzel & Akinsete, 2015, Oduwaye et al., 2011).

Indicators:

a) Percentage of women in decision-making positions: This indicator represents the number of women in senior positions and positions of power in the Makoko community. A greater proportion indicates a fairer allocation of decision-making power between the sexes. This is not only a step towards gender equality, but it is also a strategy for incorporating different ideas and life experiences into community progress.

b) Percentage of children and youth attending school: Measuring the percentage of children and teenagers who attend school reflects the community's commitment to equitable educational opportunities. A larger proportion indicates that the community is successfully offering education to its younger people, which is critical for developing social inclusion and personal empowerment.

c) Percentage of residents participating in community development programs: This metric shows community engagement in development projects and activities. Greater proportion shows that inhabitants are actively involved in determining their neighborhood's future. This participation allows members of the community to actively participate in their growth and adds to more inclusive decision-making processes. Engagement signifies a collective effort to shape the neighborhood's future and contribute to its sustainable development.

d) Number of community-owned spaces for social and cultural activities: This indicator demonstrates the availability of communal spaces set aside for social and cultural activities in the Makoko community. More of these places encourage interpersonal communication, cross-cultural interchange, and neighbourhood cohesion. These locations serve as crucial gathering spots for locals to foster a sense of community and social inclusion, ensuring that the community's diverse social and cultural requirements are met.

4. Goal no 4: Economic Sustainability

Makoko community is mainly informal, with many residents engaged in small-scale economic activities such as fishing, trading, and handicrafts. Therefore, the design and development of a sustainable floating community in Makoko should support economic sustainability and provide opportunities for residents to earn a living. This can include measures such as providing access to finance and business development services to support small and medium-sized enterprises, promoting value addition and product diversification to increase income and create new economic opportunities, and providing training and skills development to support entrepreneurship and innovation. This goal would satisfy UN SDGs 1,8,9 and accordingly the indicators have been tailored to Makoko Community UN, 2022, Hák, Janoušková, & Moldan, 2016, Oduwaye et al.,2011, Agbola & Agunbiade, 2009, Michael et al., 2017).

Indicators:

a) Average household income: This indicator may be used to estimate the Makoko community's household economic well-being. It gives information on the community's general economic stability and people' capacity to satisfy their basic necessities by establishing the average income per household.

b) The number of micro and small enterprises: The number of micro and small businesses in the region is measured by this indicator. The success of these businesses is a reflection of Makoko's entrepreneurial spirit and economic variety. A larger proportion suggests a healthier entrepreneurial environment, which might result in more prospects for employment and economic growth.

c) Percentage of residents with access to financial services: This indicator measures how easily Makoko residents may receive financial services. It is essential to ensuring that the neighborhood has access to savings accounts, loans, and other sources of funding to support its local projects and investments. A greater proportion denotes a better economic environment.

d) Percentage of residents employed in the formal sector: The percentage of locals having formal employment, that is, occupations with set hours, benefits, and job security, is measured by this indicator. A larger percentage suggests that chances for formal work are more readily accessible, which might improve the community's economic stability.

e) The number of community-led economic development projects: Community economic development activities are the main emphasis of this indicator. It shows the community's proactive efforts to create new economic possibilities and improve sustainability from within by keeping track of the number of such initiatives. Businesses that strongly emphasize community empowerment and long-term economic viability include cooperatives, trade organizations, and community-supported agriculture.

5. Goal no 5: Cultural Preservation

The Makoko community has a rich cultural heritage and identity that should be preserved and promoted in the design and development of a sustainable floating community. This can include measures such as preserving traditional building techniques and architectural styles, promoting cultural festivals and events, and integrating cultural elements into public spaces and facilities. This goal would satisfy UN SDGs 11,16 and accordingly the indicators have been tailored to Makoko Community (Oduwaye et al.,2011, UN, 2022, Hák, Janoušková, & Moldan, 2016, Michael et al., 2017).

Indicators:

a) The number of cultural heritage sites identified and protected: This indicator assesses the extent to which cultural heritage sites in the Makoko community have been identified and are being protected. These sites might be culturally significant natural sights, objects, or historic constructions. The number of sites designated as protected sites reflects the community's dedication to conserving its cultural legacy. To keep historic locations alive, preservation efforts may involve documentation, maintenance, and the implementation of safety procedures. Although currently there is no building in Makoko that has been recognized and registered with UNESCO world heritage list.

b) Percentage of residents engaged in cultural preservation activities: This indicator looks at the extent to which the local community participates in cultural preservation initiatives. It gauges the percentage of locals who actively take part in initiatives to protect and advance their cultural heritage. Examples include local history research, storytelling, and traditional arts and crafts. A greater percentage denotes a community that appreciates and actively supports the maintenance of its traditions.

c) The number of cultural events and festivals organized annually: This indicator takes into account the frequency with which local festivals and cultural events are organized like the Eyo festival and Gẹlẹdẹ festival. These meetings allow residents to mingle, celebrate their cultural traditions, and educate others about their heritage. The greater number of scheduled events demonstrates that the community's cultural identity is livelier and more durable.

d) The number of traditional building techniques and materials used in construction: This indicator keeps track of how frequently conventional building techniques and resources are applied in regional building projects. It stands for the community's dedication to protecting its natural surroundings in a way that honours its rich architectural history and distinctive cultural character. Local architectural designs, indigenous materials, and vernacular architecture are examples of traditional methods and materials that support preserving cultural identity in the built environment.

6. Goal no 6: Health and Well-being

Makoko community faces numerous health challenges, including poor access to healthcare facilities and services, inadequate sanitation and hygiene, and high levels of waterborne diseases. Therefore, the design and development of a sustainable floating community in Makoko should prioritize the health and well-being of residents. This can include measures such as providing access to clean water and sanitation facilities, promoting healthy behaviors such as handwashing and safe food handling practices, and providing access to affordable healthcare services. This goal would satisfy UN SDGs 3,6,11 and accordingly the indicators have been tailored to Makoko Community (UN, 2022, Hák, Janoušková, & Moldan, 2016, Oduwaye et al.,2011, Olafimihan, 2009, Lawanson et al., 2022).

Indicators:

a) The number of healthcare facilities: This indicator assesses the Makoko community's access to healthcare resources. These clinics provide basic healthcare services such as medical consultation, treatment, and prevention. The number of healthcare facilities reflects the community's dedication to providing inexpensive, high-quality healthcare to its residents, consequently improving their health and well-being.

b) Percentage of households with access to improved sanitation facilities: This metric measures the proportion of residences with better sanitary facilities.

Improved amenities include proper restrooms and efficient waste disposal systems. A higher proportion reflects the community's commitment to addressing sanitation concerns and ensuring residents' access to hygienic and secure sanitation facilities. Lowering the risk of waterborne infections not only benefits health but also contributes to overall well-being.

c) Percentage of households with access to clean water: This indicator measures the number of households who have access to safe, clean drinking water. Clean drinking water is essential for good health and well-being. A greater proportion reflects the community's efforts to ensure that citizens have access to clean drinking water, which is critical for minimizing waterborne illnesses and enhancing overall quality of life.

d) The number of health and hygiene education programs: This indicator tracks the number of community-wide health and hygiene education programs that have been implemented. These initiatives are critical in teaching residents about health-promoting practises and behaviours such as hand washing, proper food handling, and disease avoidance. The variety of offered programs indicates the community's dedication to educating and encouraging its people to live healthy lifestyles.

e) Percentage of residents vaccinated against preventable diseases: This indicator measures the amount of residents who have received immunizations against illnesses that can be prevented. High vaccination rates are critical for public health and the prevention of disease outbreaks. A larger proportion indicates that the community has been effective in encouraging immunisation and lowering the prevalence of certain illnesses, resulting in improved health and overall well-being.

7. Goal no 7: Sustainable Transportation

Floating communities, such as Makoko, face unique challenges related to transportation, including limited access to transportation services and waterway congestion. The goal of sustainable transportation aims to address these challenges by promoting the use of transportation options that are environmentally friendly, socially inclusive, and economically sustainable. The design and development of sustainable floating communities in Makoko should prioritize sustainable transportation options such as walking, and waterways public transportation. This will reduce greenhouse gas emissions and improve air quality. This goal would satisfy UN SDGs 7,11,13 and accordingly the indicators have been tailored to Makoko Community (SBE, 2022, UN, 2022, Hák, Janoušková, & Moldan, 2016, Oduwaye et al.,2011, Olafimihan, 2009, Lawanson et al., 2022).

Indicators:

a) The number of public transportation options available: This statistic measures the availability of public transport options in the Makoko neighbourhood. These options usually include boats, canoes, or other water-based vehicles that are appropriate for towns with a concentration on the water and are environmentally friendly. The range of options demonstrates how committed the town is to providing its inhabitants with accessible and sustainable transportation options. It's a positive move towards supporting more ecologically friendly transportation and reducing greenhouse gas emissions.
b) Percentage of households with access to non-motorized transportation: This indicator measures the percentage of households with access to non-motorized modes of transportation like Floating Platforms, Paddle Canoes or Rowboats. In addition to promoting physical activity and lowering greenhouse gas emissions, non-motorized forms of transportation are also kinder to society and the environment. A larger percentage suggests a community that appreciates low-cost, environmentally friendly transportation options that improve both health and the environment.
c) Average commute time: This statistic measures the amount of time it takes residents of the Makoko community to travel between two points. The transportation system could become more efficient and available if the average trip time is decreased. Less stress and a greater standard of living for community members are implied by shorter commutes. It demonstrates the town's commitment to giving its citizens a reliable transit system.

8. Goal no 8: Biodiversity and Ecosystem Protection

Makoko community is located in a unique ecosystem that is home to a diverse range of flora and fauna. The delicate ecological system provides important ecosystem services such as water filtration, carbon sequestration, and habitat for wildlife. The design of the community should prioritize the protection of local biodiversity and ecosystems. This can be achieved through the implementation of green spaces, the promotion of sustainable fishing practices, and the protection of mangroves and other wetland habitats. This will help to maintain the natural beauty and ecological integrity of the surrounding environment. This goal would satisfy UN SDGs 14,15 and accordingly the indicators have been tailored to Makoko Community (UN, 2022, Hák, Janoušková, & Moldan, 2016, Olafimihan, 2009, Okeke et al., 2019).

Indicators:

a) Implementation of sustainable waste management systems to reduce pollution in the water bodies: This indicator measures how effectively the Makoko community has adopted sustainable waste management techniques. These systems concentrate on reducing the amount of trash and pollution that enters water bodies, which is essential for preserving the ecological integrity of the local ecosystem. By lessening the damage that pollution does to aquatic life and ecosystems, proper waste management contributes to preserving biodiversity and the health of the environment as a whole.

b) Improved Air and water quality: In terms of air and water quality, this indicator measures the community's overall improvement. The health and viability of the local environment depend heavily on lower pollution levels, as evidenced by better air and water quality. Cleaner air serves the local mangrove as well as local inhabitants, whereas cleaner water supports aquatic life and the wider ecosystem.

c) Promotion of local biodiversity through conservation and restoration efforts: This indicator measures the level of community involvement in enhancing and conserving local biodiversity. Native plant planting, the preservation of natural ecosystems, and the creation of designated conservation zones are all examples of conservation and restoration operations. The overall wellbeing and ecological balance of the ecosystem depend heavily on the preservation of native flora and creatures of all kinds.

d) Integration of the community's traditional fishing practices into sustainable fishing practices to ensure the protection of aquatic life: The Makoko community's shift from traditional to sustainable fishing methods is assessed by this measure. Sustainable fishing methods aim to preserve aquatic life and marine ecosystems. By reducing overfishing and preserving a healthy balance between human activity and biodiversity, they help to protect the health and integrity of the local ecosystem.

9. Goal no 9: Disaster Risk Reduction

Makoko community is located in a high-risk area for natural disasters, including flooding and storms. The community should be designed to reduce the risk of disasters, ensure the safety of residents and reduce the risk of property damage. This can be achieved through the implementation of flood-resistant infrastructure, the establishment of early warning systems, and the implementation of emergency response plans. This goal would satisfy UN SDGs 9,11,13 and accordingly the indicators have been tailored to Makoko Community (UN, 2022, Hák, Janoušková, & Moldan, 2016, Olafimihan, 2009, Lawanson et al., 2022, Michael et al., 2017, Hoelzel & Akinsete, 2015).

Indicators:

a) The number of households with access to early warning systems: This indicator measures the amount of Makoko community households have access to early warning systems for natural disasters. By providing citizens with timely warnings and important information, early warning systems serve to lower the risk of disasters. When families have access to such systems, the danger to life and property is reduced because they may be prepared, evacuate, or take preventative measures when detrimental occurrences are due to occur.

b) The number of emergency shelters: This indicator evaluates the accessibility to emergency shelters in the community. During disasters, emergency shelters are essential safe havens. The number of shelters demonstrates the neighborhood's capacity and preparedness to provide emergency protection for its residents. In order to prevent anyone from becoming trapped during an emergency, proper shelters must be provided.

c) Percentage of residents trained in disaster response: This indicator measures the percentage of the local population that has received training in disaster response. Residents who have received training are more prepared to react appropriately in an emergency. A greater percentage denotes a more resilient community where residents are capable of acting rapidly in the event of a disaster to protect both themselves and others.

d) The number of community-led disaster risk management initiatives: This indicator measures the quantity of locally driven catastrophe risk reduction initiatives. These initiatives include, among others, resilience-building programmes, regional emergency response teams, and community-based disaster preparedness initiatives. The number of initiatives run by the community shows that it takes a proactive approach to catastrophe risk reduction and that it is responsible for its own security and well-being.

e) Percentage of critical infrastructure resilient to disasters: This indicator measures the percentage of vital infrastructure such as hospitals, schools, and utilities built to survive disasters. Critical services are guaranteed to continue running both during and after disasters thanks to resilient infrastructure, supporting the safety and wellbeing of the neighbourhood. A higher percentage denotes more readiness and capability to deliver essential services even under challenging conditions.

