KIT OF PARTS:

Finding the balance between fast pace building and space comfort for future healthcare.

JUNYU LIANG 2023

ABSTRACT

The increase of population densification of Auckland has put enormous pressure on supply of healthcare services and has also rise a rapid growth in the healthcare sector. The Greenlane Clinical Services Centre in Tāmaki Makaurau Auckland was chosen as the site of this research project. As the growing of urban population and advances in medical technology, the evolving speed of healthcareservices is far below the increasing speed of demond onhealthcare service, which brings huge pressure on the dailyoperation of healthcare facilities. This research project explores the role thatarchitecture can play to positively address this situation.

Relatively speaking, architecture is not able to keep up with the rate of change that healthcare demands. The financial cost and permanency of buildings prohibits its ability to adjust to current healthcare needs. This research project utilises pre-fabrication techniques and an Amoeba Strategy to develop an architecture that can adapt to change as demanded. This will ensure sustainable growth in the face of changing healthcare needs and technological advances, minimising the impact on the operation of existing departments and facilities.

Through a pre-fabrication strategy, this research focuses on the modular designs in Amoeba Strategy to explore what the Greenlane Clinical Services Centre might look like with responsiveness and comfort modular. The design component focuses on researching and summarising the current state of the Greenlane Clinical Services Centre to ensure that the design proposition considers the way in which the different modules will function and be combined to accommodate the development of the hospital facility. Through a combination of architectural, social needs and sustainability considerations, this research project aims to support the future development of the Greenlane Clinical Services Centre to ensure that the hospital is able to evolve with the times and provide high quality healthcare services to the community.

In completing this research and thesis, I would like to thank my supervisors. A special mention goes to my co-supervisor, Andrew Burgess, for your professional support and invaluable advice throughout this project.

I am deeply grateful to my parents. Always given me love and encouragement throughout my academic career. I also wish my endeavours prove to be a positive role for my younger brother and to inspire him to pursue his future.

Thank you again and forever grateful.

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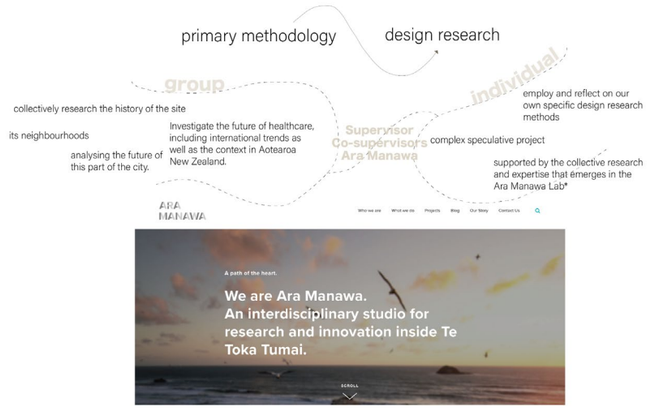
Attestation of Authorship

I hereby declare that this submission is my own work and that, to the best of my knowledge and belief, it contains no material previously published or written by another person (except where explicitly defined in the acknowledgements), nor material which to a substantial extent has been submitted for the award of any other degree or diploma of a university or other institution of higher learning.

FOREWORD

This design project was initiated by AUT architecture lab and Ara Manawa. Together, the collaborative team conducted in-depth research into the history of the site, the neighbourhood, and analysed the potential for future development. (Fig.01) Based on this research, individual design strategies were developed for Greenlane with different future directions and focuses.(Fig.02) Behind these projects is an awareness of the dramatic changes taking place in healthcare, with the aim of exploring how architecture can contribute to future healthcare processes.



*Ara Manawa is an interdisciplinary research, design and innovation studio inside the ADHB. They are a team of creative problem solvers who develop solutions to challenges in Auckland Hospital and our wider health sector.

Figure 01. Relation plan between AUT lab and Ara manawa.