10. Goal no 10: Innovation and Creativity

The design and development of sustainable floating communities in Makoko should promote innovation and creativity to find new and sustainable solutions to challenges facing the community. The design of the community should be conducive to innovation and creativity, fostering an environment that encourages experimentation, collaboration, and the exchange of ideas. This will create a dynamic and forward-thinking community that is constantly evolving and improving. This goal would satisfy UN SDGs 9,11,12 and accordingly the indicators have been tailored to

Makoko Community (UN, 2022, Hák, Janoušková, & Moldan, 2016, Olafimihan, 2009, Lawanson et al., 2022, Hoelzel & Akinsete, 2015).

Indicators:

a) The number of training and capacity-building programs: This indicator measures the number of training and capacity-building programs available in the Makoko neighborhood. These courses seek to stimulate innovation and creativity by providing students with the knowledge and skills they need to cope with local concerns. By giving training in a range of areas such as entrepreneurship, sustainable practices, and problem-solving, the community provides its members with the skills they need to think creatively and seek unique solutions.

b) Implementation of innovative and sustainable building materials and techniques in the design of floating structures: It evaluates the degree to which innovative and sustainable construction techniques and resources are utilized in the design of floating structures in the neighborhood. The use of these elements and techniques demonstrates the community's commitment to modern, environmentally responsible, and resilient construction practices. It demonstrates a dedication to continuously enhancing the community's infrastructure's environmental sustainability.

c) Promotion of sustainable livelihood options such as eco-tourism, artisanal fishing, and aquaculture: This indicator measures how successfully the neighbourhood is promoting sustainable lifestyle options that are in line with its unique qualities. Examples of sustainable lifestyles include ecotourism, artisanal fishing, and aquaculture, which not only encourage economic sustainability but also inspire cutting-edge revenue production strategies that respect and protect the local ecosystem. This promotes a flexible, progressive strategy for generating money that is advantageous to both local residents and the ecology.

d) Incorporation of renewable energy sources such as solar and wind power in the community's energy mix: This indicator evaluates the extent to which renewable energy sources, such as solar and wind power, are included into the community's energy mix. Using innovative, ecologically friendly methods for producing energy is demonstrated through the use of clean, sustainable energy sources. It lessens the neighborhood's environmental impact and promotes innovative energy generation techniques.

The Sustainable Floating Development Goals (SFDGs) provide a comprehensive framework for the development of resilient, socially inclusive, and environmentally sustainable floating settlements in Makoko. These objectives are critical to ensuring that Makoko can not only resist the difficulties posed by climate change but also improve resource efficiency and provide fair opportunity for all people by emphasizing sustainability in community design. Furthermore, by protecting the community's unique cultural history, improving inhabitants' health and well-being, and decreasing natural disaster danger, Makoko could develop into a bright and progressive community that relentlessly adapts and strengthens. Through the implementation of the SFDGs, we can pave the road for a more promising and environmentally friendly future for all individuals who reside in floating communities.

4.3.2 Prioritization of Goals and Indicators with Analytical Hierarchy Process (AHP). The process of goal setting is an essential part of planning for any project, whether it be a business venture or a community development initiative. However, determining the priority of these goals can be a challenge, particularly when there are multiple goals to consider. The Analytical Hierarchy Process (AHP) provides a solution to this challenge, by enabling experts to determine a priority list for the goals based on their opinions. AHP the pairwise comparison measurement theory developed by Thomas Saaty provides a framework that enables experts to compare and prioritize alternatives based on a set of criteria and sub-criteria (Saaty,2006). When using AHP, experts are presented with a series of paired alternatives and asked to make judgments about which alternative is more important. For example, if the goal is to improve a community's access to education, experts might be asked to compare the importance of improving school infrastructure versus hiring more teachers. The experts are then asked to assign a score to each alternative based on their opinion of its relative importance. The scores are then analyzed to determine the priority of the alternatives

(Donegan et al., 1992). To generate the goal hierarchical system, expert interviews will be conducted using the Analytical Hierarchy Process (AHP). The experts will be selected based on their knowledge and experience in the field of architecture and urban planning of floating communities. The interview process will involve presenting the experts with a set of sustainable floating development goals and asking them to compare the importance of each goal. The experts will be asked to assign scores to each goal based on their opinion of its relative importance and the survey will be conducted using a free web based (AHP) calculator and survey template that Business Performance Management Singapore (BPMSG) founder Klaus Goepel created. Notable features of this tool include the ability to calculate group consensus and handle group input, which enables in-depth analysis of decision problems (Goepel, 2018). Once the interviews are completed, the scores assigned by the experts will be analyzed to generate a priority list for sustainable floating development goals for Makoko community. The priority list will be based on the opinions of the five experts and will reflect the relative importance of each goal (Rajput & Shukla, 2012). This list can be used to guide the planning and decision-making process, ensuring that the most important goals are given priority during the Redevelopment of Makoko. Along with the development of a decision hierarchy, pairwise comparison judgments, priority calculations, and validation for consistency and consensus, the analysis of the results from the AHP calculator provided essential recommendations for creating a sustainable Makoko community.

Table 3

Global Sustainable Floating Development Goals (SFDGs) Priority List

Consistency Ratio CR: 8.7%

Cat		Priority	Rank
1	Goal 1- Resilience and Adaptation	21.4%	2
2	Goal 2- Resource Efficiency	6.7%	6
3	Goal 3- Social Inclusion	3.3%	8
4	Goal 4- Economic Sustainability	9.9%	4
5	Goal 5- Cultural Preservation	4.0%	7
6	Goal 6- Health and Well-being	20.3%	3
7	Goal 7- Sustainable Transportation	1.9%	10
8	Goal 8- Biodiversity and Ecosystem Protection	8.0%	5
9	Goal 9- Disaster Risk Reduction	21.5%	1
10	Goal 10- Innovation and Creativity	2.8%	9

Table 4

Consolidated SFDGs Decision Matrix

Aggregation of individual judgments for 5 Participant(s)

	1	2	3	4	5	6	7	8	9	10
1	1	5.57	7.97	0.83	4.17	1.48	8.36	4.26	1.84	3.13
2	0.18	1	6.58	0.53	1.84	0.16	6.32	0.80	0.14	1.96
3	0.13	0.15	1	0.20	1.34	0.20	3.67	0.35	0.18	1.78
4	1.20	1.90	4.97	1	1.68	0.34	6.97	0.84	0.16	3.09
5	0.24	0.54	0.74	0.60	1	0.21	2.78	0.35	0.20	2.54
6	0.68	6.42	4.97	2.95	4.72	1	8.16	3.57	0.92	7.11
7	0.12	0.16	0.27	0.14	0.36	0.12	1	0.39	0.19	0.76
8	0.23	1.25	2.83	1.19	2.87	0.28	2.56	1	0.70	3.52
9	0.54	7.28	5.53	6.15	5.10	1.08	5.39	1.43	1	5.22
10	0.32	0.51	0.56	0.32	0.39	0.14	1.32	0.28	0.19	1

The findings of the experts' AHP analysis offer vital direction for the Makoko community's prioritization of SFDGs. The most prominent three global priorities stand out as follows: Goal 9 - Decrease Disaster Risk (21,5%) This objective's crucial role cannot be overstated. The Makoko community suffers difficulties related to floods and storms given that it is located in a region at high risk for natural catastrophes. For the preservation of property and the safety of inhabitants, catastrophe risk mitigation must be given top priority. The urgent need for developing flood-resistant infrastructure, early warning systems, and community disaster preparedness for strengthening community resilience is reflected in the high global priority ranking. Goal 1 - Resilience and Adaptation (21.4%) achieving resilience and adaptation is crucial given the community's particular environmental concerns, including sea level rise, high winds, and other climate-related disasters. The community has to build flood-resistant buildings, design emergency routes to evacuate for extreme weather events, and make sure that essential infrastructure, including water and sewage systems, is resilient to the effects of climate change. Goal 6 - Well-being and Health (20.3%) Makoko faces a number of health difficulties, such as poor access to healthcare facilities, hygienic problems, and a high prevalence of waterborne illnesses. The improvement of health and well-being is essential to the growth of the community. To reduce threats to health and enhance inhabitants' general well-being, it is crucial to prioritize access to clean water, sanitary facilities, health education, and reasonably priced healthcare services. Three objectives, on the other hand, are listed as having the lowest global priorities: Goal 7 - Sustainable Transportation (1.9%) due to restricted access and congested waterways, the Makoko community has unique transportation issues. Sustainable mobility is essential, but as shown in the AHP surveys, it receives the lowest global priority, emphasizing the necessity of solving other urgent issues first. Goal 3 - Social Inclusion (3.3%) promoting social inclusion must be emphasized in the planning and construction of a sustainable floating community. This objective, however, has a lesser priority in light of Makoko's unique difficulties, indicating that other objectives require immediate intervention. Goal 10 - Creativity and Innovation (2.8%) although encouraging invention and creativity is essential to community development, it is given less importance in this situation and priority is given to meeting basic necessities (Goepel, 2018).

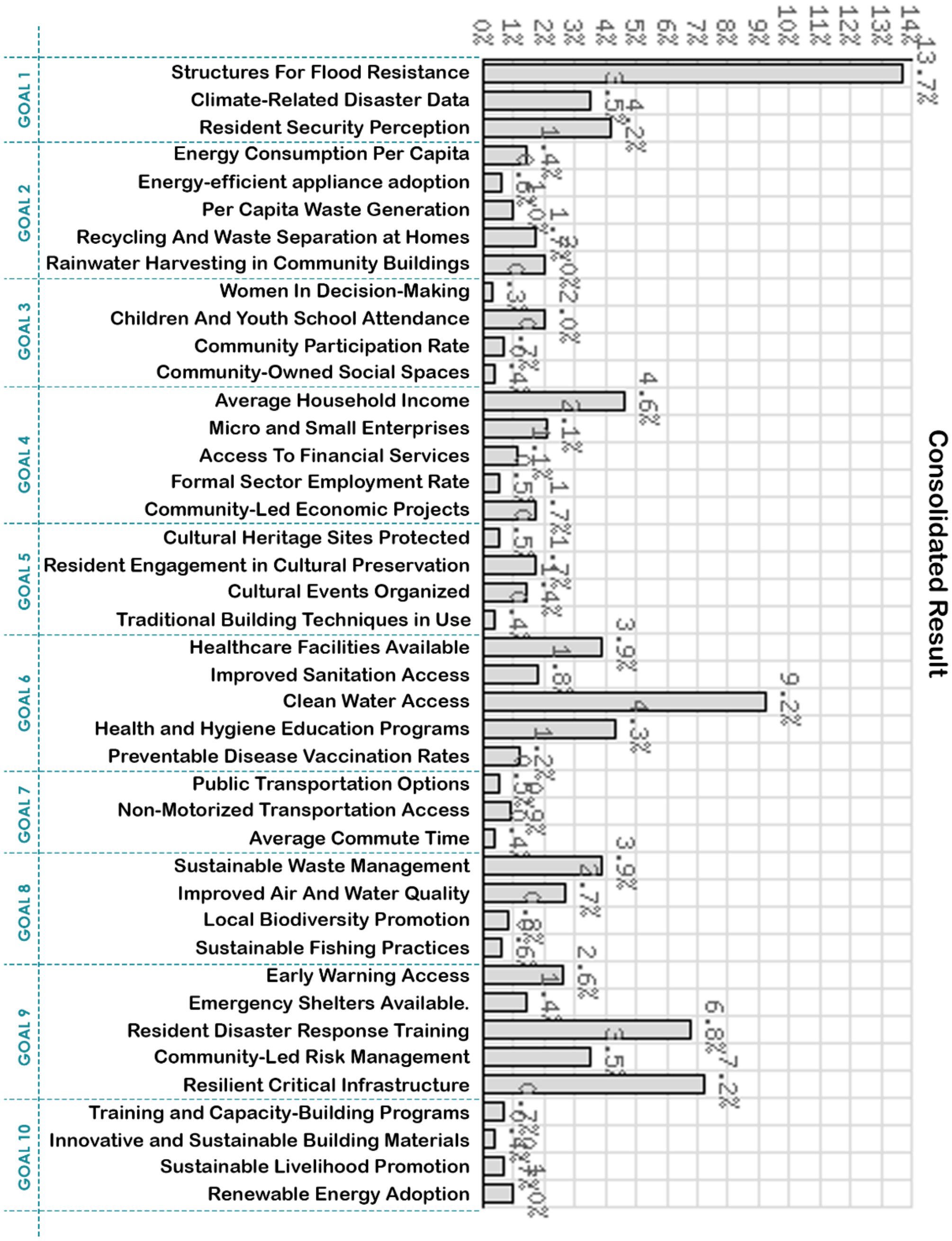

Figure 39. SFDGs Indicators Consolidated Result

Insightful information on the relative importance of the Sustainable Floating Development Goals (SFDGs) indicators as determined by the five expert participants is provided by the Consolidated result. A thorough understanding of the weighted average of each sub-criteria priority across all participants is provided by the bar chart, which displays this information visually. Within the framework of the Makoko community, several indicators have become very crucial. Within Goal 1 - Resilience and Adaptation, "Structures for Flood Resistance" with a percentage of 13.7% takes the lead as a crucial sub-criterion. The critical requirement to protect the community from its susceptibility to floods and climate-related disasters is highlighted by the sub-criteria's higher priority. To be able to enhance the area's resilience and protect its residents from the negative consequences of climate change, flood-resistant structures must be built. Within Goal 6 - Health and Well-Being, "Clean Water Access" with a percentage of 9.2% holds a crucial role in addition the indicator's staggering priority underlines how crucial it is to improve the health and general well-being of the Makoko community. The essential tenet of preventing waterborne illnesses and advancing locals' general well-being is having access to clean water. Within Goal 9 - Disaster Risk Reduction, "Resilient Critical Infrastructure" with a percentage of 7.2% is shown as a critical indicator, the priority emphasizes how urgent it is to make sure that critical services, such as water systems, healthcare facilities, and sanitation systems, can withstand the effects of climate-related dangers. A community's long-term viability and natural disaster readiness depend on resilient infrastructure. Goal 9 - Disaster Risk Reduction highlights a significant emphasis on "Resident Disaster Response Training" with a percentage of 6.8%. The importance of providing inhabitants with the expertise and abilities required to react adequately to catastrophes is emphasized by this priority. The community's readiness and resilience must be improved in order for it to respond to emergencies successfully. The noteworthy significance of "Average Household Income" with a percentage of 4.6% within Goal 4 - Economic Sustainability is indicated in the results. This indicator emphasizes how important it is to elevate citizens' income levels with the objective of promoting economic sustainability and opening up prospects for better livelihoods within the community. The crucial role of "Health and Hygiene Education Programs" with a percentage of 4.3% pertains to Goal 6 - Health and Well-Being. The centrality of these programs in encouraging healthy habits like satisfactory handwashing and safe culinary processes is highlighted by this priority. These initiatives considerably enhance the general well-being of the community's residents. Goal 8 - Biodiversity and Ecosystem Protection features a major indicator called "Sustainable Waste Management" with a percentage of 3.9%. Its importance emphasizes the necessity of establishing a framework for efficient waste management systems to lessen pollution in aquatic bodies. Such actions are essential to conserving Makoko's distinctive ecological system.

Table 5

SFDGs CR and Group Consensus Rating

Breakdown by Nodes

Details Node: SFDGs - CR: 8.7% - AHP group consensus: 78.6% high

Details Node: Goal 1- Resilience and Adaptation - CR: 6.7% - AHP group consensus: 69.8% moderate

Details Node: Goal 2- Resource Efficiency - CR: 3% - AHP group consensus: 53.8% low

Details Node: Goal 3- Social Inclusion - CR: 2.2% - AHP group consensus: 81.7% high

Details Node: Goal 4- Economic Sustainability - CR: 5.6% - AHP group consensus: 71.7% moderate

Details Node: Goal 5- Cultural Preservation - CR: 7.3% - AHP group consensus: 87.8% very high

Details Node: Goal 6- Health and Well-being - CR: 14.3% - AHP group consensus: 84.7% high

Details Node: Goal 7- Sustainable Transportation - CR: 2.5% - AHP group consensus: 51.8% low

Details Node: Goal 8- Biodiversity and Ecosystem Protection - CR: 2% - AHP group consensus: 91.2% very high

Details Node: Goal 9- Disaster Risk Reduction - CR: 7.8% - AHP group consensus: 84.3% high

Details Node: Goal 10- Innovation and Creativity - CR: 5.8% - AHP group consensus: 74.5% moderate

Overall, the AHP analysis indicates that most nodes of the decision hierarchy have a significant degree of consistency and consensus among the participants. The average CR (Consistency Ratio) across all nodes is 8.7%, which is lower than the recommended threshold of 10%. The average group consensus for all nodes is 78.2%, showing that the experts are in agreement. There are deviations such as Goal 6 - Health and Well-being, which has a higher CR, and Goal 2 - Resource Efficiency, which has a lower consensus. These disagreements may be attributed to the Makoko community's unique challenges and priorities, where certain goals, such as disaster risk reduction and health improvement, are viewed as immediate and critical needs, while others, such as sustainable transportation and innovation, are viewed as longer-term objectives (Goepel, 2018).

Table 6

Goal 1 Consolidated Priority

Details Node: Goal 1- Resilience and Adaptation - CR: 6.7% - AHP group consensus: 69.8% moderate

Consolidated Priorities

Consistency Ratio CR: 6.7%

Cat		Priority	Rank
1	Structures for flood resistance	63.8%	1
2	Climate-related disaster data	16.5%	3
3	Resident security perception	19.7%	2

Consolidated Decision Matrix

Aggregation of individual judgments for 5 Participant(s)

	1	2	3
1	1	4.99	2.51
2	0.20	1	1.07
3	0.40	0.93	1

The analysis for the first node, "Resilience and Adaptation," offers insightful data for building a resilient and adaptable floating community, supported by a consistency ratio (CR) of 6.7% and an intriguing Analytic Hierarchy Process (AHP) group consensus of 69.8% among the five participating experts in the pursuit of establishing Sustainable Floating Development Goals (SFDGs) for the Makoko community. When the consolidated priorities for this objective are evaluated, the indicator with the highest score (63.8%) is "Stilt/Floating Structures for Flood Resistance." This rating emphasizes the important function of resilient infrastructure, emphasizing the necessity to endure increasing sea levels and storms in unstable coastline communities. With a priority of 19.7%, "Resident Security Perception" follows, emphasizing the importance of inhabitants feeling safe and protected in their living environment. This sense of security helps the overall resilience of the community. The indicator titled "Climate-Related Disaster Data" is ranked next with a priority of 16.5%. Although it ranks lower than the other indicators, its inclusion recognizes the importance of data-driven solutions in tackling climate concerns, making it an important component in strengthening resilience and adaptation. The inclusion of these indicators under Goal 1, "Resilience and Adaptation," illustrates a comprehensive strategy for protecting Makoko against environmental threats, with an emphasis on resilient infrastructure, resident security perception, and data-driven decision-making (Goepel, 2018).

Table 7

Goal 2 Consolidated Priority

Details Node: Goal 2- Resource Efficiency - CR: 3% - AHP group consensus: 53.8% low

Consolidated Priorities

Consistency Ratio CR: 3.0%

Cat		Priority	Rank
1	Energy consumption per capita	21.5%	3
2	Energy-efficient appliance adoption	8.8%	5
3	Per capita waste generation	14.8%	4
4	Recycling and waste separation at homes	25.4%	2
5	Rainwater harvesting in community buildings	29.5%	1

Consolidated Decision Matrix

Aggregation of individual judgments for 5 Participant(s)

	1	2	3	4	5
1	1	1.60	1.23	1.31	0.80
2	0.62	1	0.52	0.25	0.30
3	0.81	1.93	1	0.63	0.36
4	0.76	3.97	1.58	1	1.03
5	1.25	3.32	2.79	0.97	1

The evaluation of consolidated priorities highlights the relevance of the following indicators under node of Goal 2 "Resource Efficiency," which has a consistency ratio (CR) of 3% and a solid AHP group consensus of 53.8% among the five participants. Rainwater harvesting in community structures is prioritized at 29.5%, highlighting the necessity of properly capturing and managing water resources in a floating community like Makoko, where access to fresh water might be difficult. Rainwater harvesting promotes the sustainable and effective use of water, which is consistent with global sustainability goals. Recycling and waste separation in the household comes in second, with a priority of 25.4%. In a restricted and delicate setting like Makoko, effective waste management is critical. Proper recycling and trash separation practices help to conserve resources, decrease environmental impact, and create a healthier living environment. Per capita waste generation holds a priority of 14.8%. While it is not the most important indication, it is critical for understanding the community's trash production trends. Lower per capita trash creation suggests a smaller environmental imprint, indicating a dedication to sustainability. Energy consumption per capita is prioritized at 21.5%. Efficient energy usage is a critical component of resource efficiency, especially in communities with limited access to energy supplies. Lower per capita energy use represents a more sustainable approach to energy consumption, matching with worldwide targets for lower energy consumption. The adoption of Energy-Efficient Appliances is the final indication of this objective, with a priority of 8.8%. While it rates lower than the other metrics, it nevertheless plays a role in improving resource efficiency by encouraging the use of energy-efficient appliances, which contributes to decreased energy usage. These objectives will collectively represent the community's dedication to effective resource management. Makoko's commitment to sustainable practices is demonstrated by the emphasis on rainwater harvesting, waste management, and appropriate energy usage, which aligns with the global push for resource efficiency (Goepel, 2018).

Table 8

Goal 3 Consolidated Priority

Details Node: Goal 3- Social Inclusion - CR: 2.2% - AHP group consensus: 81.7% high

Consolidated Priorities

Consistency Ratio CR: 2.2%

Cat		Priority	Rank
1	Women in decision-making	7.5%	4
2	Children and youth school attendance	60.9%	1
3	Community participation rate	20.4%	2
4	Community-owned social spaces	11.2%	3

Consolidated Decision Matrix

Aggregation of individual judgments for 5 Participant(s)

	1	2	3	4
1	1	0.14	0.26	0.81
2	7.11	1	3.73	5.07
3	3.78	0.27	1	1.58
4	1.23	0.20	0.63	1

The analysis of consolidated priorities for node of Goal 3 "Social Inclusion", which has a consistency ratio (CR) of 2.2% and a significant AHP group consensus of 81.7% among the five participants, reveals that children and youth school attendance is the highest priority at 60.9%, emphasizing the critical role of education in ensuring social inclusion in the Makoko community. This indicator demonstrates the community's commitment to providing educational opportunities, which aligns with

SDG 4 (Quality Education). The high ranking also indicates that education is critical to breaking the cycle of poverty and boosting social mobility. Another noteworthy statistic is the rate of community engagement, which has a priority of 20.4%. This emphasizes the importance of including people in the community in decision-making processes and activities that influence their lives. A high proportion of community engagement is crucial for social cohesion and empowerment, embodying the objectives of SDG 16 (Peace, Justice, and Strong Institutions). A weighting of 11.2% is given to community-owned social spaces. These areas are vital for social interactions and community building. They promote social inclusion by offering venues for communal activities and meetings, which is coherent with the concept of accessible public spaces as listed in the United Nations SDGs indicator for Goal 11 (Sustainable Cities and Communities). Despite its lower priority of 7.5%, women in decision-making play an essential role. This indicator underlines the community's emphasis on gender equity and inclusion in governance and decision-making processes. Empowering women to participate in community decisions coincides with SDG 5 (Gender Equality) and is an important feature of social inclusion. Makoko's dedication to developing a socially inclusive community is reflected in these consolidated priorities under Goal 3. The importance placed on children and youth school attendance demonstrates the belief in education as a means of social mobility. Simultaneously, community engagement and the provision of social spaces highlight the necessity of cultivating a feeling of community and inclusion among inhabitants. In addition, focusing on women's participation in decision-making demonstrates a commitment to gender parity and a more inclusive society. These interrelated principles establish the groundwork for a socially inclusive Makoko in which education, community participation, and social spaces all play important roles in promoting social cohesion and justice (Goepel, 2018).

Table 9

Goal 4 Consolidated Priority

Details Node: Goal 4- Economic Sustainability - CR: 5.6% - AHP group consensus: 71.7% moderate

Consolidated Priorities

Consistency Ratio CR: 5.6%

	Cat	Priority	Rank
1	Average household income	46.0%	1
2	Micro and small enterprises	21.1%	2
3	Access to financial services	11.1%	4
4	Formal sector employment rate	4.6%	5
5	Community-led economic projects	17.1%	3

Consolidated Decision Matrix

Aggregation of individual judgments for 5 Participant(s)

	1	2	3	4	5
1	1	2.79	5.36	4.97	3.18
2	0.36	1	1.63	5.88	1.64
3	0.19	0.61	1	3.95	0.44
4	0.20	0.17	0.25	1	0.23
5	0.31	0.61	2.29	4.32	1

Under node of Goal 4 "Economic Sustainability," which has a consistency ratio (CR) of 5.6% and a strong AHP group consensus of 71.7% among the five participants, the analysis of consolidated priorities reveals that average household income is the highest priority, commanding a significant 46.0%. This measure reflects the community's attention to increasing the economic well-being of households. A greater average household income equates to improved living standards, poverty reduction, and economic growth, which are consistent with the aims of Sustainable Development Goal 1 (No Poverty) and Sustainable Development Goal 8 (Decent Work and Economic Growth). Micro and small businesses place second with a priority of 21.1%. Encourage the expansion of small enterprises, which play an important role in creating local jobs, lowering income inequality, and encouraging economic diversity. This coincides with the aims of SDG 8, which focuses on decent work and economic growth. Furthermore, community-led economic initiatives have a priority of 17.1%, these projects generate economic activity within the community and frequently indicate sustainable development concepts. They may empower communities by facilitating self-employment and building economic resilience, this objective influences the theme of SDG 9 (Industry, Innovation, and Infrastructure). With a priority of 11.1%, Access to financial services comes next. Ensuring that community members have access to financial resources and services is critical for financial inclusion and entrepreneurship. It contributes to the aims of Sustainable Development Goal 10 (Reduced Inequalities) as well as the community's overall economic sustainability. While the formal sector employment rate of 4.6% is the lowest in the rankings, it is nonetheless significant in the context of Makoko. Even though it scores lower than other metrics, it demonstrates the community's appreciation of the value of formal work opportunities and solid job prospects given by the government or commercial players. This corresponds to (UN) Sustainable Development Goal 8, and the community's commitment to economic sustainability is demonstrated by these unified objectives under Goal 4. Prioritizing average household income demonstrates the value of people's financial well-being. Simultaneously, supporting micro and small businesses as well as community-led economic projects reflects the intention to foster local economic growth. Access to financial services demonstrates the community's commitment to financial inclusion, and the focus on formal sector employment rates suggests a comprehensive approach to economic sustainability. These economic goals work together to help Makoko become a more resilient and self-sufficient community, where economic growth, poverty reduction, and financial inclusion are essential components of the development agenda (Goepel, 2018).