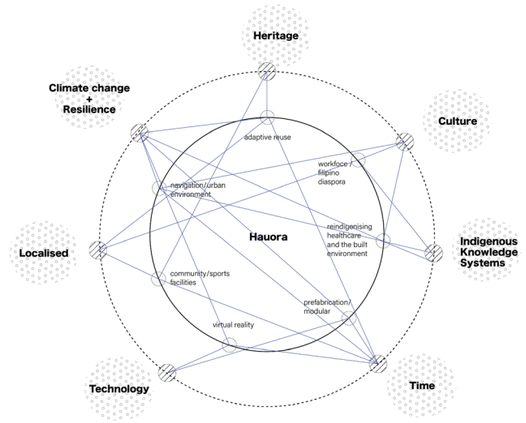


Figure 02. lab focuses on the future healthcare in different future directions and focus.

INTRODUCTION

The aim of this thesis project is to explore from an architectural perspective, how to respond to the rapid change and renewal of healthcare buildings. Both healthcare and construction industries have undergone rapid evolution and development over time. Setting Greenlane Clinical Services Centre (GCSC) as the design site. The Amoeba strategy, a form of modular/prefabricated construction that aims to provide a responsive space to support healthcare spaces.(Fig.03)

This thesis adopts the following structure to achieve its research objectives: firstly, in Contextualizing (Part 1), key contextual information is gained through a study of the site's history, constraints, and needs, as well as elaboration on prefabrication. In Methodology (Part 2), propose design method to assist in the formulation of design solutions; precedents (Part 3) then draw experiences from the study of relevant successful prefabrication and modularization cases; finally, in Design Explorations (Part 4) and design strategy (Part 5), I explore the details of the design strategy in detail.

This project utilises the 'Amoeba Strategy', which is based on the many renovations and modifications that GCSC has undergone in the past, and I found that the master plan no longer met the needs of GCSC and the concept of the Amoeba Strategy was to compare the new building design to the form of an amoeba, which can 'grow' and 'retreat' to be highly adaptable, also using the concept of biophilia to find a balance between physical structure and mental comfort in modular elements to improve the overall experience of the healthcare environment. These building blocks can be inserted into existing buildings like 'plug-in' or 'pop-up' on site, creating a relatively free, irregular form. This strategy also involves strengthening the existing building through structural retrofitting walls in preparation for healing the building and more modular designs in the future.

The timeframe of this strategy looks at the future and aims to meet the higher intensity timescale of development and growing demand for space, covering different scenarios ranging from rapid growth to decreasing demand in the future to ensure that development and change are supported with minimal disturbance to the site. However, this thesis design focuses on the needs of the GCSC at this stage and examines in detail the specific design and function in the modular blocks. Overall, the aim is to provide a sustainable architectural Strategy to buildings with a long history of adaptability over time.