Table 10

Goal 5 Consolidated Priority

Details Node: Goal 5- Cultural Preservation - CR: 7.3% - AHP group consensus: 87.8% very high

Consolidated Priorities

Consistency Ratio CR: 7.3%

Cat		Priority	Rank
1	Cultural heritage sites protected	11.4%	3
2	Resident engagement in cultural preservation	42.6%	1
3	Cultural events organized	35.3%	2
4	Traditional building techniques in use	10.8%	4

Consolidated Decision Matrix

Aggregation of individual judgments for 5 Participant(s)

	1	2	3	4
1	1	0.26	0.53	0.61
2	3.84	1	1.00	5.30
3	1.89	1.00	1	4.54
4	1.64	0.19	0.22	1

The analysis of consolidated priorities reveals that Resident engagement in cultural preservation is assigned the highest priority, representing a substantial 42.6%, for node of Goal 5 "Cultural Preservation," which has a consistency ratio (CR) of 7.3% and a strong AHP group consensus of 87.8% among the five participants. This will demonstrate the community's commitment to actively engaging its members in the preservation of its cultural heritage. This approach is consistent with SDG 11 (Sustainable Cities and Communities), in which cultural preservation contributes to the development of inclusive, safe, resilient, and sustainable communities. Furthermore, with a priority of 35.3%, cultural events organized is immediately followed. Organizing cultural events is an important aspect of preserving cultural traditions and identity, particularly in a community like Makoko, where many events take place. Such gatherings can also be used to enhance social cohesiveness and community involvement. This objective is consistent with the ideals of Sustainable Development Goals 11 and 17 (Partnerships for the Goals). Protected cultural heritage sites have a priority of 11.4%. While they may not be the most important, their preservation is nonetheless seen as an important part of the community's cultural preservation efforts. One of the few communities on the shoreline that has endured for more than 150 years is Makoko. There are many Akoko trees (Newbouldia Laevis) in the region, but because there is a great demand for timber, most of them have been chopped down (Duke, 2018). Protecting cultural heritage locations helps to preserve historical and cultural identity, adding to the community's general well-being and cultural enrichment. Traditional building techniques in use, with a priority of 10.8%, remain an important part of Makoko's cultural preservation, although placing last among these factors. There are three vernacular building typologies consisting of plank/bamboo structures, in fills, and brick structures although more than 52% live in plank/bamboo structures due to its construction cost. Traditional construction techniques are an important part of the community's architectural legacy, while there is a need for a new sustainable building style, keeping its traditional aspects is critical. Recognizing this demonstrates the community's dedication to preserving its architectural and cultural uniqueness. This objective is consistent with Sustainable Development Goals 11 and 9 (Industry, Innovation, and Infrastructure). These cultural goals work together to preserve Makoko's distinct cultural character by encouraging cultural vitality, community engagement, and historical preservation.

Table 11

Goal 6 Consolidated Priority

Details Node: Goal 6- Health and Well-being - CR: 14.3% - AHP group consensus: 84.7% high

Consolidated Priorities

Consistency Ratio CR: 14.3%

Cat		Priority	Rank
1	Healthcare facilities available	19.0%	3
2	Improved sanitation access	9.0%	4
3	Clean water access	45.1%	1
4	Health and hygiene education programs	21.0%	2
5	Preventable disease vaccination rates	5.8%	5

Consolidated Decision Matrix

Aggregation of individual judgments for 5 Participant(s)

	1	2	3	4	5
1	1	4.26	0.21	0.87	3.78
2	0.23	1	0.40	0.21	2.61
3	4.69	2.50	1	3.65	3.65
4	1.15	4.74	0.27	1	3.52
5	0.26	0.38	0.27	0.28	1

Under Goal 6, "Health and Well-being," the five participants had a consistency ratio (CR) of 14.3% and a good Analytic Hierarchy Process (AHP) group consensus of 84.7%. The examination of aggregated priorities reveals that clean water access is given the greatest priority, accounting for 45.1% of all priorities. This emphasizes the crucial need to supply citizens with clean and safe drinking water. Currently there are no sustainable supply of water in the area, the only source of clean water is from a reservoir located on the mainland area. Access to safe drinking water is a fundamental human right and guaranteeing these fits with SDG 6 (Clean Water and Sanitation). Health and hygiene education programs are prioritized at 21.0%. This demonstrates the community's dedication to increasing health awareness and sanitary practices. Presently the residents lack health and hygiene knowledge which has led to the improper disposal of all types of wastes leading to air and water pollution. Education programs may help citizens lead better lifestyles and prevent illnesses, which aligns with SDG 3 (Good Health and Well-being). Healthcare facilities availability is prioritized at 19.0%. While it is not the most important indicator, it recognizes the value of having healthcare services available to the population. Adequate healthcare facilities contribute to overall well-being and ensure citizens have access to needed medical treatment. With a 9.0% priority access to improved sanitation is forthcoming, suggesting that access to adequate sanitary facilities is an essential component of public health. Access to sanitary services aids in illness prevention and adds to the well-being of the community. Vaccination rates for preventable diseases, although having the lowest priority at 5.8%, are not disregarded. They continue to emphasize the importance of vaccination programs in preventing infectious illnesses. While it is the lowest ranking in this context, it represents the community's desire to safeguard inhabitants from avoidable illnesses. Goal 6's unified priorities represent the community's commitment to improving health and well-being. While certain indicators are more important than others, they all contribute to a healthier and more resilient community.

Table 12

Goal 7 Consolidated Priority

Details Node: Goal 7- Sustainable Transportation - CR: 2.5% - AHP group consensus: 51.8% low

Consolidated Priorities

Consistency Ratio CR: 2.5%

Cat		Priority	Rank
1	Public transportation options	28.1%	2
2	Non-motorized transportation access	50.3%	1
3	Average commute time	21.6%	3

Consolidated Decision Matrix

Aggregation of individual judgments for 5 Participant(s)

	1	2	3
1	1	0.48	1.52
2	2.09	1	1.99
3	0.66	0.50	1

Within node Goal 7, "Sustainable Transportation," where the Consistency Ratio (CR) is 2.5% and the AHP group consensus is 51.8% among the five participants, the analysis of consolidated priorities reveals that "Non-motorized transportation access" ranks first with a significant 50.3% priority. This high rating demonstrates the community's dedication to fostering environmentally friendly and sustainable forms of mobility, such as walking, boating, and cycling if the pathway is provided. It represents a commitment to minimize dependency on motorized vehicles, contributing to environmental sustainability and harmonizing with SDG 11 (Sustainable Cities and Communities). "Public transport options" come in second with a priority of 28.1%, recognizing the significance of providing inhabitants with quick and accessible public transport services. Accessible public transit improves mobility while reducing automobile congestion and pollution. By supporting safer and more accessible transit choices, this objective fits with the UN Sustainable Development

Goal 11 (Sustainable Cities and Communities) and Sustainable Development Goal 3 (Good Health and Well-being). "Average commute time" is categorized with 21.6% priority. While it is not the most important indication, it demonstrates the community's desire to reduce commuting times and improve transportation efficiency. By saving time and minimizing congestion, a reduced average travel time can improve inhabitants' quality of life. These unified goals under Goal 7 demonstrate the community's commitment to developing a more sustainable transportation system. Prioritizing non-motorized transportation and public transit can result in less traffic congestion, better air quality, and a more ecologically friendly transportation network.

Table 13

Goal 8 Consolidated Priority

Details Node: Goal 8- Biodiversity and Ecosystem Protection - CR: 2% - AHP group consensus: 91.2% very high

Consolidated Priorities

Consistency Ratio CR: 2.0%

	Cat	Priority	Rank
1	Sustainable waste management	49.1%	1
2	Improved air and water quality	33.8%	2
3	Local biodiversity promotion	9.5%	3
4	Sustainable fishing practices	7.6%	4

Consolidated Decision Matrix

Aggregation of individual judgments for 5 Participant(s)

	1	2	3	4
1	1	2.00	4.55	5.19
2	0.50	1	3.99	5.43
3	0.22	0.25	1	1.27
4	0.19	0.18	0.79	1

The study of consolidated priorities reveals that in the context of Node: Goal 8 "Biodiversity and Ecosystem Protection," which has a low Consistency Ratio (CR) of 2% and a robust AHP group consensus of 91.2% across the five participants, "Sustainable waste management" takes the top place with a priority of 49.1%, indicating the community's commitment to developing sustainable waste management methods to prevent pollution and safeguard the aquatic bodies surrounding the floating community. Waste management that is effective can assist in protecting the local ecology and aquatic ecosystems while also contributing to a cleaner and healthier living environment. By tackling pollution reduction and marine conservation, this objective correlates with Sustainable Development Goal 12 (Responsible Consumption and Production) and Sustainable Development Goal 14 (Life Below

Water)."Improved air and water quality" follows with a priority of 33.8%, emphasizing the importance of efforts aimed at improving the quality of both the community's air and water. Improved air and water quality can have a direct influence on the health and well-being of inhabitants, lowering the risks of environmental health conditions. Furthermore, it contributes to SDG 3 (Good Health and Well-being) by establishing a healthier living environment for the community. "Local biodiversity promotion" is a 9.5% priority. While not the highest, it reflects the community's understanding of the need to preserve and restore local biodiversity. "Sustainable fishing practices" have a 7.6% priority. As the primary provider of fish to Lagos state, this rating reflects the community's dedication to moving from traditional fishing practices to more sustainable techniques. Adopting sustainable fishing practices is in line with SDG 14 (Life Below Water) and encourages responsible and sustainable aquatic life protection. These unified priorities under Goal 8 demonstrate the community's commitment to safeguarding its unique ecology and biodiversity. Prioritizing sustainable waste management, better air and water quality, local biodiversity enhancement, and sustainable fishing practices will all help to make the Makoko community healthier, more sustainable, and more resilient.

Table 14

Goal 9 Consolidated Priority

Details Node: Goal 9- Disaster Risk Reduction - CR: 7.8% - AHP group consensus: 84.3% high

Consolidated Priorities

Consistency Ratio CR: 7.8%

Cat		Priority	Rank
1	Early warning access	12.2%	4
2	Emergency shelters available	6.6%	5
3	Resident disaster response training	31.5%	2
4	Community-led risk management	16.1%	3
5	Resilient critical infrastructure	33.6%	1

Consolidated Decision Matrix

Aggregation of individual judgments for 5 Participant(s)

	1	2	3	4	5
1	1	4.32	0.23	0.58	0.23
2	0.23	1	0.37	0.51	0.19
3	4.34	2.71	1	1.72	1.15
4	1.72	1.96	0.58	1	0.53
5	4.30	5.40	0.87	1.89	1

In the context of node for Goal 9 "Disaster Risk Reduction," which has a Consistency Ratio (CR) of 7.8% and an overwhelming AHP group consensus of 84.3%

among the five participants, the analysis of consolidated priorities highlights the "Resilient critical infrastructure" with a ranking of 33.6% at the top of the priorities list. This high priority reflects the community's significant emphasis on creating and maintaining infrastructure capable of withstanding numerous calamities. Resilient infrastructure is critical for assuring the community's continued operation even in the face of adversity. This goal correlates with SDG 9 (Industry, Innovation, and Infrastructure) by emphasizing the significance of robust and sustainable infrastructure. Following closely is "Resident disaster response training" with a priority of 31.5%. This ranking highlights the significance of equipping residents with the knowledge and skills to respond effectively to disasters. Adequate training empowers the community to be better prepared and more resilient when faced with emergencies. Next with a rating of 16.1% priority is "Community-led risk management". While not the highest, it demonstrates the community's commitment to actively managing and mitigating risks that could lead to disasters. This approach empowers the community to take charge of its own disaster risk reduction efforts. "Early warning access" has a priority of 12.2%, indicating that the community recognizes the value of early access to warnings and information about impending disasters. Early warning systems are critical in reducing loss of life and property during natural catastrophes. This is consistent with a number of worldwide catastrophe risk reduction strategies that emphasize early warning and community preparedness. "Emergency shelters available" has a priority of 6.6%. While not the highest, it demonstrates the critical need to have shelters in place to give safety and protection during catastrophes. Adequate shelter facilities are critical for protecting the community during disasters. These consolidated objectives under Goal 9 demonstrate the community's commitment to catastrophe risk reduction and resilience-building. These goals guarantee that the Makoko community is better prepared to handle and respond to any risks and difficulties, resulting in a more resilient and secure living environment.

Table 15

Goal 10 Consolidated Priority

Details Node: Goal 10- Innovation and Creativity - CR: 5.8% - AHP group consensus: 74.5% moderate

Consolidated Priorities

Consistency Ratio CR: 5.8%

Cat		Priority	Rank
1	Training and capacity-building programs	26.0%	2
2	Innovative and sustainable building materials	13.6%	4
3	Sustainable livelihood promotion	23.8%	3
4	Renewable energy adoption	36.6%	1

Consolidated Decision Matrix

Aggregation of individual judgments for 5 Participant(s)

	1	2	3	4
1	1	3.09	1.01	0.45
2	0.32	1	0.72	0.47
3	0.99	1.38	1	0.83
4	2.24	2.12	1.20	1

The study of consolidated priorities indicates that Goal 10, "Innovation and Creativity," has a Consistency Ratio (CR) of 5.8% and a good AHP group agreement of 74.5% among the five participants. With a remarkable score of 36.6%, "Renewable energy adoption" is at the forefront of these consolidated objectives This high priority emphasizes the community's intention to use renewable energy sources such as solar or wind power, which are not only ecologically good but also long-term. Embracing renewable energy correlates with Sustainable Development Goal 7 (Affordable and Clean Energy) by emphasizing clean and sustainable energy sources. With a priority of 26.0%, "Training and capacity-building programs" follows close behind. This rating highlights the importance of providing knowledge, abilities, and resources to the community in order to stimulate innovation and creativity. These programs provide chances for community members to learn, develop, and acquire the tools needed to make a good change in the community. This objective is consistent with several SDGs, notably Goal 4 (Quality Education) and Goal 9 (Industry, Innovation, and Infrastructure). Sustainable livelihood promotion is a priority for 23.8% of respondents, highlighting the importance of cultivating sustainable livelihoods within the community. Economic development, community well-being, and environmental sustainability are all strongly related to this aim. It is consistent with numerous SDGs, notably Goal 1 (No Poverty) and Goal 8 (Decent Work and Economic Growth). "Innovative and sustainable building materials" has a priority of 13.6%, indicating the community's desire to adopt innovative and ecologically friendly construction materials and practices. Using such materials might help minimize the construction's environmental imprint and improve the overall sustainability of the built environment. By bolstering sustainable development and infrastructure, this objective corresponds with Sustainable Development Goal 11 (Sustainable Cities and Communities). Goal 10 priorities underscore the community's commitment to innovation and creativity, resulting in a more sustainable, resilient, and forward-thinking community. These principles are critical in creating a community that adapts and develops on a continuous basis, paving the path for a better and more inventive future for all people.

The findings from the survey establish an extensive framework for well-informed decision-making and resource allocation in line with Makoko's sustainability goals and unique context, complemented by data tables and bar charts obtained from the AHP analysis. Recognizing and addressing the distinctive difficulties and possibilities within the Makoko Community can be done in a systematic manner with the implementation of this prioritized list and visual representations.

4.3.3 Networking Analysis of Goals and Indicators with Analytical Network Process (ANP). The complexities of implementing Sustainable Floating Development Goals (SFDGs) for communities experiencing multidimensional issues, such as Makoko, need the use of a decision-making process that can accommodate and emphasize interdependence and feedback among various factors. In this context, Thomas Saaty's Analytic Network Process (ANP) established in 1996 emerges to be a suitable solution. Traditional Multi-Criteria Decision-Making (MCDM) methodologies frequently fall short in their analysis when confronted with sophisticated challenges inside a hierarchy or network structure (Burnaz & Topcu, 2006). ANP effectively replaces rigid hierarchies as shown in the AHP survey with flexible networks, where relationships are not simply categorized as higher or lower. ANP acknowledges the intricate interplay among elements and accommodates inner and outer dependencies within the network (Saaty, 2006). The application of ANP to Makoko's Sustainable Floating Development Goals (SFDGs) is not only plausible but also obligatory. Because of the intricacies of this floating community's concerns, such as climatic resilience, resource efficiency, and social inclusion, a method that can properly account for the complicated interaction of these aims is required. Because of ANP's flexibility to dependencies and feedback loops among the criteria, it is a vital tool for creating a roadmap for Makoko. Subsequently, ANP will be used to analyze and prioritize tailored SFDGs and indicators for Makoko, highlighting the possibility of making informed, roadmap for a better development. ANP is an effective methodology for decision-making since it quantifies subjective assessments by comparing pairs of inputs to ascertain the relative weight of criteria and value of alternatives. The supermatrix incorporates these dependencies and enables a thorough depiction of relationships through the construction of a network.

The Analytic Network Process (ANP) approach, facilitated through the SuperDecisions software, will be critical in the goal of developing a stable hierarchical structure of intersections for Makoko's Sustainable Floating Development Goals (SFDGs). The method of analysis is consistent with the goals' multifaceted and interrelated elements, providing a thorough and detailed examination. As opposed to AHP, which assumes a linear hierarchy, ANP allows for the modelling of dependencies and interactions among elements within a network structure, accommodating the complexity of systems. Because of its adaptability, ANP can depict the dynamic relationships between criteria and alternatives more accurately, which makes it especially useful in situations with non-linear and interrelated element interactions. Scores will be awarded to each objective using the SuperDecisions program based on the relationship and judgment of their relative importance (Saaty, 2007). This comprehensive method will produce a more realistic portrayal of relative priorities, taking into consideration the complex web of factors that characterize Makoko's development aspirations. Once the ANP inquiry questions are completed, the program will aid in the evaluation of the results. The end result will be a prioritized set of Sustainable Floating Development Goals customized especially to the Makoko community. This list captures the interdependence and relative importance of each target adequately. The ANP approach's strength, as solidified by the SuperDecisions software, is in its capacity to take into account the complicated web of correlations and interdependence within the community's development goals, paving the path for a more sustainable and resilient future. The relationships between pairs of SFDGs and

Indicators were created to run the analysis on the program. The following criterion groupings were used to create the pairwise comparison chart:

- Cluster A Goal 1: Resilience and Adaptation

  A1 Stilt/floating structures for flood resistance.

  A2 Climate-related disaster data.

  A3 Resident security perception.
- Cluster B Goal 2: Resource Efficiency

  B1 Energy consumption per capita.

  B2 Energy-efficient appliance adoption.

  B3 Per capita waste generation.

  B4 Recycling and waste separation at homes.

  B5 Rainwater harvesting in community buildings.
- Cluster C Goal 3: Social Inclusion

  C1 Women in decision-making.

  C2 Children and youth school attendance.

  C3 Community participation rate.

  C4 Community-owned social spaces.
- Cluster D Goal 4: Economic Sustainability

  D1 Average household income.

  D2 Micro and small enterprises.

  D3 Access to financial services.

  D4 Formal sector employment rate.

  D5 Community-led economic projects.
- Cluster E Goal 5: Cultural Preservation

  E1 Cultural heritage sites protected.

  E2 Resident engagement in cultural preservation.

  E3 Cultural events organized.

  E4 Traditional building techniques in use.
- Cluster F Goal 6: Health and Well-being

  F1 Healthcare facilities available.

  F2 Improved sanitation access.

  F3 Clean water access.

F4 Health and hygiene education programs.

F5 Preventable disease vaccination rates.

- Cluster G Goal 7: Sustainable Transportation

  G1 Public transportation options.

  G2 Non-motorized transportation access.

  G3 Average commute time.

- Cluster H Goal 8: Biodiversity and Ecosystem Protection

  H1 Sustainable waste management.

  H2 Improved air and water quality.

  H3 Local biodiversity promotion.

  H4 Sustainable fishing practices.

- Cluster I Goal 9: Disaster Risk Reduction

  I1 Early warning access.

  I2 Emergency shelters available.

  I3 Resident disaster response training.

  I4 Community-led risk management.

  I5 Resilient critical infrastructure.

- Cluster J Goal 10: Innovation and Creativity

  J1 Training and capacity-building programs.

  J2 Innovative and sustainable building materials.

  J3 Sustainable livelihood promotion.

  J4 Renewable energy adoption.

A crucial aspect of pursuing Sustainable Floating Development Goals (SFDGs) is comprehending the complex interrelationships between the designated indicators and targets. The notions of interdependency and outer dependence might be crucial in deciphering the intricacies present in the sustainable development framework of the objectives. The term "interdependency" describes the reciprocal power that certain objectives have over others, forming a network of interconnection that highlights the SFDGs' comprehensive character. For example, there is an intrinsic relationship between the aim of "Community-led risk management" (I4) and the goal of "Stilt/floating structures for flood resistance" (A1). The community's capacity to efficiently manage and reduce hazards is directly impacted by the creation of resilient structures. On the other hand, outer dependence refers to situations in which a certain objective influences others without having a major impact on them. The "Sustainable livelihood promotion" objective (J3), which may have a significant impact on many facets of the community but is less vulnerable to direct influence from goals like "Improved sanitation access" (F2), is an example of outer dependence within the SFDGs. To build a thorough knowledge of how the objectives interact within the complex fabric of sustainable development, it is essential to recognize these interdependencies and outer dependencies.

Table 16

SFDGs Indicators Pairwise Connection matrix

	Goal 1			GOAL 2					GOAL 3				GOAL 4					GOAL 5				GOAL 6					GOAL 7			GOAL 8				GOAL 9					GOAL 10			
	A1	A2	A3	B1	B2	B3	B4	B5	C1	C2	C3	C4	D1	D2	D3	D4	D5	E1	E2	E3	E4	F1	F2	F3	F4	F5	G1	G2	G3	H1	H2	H3	H4	I1	I2	I3	I4	I5	J1	J2	J3	J4
A1		x	x		x		x	x		x				x					x		x	x	x	x						x				x	x	x		x	x		x	x
A2	x		x	x	x				x	x		x	x	x	x	x						x	x	x	x	x				x		x	x	x	x	x	x				x	x
A3	x	x					x	x		x		x	x	x	x	x	x					x	x	x	x	x																x
B1		x			x				x	x										x		x																x		x	x	
B2		x		x			x				x									x		x																x		x	x	
B3									x																									x								
B4						x			x				x		x	x	x				x	x			x	x	x							x							x	
B5	x						x		x																					x								x				
C1		x		x	x													x	x			x														x						
C2	x			x	x									x				x	x	x																						
C3																									x	x	x		x										x			
C4	x		x						x																																	
D1			x						x																						x				x							
D2	x		x							x			x							x		x												x						x		
D3			x																																			x		x		
D4			x												x																						x				x	
D5			x																						x		x	x	x				x	x			x	x	x			
E1	x		x																			x			x	x	x	x	x		x	x	x	x	x		x	x	x	x	x	
E2	x	x	x				x		x				x		x	x	x								x	x	x															
E3				x	x				x																																x	
E4									x																																	
F1	x			x	x								x																												x	
F2	x																				x											x		x				x			x	
F3											x				x								x																		x	
F4	x					x				x									x																				x		x	
F5													x				x								x							x		x		x			x	x	x	
G1																																			x						x	
G2							x																				x														x	
G3				x					x		x																														x	
H1																						x																x			x	
H2							x	x																			x												x		x	
H3												x		x	x	x				x	x			x	x	x														x	x	
H4																																									x	
I1	x	x	x		x												x	x										x									x	x	x	x	x	
I2																																								x		
I3	x		x				x				x																								x		x	x	x	x	x	
I4	x	x	x							x						x															x			x	x	x		x				x
I5	x	x	x	x	x			x						x		x	x	x		x		x				x	x					x		x	x	x	x		x	x	x	x
J1	x		x		x			x	x				x																	x			x	x			x				x	
J2	x		x	x	x				x	x			x	x	x																			x				x	x		x	
J3	x	x	x	x	x		x	x	x	x	x		x	x	x	x	x				x		x		x		x	x	x	x	x	x	x	x		x		x	x	x		x
J4	x	x	x																																	x				x		

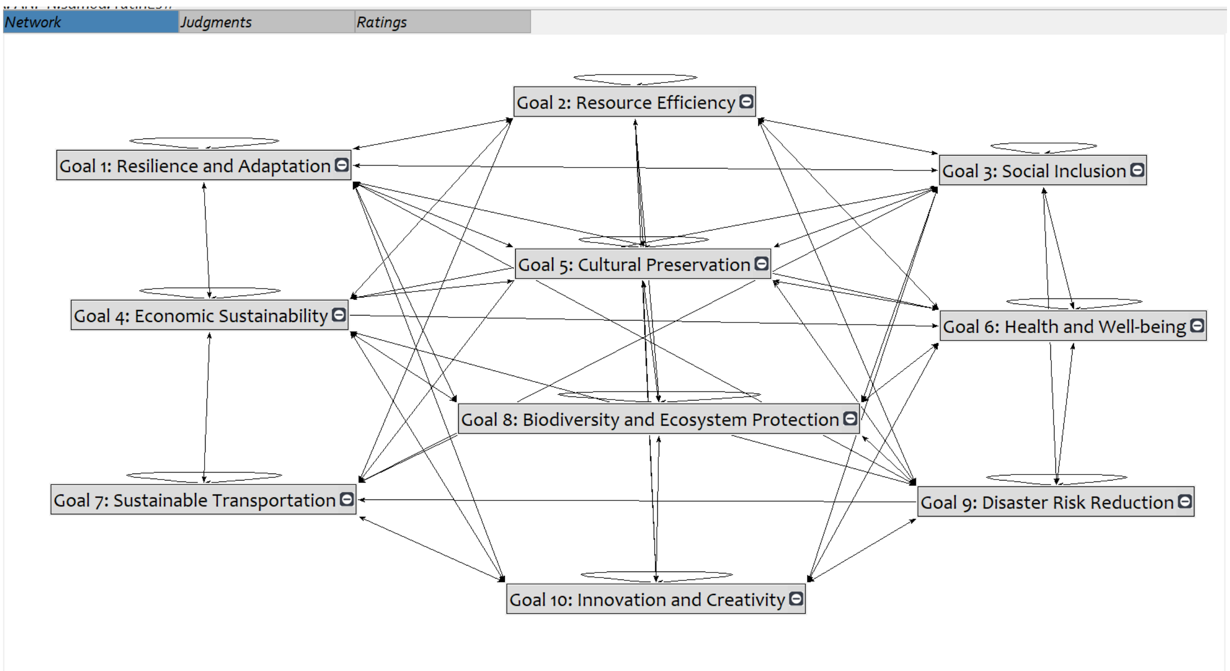

Figure 40. SFDGs Network diagram on SuperDecisions for the goals.

The pairwise connection matrix has been displayed graphically showing the interdependency and outer dependency relations of the SFDGs (Table 16). This matrix's entries reflect the presence of a direct link between criteria i and criterion j, if criteria i has an effect on criterion j, the entry will be marked with an asterisk (*). When there is no relationship, the entry is blank. This decision matrix was subsequently transformed into a network model with the Super Decisions software's design module (Figure 40).

Table 17

SFDGs and Indicators for Makoko Community ANP results

Goals and Indicators	Normalized by Cluster (%)	Limiting Priorities (%)
A Goal 1: Resilience and Adaptation		
A1 Stilt/floating structures for flood resistance.	57.183%	7.2017%
A3 Resident security perception.	31.830%	4.0087%
A2 Climate-related disaster data.	10.988%	1.3838%
B Goal 2: Resource Efficiency		
B4 Recycling and waste separation at homes.	33.588%	3.6694%
B5 Rainwater harvesting in community buildings.	26.379%	2.8818%
B3 Per capita waste generation.	18.564%	2.0281%
B1 Energy consumption per capita.	15.540%	1.6977%
B2 Energy-efficient appliance adoption.	5.930%	0.6478%
C Goal 3: Social Inclusion		
C3 Community participation rate.	58.105%	8.1384%
C4 Community-owned social spaces.	20.624%	2.8886%
C2 Children and youth school attendance.	13.716%	1.9211%
C1 Women in decision-making.	7.555%	1.0582%
D Goal 4: Economic Sustainability		
D2 Micro and small enterprises.	63.602%	3.8125%
D3 Access to financial services.	23.322%	1.3980%
D1 Average household income.	6.825%	0.4091%
D5 Community-led economic projects.	6.251%	0.3747%
D4 Formal sector employment rate.	0.00%	0.00%
E Goal 5: Cultural Preservation		
E3 Cultural events organized.	43.111%	3.8071%
E2 Resident engagement in cultural preservation.	29.965%	2.6462%
E4 Traditional building techniques in use.	21.819%	1.9268%
E1 Cultural heritage sites protected.	5.106%	0.4509%

F Goal 6: Health and Well-being		
F3 Clean water access.	27.763%	3.1598%
F1 Healthcare facilities available.	22.139%	2.5197%
F2 Improved sanitation access.	21.964%	2.4998%
F4 Health and hygiene education programs.	18.461%	2.1011%
F5 Preventable disease vaccination rates.	9.673%	1.1009%
G Goal 7: Sustainable Transportation		
G2 Non-motorized transportation access.	53.260%	3.4689%
G3 Average commute time	31.727%	2.0664%
G1 Public transportation options.	15.013%	0.9778%
H Goal 8: Biodiversity and Ecosystem Protection		
H1 Sustainable waste management.	48.463%	4.4245%
H2 Improved air and water quality.	33.064%	3.0186%
H3 Local biodiversity promotion.	11.730%	1.0709%
H4 Sustainable fishing practices.	6.743%	0.6156%
I Goal 9: Disaster Risk Reduction		
I5 Resilient critical infrastructure.	56.833%	5.0223%
I3 Resident disaster response training.	15.874%	1.4028%
I2 Emergency shelters available.	10.185%	0.9000%
I1 Early warning access.	9.724%	0.8593%
I4 Community-led risk management.	7.384%	0.6525%
J Goal 10: Innovation and Creativity		
J3 Sustainable livelihood promotion.	73.450%	8.6586%
J4 Renewable energy adoption.	16.599%	1.9568%
J2 Innovative and sustainable building materials.	6.652%	0.7842%
J1 Training and capacity-building programs.	3.299%	0.3889%

The results of the Analytic Network Process (ANP) study provide critical insights into Makoko's prioritization of Sustainable Floating Development Goals (SFDGs). The Normalized by Cluster and Limiting percentages illustrate the relative importance of each aim, providing a full insight into the community's distinct needs and goals. The highest priority (73.45%) is allocated to the promotion of sustainable livelihoods, emphasizing the community's determination to a self-sufficient and ecologically friendly way of life. This prioritization has a broad impact beyond its immediate context, directly interconnecting with numerous indicators under the (SFDGs) framework. Notably, the emphasis on sustainable lifestyles resonates well with the aim of "Recycling and waste separation at homes". In this case, the community's commitment to responsible waste management is inextricably linked to the larger goal of fostering a sustainable and ecologically conscious lifestyle. Furthermore, the promotion of sustainable lifestyles is synergistic with "Renewable energy adoption", emphasizing the inherent relationship between self-sufficiency and the use of renewable energy sources. Makoko's community participation percentage of 58.11% is vital, demonstrating the community's desire for active involvement and interaction among its inhabitants. Residents may participate to decision-making processes and development projects through active participation, which aligns with UN’s SDG 11 (Sustainable Cities and Communities). Beyond just being represented numerically, community involvement has a profound influence on "health and hygiene education programs" and "resident disaster response training." The efficacy of health and hygiene programs is enhanced by actively participating citizens, who guarantee that the programs are customized to meet the unique requirements of the community. In a similar vein, community involvement is essential to the effectiveness of disaster response training, building a community that is more threat-resistant and ready. Given Makoko's sensitivity to climate-related catastrophes stilt and floating structures for flood resistance are prioritized at 57.18%. These kinds of structures are critical for ensuring community resilience in the face of increasing sea levels and extreme weather events, which aligns with UN’s SDG 13 (Climate Action) and SDG 11 (Sustainable Cities and Communities). These flood-resistant buildings have an effect that goes beyond just serving their intended function. "Community-owned social spaces" and "Resilient critical infrastructure" are being shaped in large part by the emphasis on resilient infrastructure. Flood-resistant buildings help to create common areas that promote resilience and community cohesiveness. Furthermore, in line with the overarching objective of guaranteeing resilient vital infrastructure, this kind of infrastructure serves as the foundation for a community's capacity to respond to emergencies and catastrophes. Similarly, with 16.60% uptake, renewable energy is critical for transitioning to cleaner and more sustainable energy sources and lowering carbon emissions. Although it is not the highest priority, with 15.87% Resident disaster response training is critical for developing resilience and decreasing the impact of climate-related catastrophes. While it may not be the major priority, with 3.30% investing in training and capacity-building programs is vital for providing community members with the skills and information required for sustainable development. The lower priority given to cultural heritage sites protected by 5.11% shows that greater attention may be needed to secure and preserve the community's distinctive cultural and historical elements. Protecting cultural heritage is consistent with UN’s Sustainable Development Goals 11 (Sustainable Cities and Communities) and 16 (Peace, Justice, and Strong Institutions). These prioritizations reflect the Makoko community's unique context and challenges and should be taken into account in future development initiatives to ensure alignment with both the Sustainable Floating Development Goals (SFDGs) and the United Nations' Sustainable Development Goals (SDGs) for a more sustainable and resilient Makoko.

Chapter 5

Discussion And Conclusion: Recommendations For Sustainable Development of Makoko Community as A Floating Slum

Amid severe challenges, the need for sustainable development in Makoko, the floating slum community, cannot be stressed. The community is grappling with a variety of urban and environmental concerns, including the growing threat of climate-related disasters. Residents navigate the hazards provided by inadequate flood-resistant constructions and a lack of energy-efficient solutions, emphasizing the vital need for planned initiatives (Agbola & Agunbiade, 2009). This study's comprehensive exploration of sustainable development in Makoko reveals that for it to become a successful settlement, it must address its environmental, social, and economic concerns. To address the severe deficiencies of Makoko, an extensive review of the literature produced an insightful understanding of the theoretical underpinnings of slums, floating settlements, and the United Nations Sustainable Development Goals. The study developed a better understanding of the diversity of floating communities and the variables driving their formation by examining the historical development of floating settlements, which demonstrate their flexibility and durability across many geographies and periods. Comprehending this historical background offers significant insights for modern-day interventions in Makoko, highlighting the significance of culturally sensitive and contextual strategies. Furthermore, the development of contemporary floating dwellings demonstrated the nexus between social requirements and technology. In terms of proposal solution for individual structures, each building needs to be studied to figure out the best approach to solutions that will make it adaptable to the environmental conditions like flooding that occurs up to four times a year. Innovative solutions arising from demand are exemplified by the development of floating technologies, which range from the use of bamboo and waste barrels to the integration of concrete shells and polystyrene foam cores for foundations (Adeyemi, 2012). The community's economic standing has become a crucial element affecting the viability and sustainability of floating structures. Using this economic lens to develop interventions in Makoko is a great way to emphasize the necessity of inclusive approaches that take into account people' financial capabilities, as demonstrated by the design of the Makoko floating school. In addition, the investigation of sustainable urban design concepts highlighted the importance of a multifaceted strategy. Sustainable urban design takes into account social, economic, and environmental factors in addition to architectural features. Drawing from the literature, this comprehensive understanding functions as a guiding concept for developing interventions in Makoko that extend beyond infrastructure development to promote community resilience and overall well-being.

The primary goal of the study was to develop the Sustainable Floating Development Goals (SFDGs) for Makoko based on a meticulous adaptation of the United Nations' Sustainable Development Goals (SDGs) and to prioritize these goals using the Analytic Hierarchy Process (AHP) and Analytic Network Process (ANP) methodologies. The advantages of this tailored approach are numerous providing a complete framework that not only acknowledges the community's inherent vulnerabilities but also allows it to begin on a sustainable path. The SFDGs serve as a beacon for Makoko, representing a locally relevant and internationally educated blueprint for a sustainable and prosperous future. The SFDGs and their indicators efficiently address the enormous knowledge gaps surrounding urban design for the Makoko floating community. To facilitate satisfying the research questions, the study intended to understand the social, physical, and environmental obstacles to Makoko's sustainable growth as well as to pinpoint architectural and urban design strategies that are appropriate for the local context. The literature's insights highlighted the necessity of an all-encompassing solution that takes social and environmental factors into account in addition to addressing infrastructural inadequacies. Examining how the problems of floating slums and the Sustainable Development Goals (SDGs) interact showed that architecture has a lot to offer in terms of disaster risk reduction, resilient infrastructure, and community well-being. The literature underlined how the SDGs are interrelated and how architectural interventions might act as catalysts to help achieve many objectives at once. The Analytic Hierarchy Process (AHP) and Analytic Network Process (ANP) surveys' analysis of goal priorities highlighted how urgent it is to address disaster risk reduction, resilience, and health and well-being in Makoko. The study came to the conclusion that before moving on to longer-term goals, priorities should be in line with the community's urgent requirements. The findings of comparing the ANP and AHP data sets demonstrated their complimentary nature, highlighting the significance of particular objectives through the use of targeted hierarchies (AHP) and taking interdependencies between goals into account (ANP). The data generated from AHP and ANP surveys serve as vital tools during the various stages of planning and implementation for Makoko in the field of sustainable development. AHP data, with its emphasis on pairwise comparisons and expert judgments, is critical in the early stages of design and planning, providing a clear understanding of priorities and goals that would help designers know which goals had to be implemented first or required more attention because these were the community's urgent needs. Because the data shows the holistic relationships of the goals, ANP extends this knowledge from design into the construction phase, ensuring that the community's resilience and sustainability are integrated seamlessly into every aspect of development.

The prioritized goals from both the AHP and ANP surveys highlight the Makoko community's significant requirements. Among the ten goals, Goal 9 -'Disaster Risk Reduction', Goal 1 - 'Resilience and Adaptation,' and Goal 6 - 'Health and Well-being' are the most important priority respectively. Given its sensitivity to natural calamities Goal 9 -' Disaster Risk Reduction,' is critical for Makoko. The community experiences floods at least four times per year, making disaster risk reduction investments critical to protecting citizens and infrastructure from these recurring risks (Michael et al., 2017). Furthermore, Poor building techniques and inadequate urban planning subject the population to dangers, emphasising the critical need for Goal 1- 'Resilience and Adaptation' in Makoko, where existing dwelling structures are vulnerable to floods. Stressing the need of robust and responsive architecture in reducing the effects of climate change and safeguarding the safety of citizens. Finally, Goal 6, 'Health and Well-being,' is critical in Makoko to address common health concerns caused by poor waste management and sanitation practices. The community confronts health hazards due to a lack of access to clean water and healthcare services, which Goal 6 attempts to remedy (Oduwaye et al., 2011). Improvements in sanitation and healthcare facilities are critical for improving the community's general well-being and addressing illness and insufficient health services. Makoko can make great strides towards being a sustainable city and provide its residents with an ecologically conscious urban environment by giving these planning elements top priority and working towards them. This study serves as a valuable reference for urban planners and policymakers seeking to develop and implement effective strategies for sustainable urban development in Makoko.

In addressing Goal 1 - 'Resilience and Adaptability', the core hinges on the necessity for resilient building architecture, especially those constructed for flood protection. Makoko's existing susceptibility to floods, caused by poor construction and poor urban planning, demands a paradigm shift in building design (Adeyemi, 2012). The importance ascribed to this feature in the surveys reflects the urgent need for flood-resistant and flexible architectural interventions. Deficiencies in current structures subject the community to further hazards, emphasizing the immediate need for resilient design. Any new construction should satisfy the guidelines for incorporating climate-related catastrophe data into Makoko's architectural design fabric (Okeke et al., 2019). Integrating such data into the design process is critical for battling the difficulties posed by sea-level rise and developing efficient and robust buildings that are customized to Makoko's environmental dynamics. Prioritizing ‘resilience and adaptability’ predicts an increase in resident security perception, resident’s disposition of security is projected to improve as the architectural environment improves, incorporating flood-resistant constructions, lessening anxieties from recurring flooding occurrences. In order to lessen the effects of flooding, flood-resistant constructions must be designed and built in Makoko utilising locally obtained materials like bamboo and wood and raised on stilts or floating platforms. In the case of floating foundations, the building rises in tandem with the sea level rise, but the foundation materials need to be able to sustain constant exposure to water for longer lifespans. For stilt foundations, projected sea level statistics must be examined to establish the appropriate foundation levels for the structures. Furthermore, creating green roofs or floating gardens may support sustainable agricultural methods while aiding in the absorption of surplus water during floods.

In addition, according to the Makoko survey results, the focus point of Goal 9 - 'Disaster Risk Reduction' is the urgent necessity for robust critical infrastructure. To emphasize, present infrastructure is vulnerable to climate-related hazards, and specific safeguards must be in place to minimize disasters, emphasizing the crucial relevance of this aim (Hoelzel & Akinsete, 2015). The emphasis on 'Resilient Critical

Infrastructure' which is the highest ranked indicator is vital for ensuring that essential services including water systems, healthcare facilities, and sanitation systems can survive the effects of environmental hazards. Schools, utility systems and medical facilities, for instance, can be raised on sturdy bases or have barriers that can withstand flooding installed. Installing adaptable transportation systems, such as water shuttles or elevated pathways, may guarantee that people have access to necessities in an emergency. This emphasis aligns with the imperative of fortifying Makoko's infrastructure against vulnerabilities, as these are essential buildings that are required during the emergency period, if they are damaged, crucial amenities that could help residents will be forced to suspension, although all these services are currently unavailable. The top rating of 'Resilient Critical Infrastructure' demonstrates a widespread recognition of the perilous need to future-proof essential services like healthcare buildings. Furthermore, the priority given to 'Resident Disaster Response Training' demonstrates the importance of providing residents with the understanding and expertise needed for efficient disaster response. Improving community readiness and adaptability is critical for effectively navigating calamities, and early intervention may even save lives during disasters. Implementing resident disaster response training programs in Makoko may entail organizing community workshops and simulations supervised by local emergency response teams. Residents, for example, can learn fundamental first aid and evacuation strategies designed specifically for the inherent hazards of living in a floating community. Providing training materials in local languages and enlisting community leaders as teachers can improve the success of these initiatives. Another key ‘Disaster Risk Reduction’ approach for Makoko is 'Early Warning Access,' which emphasizes the critical need for timely catastrophe information in flood-prone Makoko. This kind of innovation has the potential to reduce the amount of damage done to the region, and effective warning systems can permit rapid reactions and evacuations, which Makoko sorely requires. Similarly, the emphasis on 'Emergency Shelters Available' underlines the community's commitment to readiness, emphasizing the need for easily accessible and well-equipped shelters for climate-related natural disasters. These safe havens which aren’t available in Makoko during crises attempt to offer refuge for inhabitants whose homes may have been destroyed during calamities, and they serve as the final layer of safety in Makoko's Disaster Risk Reduction strategy.

Another critical need that Makoko requires is Goal 6 - ‘Health and Well-being’, this is an essential requirement that all citizens require, and properly implementing it in Makoko requires a number of thresholds to be achieved. According to the findings, the first and most important criterion is clean water access, which addresses the pressing issue of poor water conditions. Currently, there is no clean water access in the community, and the only available source of water is a water well on the mainland, and the supply has been monetized (Olafimihan, 2009). To promote clean water availability in Makoko, endeavors might concentrate on the installation of decentralized water purifying systems driven by renewable energy sources such as solar panels. For example, community-based water treatment systems can be installed in crucial regions, using gravity-fed systems or basic filtering techniques. Educating households on rainwater collection techniques in addition to providing availability to water storage containers can also help complement clean water supplies. Future designers and urban policymakers must determine on clean water access strategies, and the manner of distribution must be customized to the setting of Makoko. Another vital hallmark that the residents significantly require is health and hygiene education programs, at present, the people living in that area have little to no awareness of the correct hygiene ethics required for a healthy lifestyle. Hygiene seminars in schools for children or educational workshops for local inhabitants can assist in teaching people how to live healthy lifestyles. The data analysis also shows the importance of having appropriate healthcare facilities available and having access to medical services is critical in the face of widespread health problems. These facilities play an important role in enhancing the health and well-being of people in that region, and there are currently no good healthcare services accessible. Improved Sanitation Access is another key requirement for Makoko, considering the community is located on water suitable sanitation facilities are required, which the existing Makoko lacks (Oduwaye et al.,2011). This hygiene and sanitation dilemma offers substantial health hazards to the population since most excrement is discharged into the water, generating air and water pollution. Prioritizing better sanitation access recognizes the importance of appropriate facilities in mitigating health risks and improving the general well-being of Makoko's population. This is consistent with the larger goal of improving health and establishing a sustainable and sanitary living environment in the community.

The highest-priority indicator for the Analytical Network Process (ANP) survey is 'Promotion of Sustainable Livelihood', which is critical to Makoko's well-being. This aim is dependent on several indicators in the SFDGs, forming a comprehensive network that reflects the Makoko community's determination and active engagement to achieve sustainability. The adoption of renewable energy and innovative construction materials directly contributes to sustainable livelihood by stimulating consumption and minimizing environmental effects (Lawanson et al., 2022). Improved air and water quality improves the quality of life and promotes a healthier environment, which is essential to livelihood activities. Sustainable waste management and health and hygiene education programs not only provide a cleaner living environment but also provide Makoko inhabitants with information that allows them to adopt sustainable habits. Increasing the average family income is linked to economic sustainability, which is a critical component of fostering a sustainable lifestyle since each household income influences the amount of involvement and sustainable livelihood that can be adopted. According to the survey results, the network of 'Promotion of Sustainable Livelihood' is vital for Makoko's long-term growth. Its acceptance in Makoko highlights the community's dedication, participation, and involvement in Sustainable Livelihoods, all of which contribute to their overall well-being. The SFDGs' dependent approach assures that the community's livelihood is resilient, ecologically conscientious, and consistent with the ideals of sustainable development.

The emphasized goals in this research highlight severe deficiencies in Makoko's infrastructure and services. The suggested Sustainable Floating Development Goals reflect the community's local needs and emphasize the necessity of strategic interventions and sustainable urban development projects. Addressing these principles is critical to creating a resilient, sustainable, and prosperous Makoko community despite its particular obstacles. The findings of this study provide vital insights to guide future efforts targeted at the holistic development of this unique floating community.

REFERENCES

Abubakar, I. R., & Dano, U. L. (2019). Sustainable urban planning strategies for mitigating climate change in Saudi Arabia. *Environment, Development and Sustainability*, 22(6), 5129–5152. https://doi.org/10.1007/s10668-019-00417-1

Al-Harbi, K. M. A.-S. (2001). Application of the AHP in Project Management. International Journal of Project Management, 19(1), 19–27. https://doi.org/10.1016/s0263-7863(99)00038-1

Ajayi, O., Oviasogie, F., Azuh, D., & Duruji, M. (2014). Urban renewal strategies in developing nations: A focus on Makoko, Lagos State, Nigeria. *European Scientific Journal.*

Ambica, A., & Venkatraman, K. (2015). Wetland wastewater treatment system for small city suburbs – a review. *Indian Journal of Science and Technology*, 8(32). doi:10.17485/ijst/2015/v8i32/88880

Aragonés-Beltrán, P., Chaparro-González, F., Pastor-Ferrando, J.-P., & Pla-Rubio, A. (2014). An AHP (analytic hierarchy process)/ANP (Analytic Network process)-based multi-criteria decision approach for the selection of solar-thermal power plant investment projects. *Energy*, 66, 222–238. https://doi.org/10.1016/j.energy.2013.12.016

Aragonés-Beltrán, P., Chaparro-González, F., Pastor-Ferrando, J. P., & Rodríguez-Pozo, F. (2010). An ANP-based approach for the selection of Photovoltaic Solar Power Plant Investment Projects. *Renewable and Sustainable Energy Reviews*, 14(1), 249–264. https://doi.org/10.1016/j.rser.2009.07.012

Baykasoğlu, A., Dereli, T., & Yılankırkan, N. (2009). Application of cost/benefit analysis for surgical gown and drape selection: A case study. *American Journal of Infection Control*, 37(3), 215–226. https://doi.org/10.1016/j.ajic.2008.10.031

Bhatt, M. P. (2020). Modular maritime metropolis: A review on Sustainable Floating City. *International Journal of Engineering Research* And, V9(05). doi:10.17577/ijertv9is050600

Burnaz, S., & Topcu, Y. I. (2006). A multiple-criteria decision-making approach for the evaluation of retail location. *Journal of Multi-Criteria Decision Analysis*, 14(1–3), 67–76. https://doi.org/10.1002/mcda.401

Cappo, D., & Verity, F. (2014). Social Inclusion and integrative practices. *Social Inclusion*, 2(1), 24–33. https://doi.org/10.17645/si.v2i1.50

Carmona, M. (2009). Sustainable urban design: Principles to practice. *International Journal of Sustainable Development*, 12(1), 48. doi:10.1504/ijsd.2009.027528

Chang, A.-Y., Hu, K.-J., & Hong, Y.-L. (2013). An ISM-ANP approach to identifying key agile factors in launching a new product into mass production. *International Journal of Production Research*, *51*(2), 582–597. https://doi.org/10.1080/00207543.2012.657804

Chatzimouratidis, A. I., & Pilavachi, P. A. (2007). Objective and subjective evaluation of power plants and their non-radioactive emissions using the analytic hierarchy process. *Energy Policy*, *35*(8), 4027–4038. https://doi.org/10.1016/j.enpol.2007.02.003

Charumitra, B., Kumar, D. K., & Anupama, S. (2014). Slum Redevelopment Strategy: A Way forward to Urban Environment Management through Inclusive Approach.

Chowdhury, F. J., & Amin, A. N. (2006). Environmental assessment in slum improvement programs: Some evidence from a study on infrastructure projects in two Dhaka slums. *Environmental Impact Assessment Review*, 26(6), 530-552. doi:10.1016/j.eiar.2005.11.004

Cerro, C. (2016). Floating architecture in the developing world. *WIT Transactions on Ecology and the Environment*. https://doi.org/10.2495/sc160551

Dal Cin, F., Hooimeijer, F., & Matos Silva, M. (2021). Planning the urban waterfront transformation, from infrastructures to Public Space Design in a sea-level rise scenario: The European Union Prize for contemporary architecture case. *Water*, 13(2), 218. doi:10.3390/w13020218

Dey, P. K. (2006). Integrated Project Evaluation and selection using multiple-attribute decision-making technique. *International Journal of Production Economics*, *103*(1), 90–103. https://doi.org/10.1016/j.ijpe.2004.11.018

Dias, N., Curwell, S., & Bichard, E. (2014). The current approach of urban design, its implications for Sustainable Urban Development. *Procedia Economics and Finance*, 18, 497-504. doi:10.1016/s2212-5671(14)00968-x

Donegan, H. A., Dodd, F. J., & McMaster, T. B. (1992). A new approach to AHP decision-making. *The Statistician*, 41(3), 295. https://doi.org/10.2307/2348551

Duke, S. (2018). Float City. Makoko: (re)development of an aquatic home. https://doi.org/10.22215/etd/2018-12900

Elrayies, G. M. (2016). Rethinking slums: An approach for slums development towards Sustainability. *Journal of Sustainable Development*, *9*(6), 225. https://doi.org/10.5539/jsd.v9n6p225

Endangsih, T., & Ikaputra. (2020). Floating houses technology as alternative living on the water. *IOP Conference Series: Materials Science and Engineering*, 797(1), 012020. https://doi.org/10.1088/1757-899x/797/1/012020

Erdogan, S. A., Šaparauskas, J., & Turskis, Z. (2017). Decision making in construction management: AHP and expert choice approach. *Procedia Engineering*, 172, 270–276. https://doi.org/10.1016/j.proeng.2017.02.111

Ezeh, A., Oyebode, O., Satterthwaite, D., Chen, Y.-F., Ndugwa, R., Sartori, J., Mberu, B., Melendez-Torres, G. J., Haregu, T., Watson, S. I., Caiaffa, W., Capon, A., & Lilford, R. J. (2017). The history, geography, and sociology of slums and the health problems of people who live in slums. *The Lancet*, *389*(10068), 547–558. https://doi.org/10.1016/s0140-6736(16)31650-6

Fleming, A., Wise, R. M., Hansen, H., & Sams, L. (2017). The Sustainable Development Goals: A case study. *Marine Policy*, 86, 94-103. doi:10.1016/j.marpol.2017.09.019

Goepel, K. D. (2018). Implementation of an online software tool for the Analytic Hierarchy Process (AHP-OS). *International Journal of the Analytic Hierarchy Process*, 10(3). https://doi.org/10.13033/ijahp.v10i3.590

Hák, T., Janoušková, S., & Moldan, B. (2016). Sustainable development goals: A need for relevant indicators. *Ecological Indicators*, 60, 565-573. doi:10.1016/j.ecolind.2015.08.003

Hannula, E.-L. (2012). *Going green: A handbook of sustainable housing practices in developing countries*. UN-HABITAT.

Harputlugil, T. (2018). Analytic Hierarchy Process (AHP) as an assessment approach for Architectural Design: Case Study of Architectural Design Studio. *Iconarp International J. of Architecture and Planning*, *6*(2), 217–245. doi:10.15320/iconarp.2018.53

Hsu, P.-F., Wu, C.-R., & Li, Y.-T. (2008). Selection of infectious medical waste disposal firms by using the analytic hierarchy process and sensitivity analysis. *Waste Management*, *28*(8), 1386–1394. https://doi.org/10.1016/j.wasman.2007.05.016

Hsieh, L.-F., Lin, L.-H., & Lin, Y.-Y. (2008). A service quality measurement architecture for Hot Spring Hotels in Taiwan. *Tourism Management*, *29*(3), 429–438. https://doi.org/10.1016/j.tourman.2007.05.009

Hummel, J. M., Snoek, G. J., Til, J. A., Rossum, W. van, & IJzerman, M. J. (2005). A multicriteria decision analysis of augmentative treatment of upper limbs in persons with tetraplegia. *The Journal of Rehabilitation Research and Development*, *42*(5), 635. https://doi.org/10.1682/jrrd.2004.07.0088

Jung, C., & Awad, J. (2023). Sharjah sustainable city: An analytic hierarchy process approach to urban planning priorities. *Sustainability*, 15(10), 8217. doi:10.3390/su15108217

Kizilova, S. A. (2020). Autonomous Reserve housing in the aquatic environment: Designing a self-sustainable floating module. *Journal of Physics: Conference Series*, 1614(1), 012003. doi:10.1088/1742-6596/1614/1/012003

Ko, K. K. (2015). Realising a floating city: A feasibility study of the construction of a floating city. Delfth University of Technology.

Larco, N. (2015). Sustainable urban design – A (draft) framework. *Journal of Urban Design*, 21(1), 1–29. doi:10.1080/13574809.2015.1071649

Lee, D. K., Park, S. Y., & Park, S. U. (2007). Development of assessment model for demand-side management investment programs in Korea. *Energy Policy*, *35*(11), 5585–5590. https://doi.org/10.1016/j.enpol.2007.05.029

Lifang, Q., Yichuan, Z., & Wei, C. (2008). Evaluation of urban river landscape design rationality based on AHP. *Water Science and Engineering* , *1*(4), 75–81. doi:DOI: 10.3882/j.issn.1674-2370.2008.04.008

Liu, H.-T. (2013). An integrated fuzzy decision approach for product design and Evaluation. *Journal of Intelligent & Fuzzy Systems*, *25*(3), 709–721. https://doi.org/10.3233/ifs-120677

Lin, H.-F., & Huang, Y.-W. (2015). Factors affecting passenger choice of low cost carriers: An analytic network process approach. *Tourism Management Perspectives*, *16*, 1–10. https://doi.org/10.1016/j.tmp.2015.05.005

Lin, F.-Y., Spijkers, O., & van der Plank, P. (2021). Legal Framework for Sustainable Floating City Development: A case study of the Netherlands. *Lecture Notes in Civil Engineering*, 433–460. doi:10.1007/978-981-16-2256-4_27

Lin, Y.-H., Chih Lin, Y., & Tan, H.-S. (2018). Design and functions of Floating Architecture – A Review. *Marine Georesources & Geotechnology*, 37(7), 880–889. doi:10.1080/1064119x.2018.1503761

López Chao, A., Casares Gallego, A., Lopez-Chao, V., & Alvarellos, A. (2020). Indicators framework for sustainable urban design. *Atmosphere*, 11(11), 1143. doi:10.3390/atmos11111143

Mehta, B., Dastur, A., & Janus, S. (2008). Approaches to urban slums: A multimedia sourcebook on adaptive and proactive strategies. The World Bank.

Mersal, A. (2016). Sustainable urban futures: Environmental planning for sustainable urban development. *Procedia Environmental Sciences*, 34, 49–61. doi:10.1016/j.proenv.2016.04.005

Michael, A. O., Isaac, O. O., & Olusola, O. P. (2017). Urban Renewal Strategies in developing nations: A focus on Makoko, Lagos State, Nigeria. *Journal of Geography and Regional Planning*, 10(8), 229–241. doi:10.5897/jgrp2017.0631

Moon, C. (2015). A study on the Floating House for New Resilient Living. *Journal of the Korean Housing Association*, 26(5), 97–104. https://doi.org/10.6107/jkha.2015.26.5.097

Moon, C. (2014). Three dimensions of sustainability and floating architecture. *International Journal of Sustainable Building Technology and Urban Development*, *5*(2), 123–127. https://doi.org/10.1080/2093761x.2014.908809

Moon, C. (2011). Sustainable Characteristics of Floating Architecture. Kunsan National University, Korea.

Moughtin, C., Cuesta, R., Sarris, C., & Signoretta, P. (1999). Urban design: Method and techniques. Architectural Press.

Moalagh, M., & Ravasan, A. Z. (2013). Developing a practical framework for assessing ERP post-implementation success using fuzzy analytic network process. *International Journal of Production Research*, *51*(4), 1236–1257. https://doi.org/10.1080/00207543.2012.698318

Mu, E., & Pereyra-Rojas, M. (2016). Understanding the analytic hierarchy process. *Practical Decision Making*, 7–22. https://doi.org/10.1007/978-3-319-33861-3_2

Naing, N., Santosa, H. R., & Soemarno, I. (2011). Living on the floating houses for sustainable livelihoods at Lake Tempe, South Sulawesi. *Environment and Urbanization ASIA*, 2(1), 93–108. doi:10.1177/097542531000200107

Napoli, G., & Schilleci, F. (2014). An application of analytic network process in the planning process: The case of an urban transformation in Palermo (Italy). *Computational Science and Its Applications – ICCSA 2014*, 300–314. doi:10.1007/978-3-319-09150-1_22

Navarro, T. G., Melón, M. G., Martín, D. D., & Dutra, S. A. (2008). Evaluation of urban development proposals An ANP approach. *PROCEEDINGS OF WORLD ACADEMY OF SCIENCE, ENGINEERING AND TECHNOLOGY*, *V34*, 498–508.

Nguyen, T. T. (2021). Architectural design guideline for sustainable floating houses and floating settlements in Vietnam. *Lecture Notes in Civil Engineering*, 461–474. doi:10.1007/978-981-16-2256-4_28

Parienté, W. (2017). Urbanization in SUB-SAHARAN Africa and the challenge of access to basic services. *Journal of Demographic Economics*, *83*(1), 31–39. https://doi.org/10.1017/dem.2017.3

Pazzini, M., Corticelli, R., Lantieri, C., & Mazzoli, C. (2022). Multi-criteria analysis and decision-making approach for the urban regeneration: The application to the Rimini Canal Port (Italy). *Sustainability*, *15*(1), 772. doi:10.3390/su15010772

Penning-Rowsell, E. (2019). Floating architecture in the landscape: Climate change adaptation ideas, opportunities and challenges. *Landscape Research*, 45(4), 395–411. https://doi.org/10.1080/01426397.2019.1694881

Peng, K.-H., & Tzeng, G.-H. (2017). Exploring heritage tourism performance improvement for making sustainable development strategies using the hybrid-modified MADM model. *Current Issues in Tourism*, *22*(8), 921–947. https://doi.org/10.1080/13683500.2017.1306030

Putro, J., & Zain, Z. (2021). Active and passive adaptation of floating houses (Rumah Lanting) to the tides of the Melawi River in West Kalimantan, Indonesia. *Geographical Pannonica*, 25(2), 72–84. https://doi.org/10.5937/gp25-30422

Rajput, V., & Shukla, D. A. C. (2012). Decision-making using the Analytic Hierarchy Process (AHP). *International Journal of Scientific Research*, 3(6), 135–136. https://doi.org/10.15373/22778179/june2014/47

Rehman, S. (2020). Elective Report Floating Architecture (thesis).

Roshko, T. (2011). The floating dwellings of Chong Kneas, Cambodia. *Buildings & Landscapes: Journal of the Vernacular Architecture Forum*, 18(2), 43. doi:10.5749/buildland.18.2.0043

Saaty, R. W. (1987). The analytic hierarchy process—what it is and how it is used. *Mathematical Modelling*, *9*(3–5), 161–176. https://doi.org/10.1016/0270-0255(87)90473-8

Saaty, T. L. (2006). The Analytic Network Process. *Decision Making with the Analytic Network Process*, 1–26. https://doi.org/10.1007/0-387-33987-6_1

Saaty, T. L. (2007). Time Dependent decision-making; Dynamic Priorities in the AHP/ANP: Generalizing from points to functions and from real to complex variables. *Mathematical and Computer Modelling*, *46*(7–8), 860–891. https://doi.org/10.1016/j.mcm.2007.03.028

Saaty, T.L. (2008) 'Decision making with the analytic hierarchy process', *Int. J. Services Sciences*, Vol. 1, No. 1, pp.83–98.

Salehi, N., Zabihi, H., & Zarabadi, Z. S. (2014). Evaluation of the Most Influential Criteria of Desirability of High-rise Buildings in Urban Landscape Using ANP. *Journal of Civil Engineering and Urbanism*, *4*(3), 345–352.

SDGs - SBE-series. SBE. (2022, April 14). Retrieved March 27, 2023, from http://www.sbe-series.org/the-sbe-series/sdgs/

Shin, C.-O., Yoo, S.-H., & Kwak, S.-J. (2007). Applying the analytic hierarchy process to evaluation of the National Nuclear R&D projects: The case of Korea. *Progress in Nuclear Energy*, *49*(5), 375–384. https://doi.org/10.1016/j.pnucene.2007.03.001

Simon, D., & Arfvidsson, H. (2015, July 7). *Pilot project to test potential targets and indicators for the urban*. mistraurbanfutures. Retrieved March 2023, from https://www.mistraurbanfutures.org/files/pilot-project-to-test-potential-targets-and-indicators.pdf

Smeddle, L. T., & Roux, J. (2015, March 11). *The struggle for integrated sustainable settlements.* yumpu.com. Retrieved February 2023, from https://www.yumpu.com/en/document/read/37513765/the-struggle-for-integrated-sustainable-settlements

Smith, M. E. (2007). Form and meaning in the earliest cities: A new approach to ancient urban planning. *Journal of Planning History*, 6(1), 3–47. https://doi.org/10.1177/1538513206293713

Trang, N. T. T. (2016). Architectural Approaches to a Sustainable Community with Floating House Units Adapting to Climate Change And Sea Level Rise In Vietnam. *World Academy of Science, Engineering and Technology International Journal of Civil, Environmental, Structural, Construction and Architectural Engineering*.

Trang, N. T. T., & Vukorep, I. (2021). Promoting sustainability and resilience in Vietnam's Floating Community: The assessment of innovative housing units and materials for adaptation to climate change. *BTU Cottbus - Senftenberg*.

Umar, T. (2020). Making future floating cities sustainable: A way forward. *Proceedings of the Institution of Civil Engineers - Urban Design and Planning*, 173(6), 214–237. https://doi.org/10.1680/jurdp.19.00015

U, N. (2022). *Sustainable development goals report 2022*. UNITED NATIONS.

Valipour, A., Yahaya, N., Md Noor, N., Kildienė, S., Sarvari, H., & Mardani, A. (2015). A fuzzy analytic network process method for risk prioritization in freeway PPP projects: An Iranian case study. *Journal of Civil Engineering and Management*, *21*(7), 933–947. https://doi.org/10.3846/13923730.2015.1051104

Wang, J. (2021). Research on design factors of urban public space safety based on ISM and AHP. *Advances in Intelligent Systems and Computing*, 243–251. doi:10.1007/978-3-030-69999-4_33

Zivkovic, M., Jovanovic, G., & Kondic, S. (2014). Flexible planning strategies of sustainable city development. *Facta Universitatis - Series: Architecture and Civil Engineering*, 12(3), 273–286. doi:10.2298/fuace1403273z

Others:

Abdel, H. (2022, May 26). *Sanjaynagar Slum Redevelopment Project / Community Design Agency*. ArchDaily. https://www.archdaily.com/982534/sanjaynagar-slum-rehabilitation-project-community-design-agency

Adeyemi, K. (2012). NLÉ2. NLE. Retrieved January 15, 2023, from https://www.nleworks.com/case/makoko-floating-school/

Aravena, A. (2016, November 3). *Quinta Monroy*. DAC. https://dac.dk/en/knowledgebase/architecture/quinta-monroy/#gallery-1

Blecher, M., & Maarbjerg, M. (2021). *Land on water*. MAST. https://mast.dk/land-on-water

Bjarke Ingels Group. BIG. (2019). Retrieved January 15, 2023, from https://big.dk/.

Caballero, P. (2017, September 29). *Mkombozi Primary School / architectural pioneering consultants*. ArchDaily. https://www.archdaily.com/1007494/mkombozi-primary-school-architectural-pioneering-consultants?ad_source=search&ad_medium=projects_tab

COLLINS, W. (2012). Retrieved from https://www.dictionary.com/browse/slum

Florian, M.-C. (2022, October 24). Mast designs a sustainable, modular system for building floating architecture. ArchDaily. Retrieved March 2023, from https://www.archdaily.com/991029/mast-designs-a-sustainable-modular-system-for-building-floating-architecture

Foka, E., & Tsaparoglou, A. (2014). *The floating grid*. jonian silaj (architecture + urbanism). https://www.juaj.nl/the-floating-grid.html

Julie. (2014, August 17). *A tour of the Dharavi slum in Mumbai, India*. Earth Trekkers. https://www.earthtrekkers.com/tour-dharavi-slum-mumbai-india/#comment-62101

Land on water. MAST. (2022). Retrieved January 15, 2023, from https://mast.dk/land-on water?utm_medium=website&utm_source=archdaily.com

Maarbjerg, M., & Blecher, M. (2021). Land on water. MAST. Retrieved March 2023, from https://mast.dk/land-on-water

Riise, J., & Adeyemi, K. (2015). Case study: Makoko floating school. Current Opinion in Environmental Sustainability, 13, 58–60. https://doi.org/10.1016/j.cosust.2015.02.002

Quinta Monroy. ELEMENTAL. (2004, January). Retrieved from https://dac.dk/en/knowledgebase/architecture/quinta-monroy/

Yakubu, P. (2023, May 12). *The floating village of ganvie: A model for socio-ecological urbanism*. ArchDaily. https://www.archdaily.com/1000658/the-floating-village-of-ganvie-a-model-for-socio-ecological-urbanism?ad_source=search&ad_medium=search_result_all