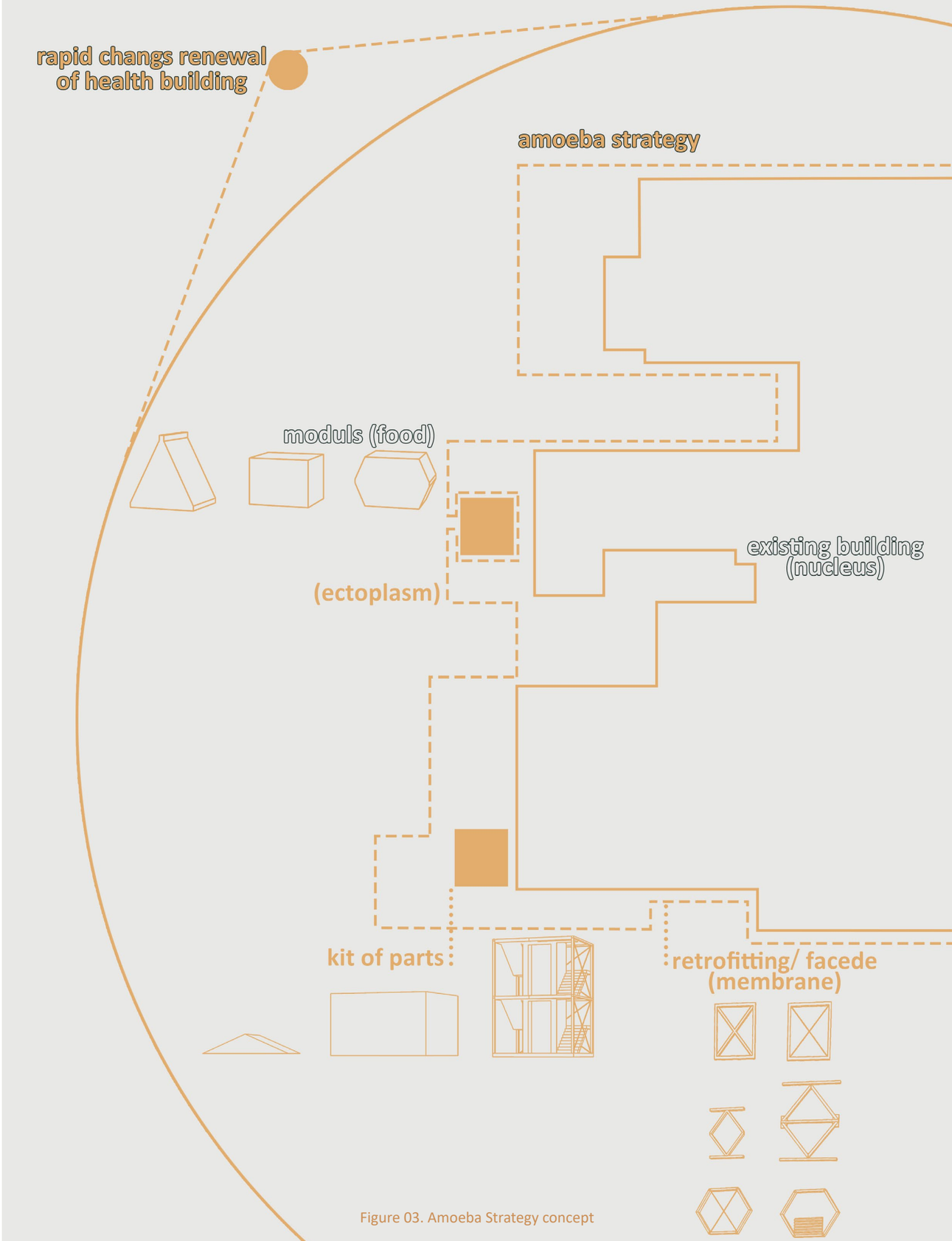


Figure 03. Amoeba Strategy concept

PART 1: CONTEXTUALIZING



Figure 04. Site Surrounding map



Figure 05. Site Map and Location

1.1 GREENLANE CLINICAL SERVICES CENTRE

The Greenlane Clinical Services Centre (be abbreviated to GCSC) is a tertiary medical facility located in Greenlane, a residential suburb in the centre of Tāmaki Makaurau Auckland, New Zealand.(Fig.04) Greenlane is a historic site located in the centre of Auckland, New Zealand. The campus is located next to Cornwall Park, separated by a historic stone wall, and next to Maungakiekie (One Tree Hill). This hill is one of the city's most iconic sights and adds to the magnificent scenery of the surrounding area.(Fig.05)

Greenlane's history is inextricably related to the growth of the City of Auckland. The history of Cornwall Park can be traced back to 67,000 years the eruption of Maungakiekie, formed the conical hill shape of Cornwall Park and Maungakiekie (One Tree Hill) today.[1] (Fig.06)

1 "Our History." Cornwall Park. Accessed june 22, 2023. https://cornwallpark.co.nz/history.

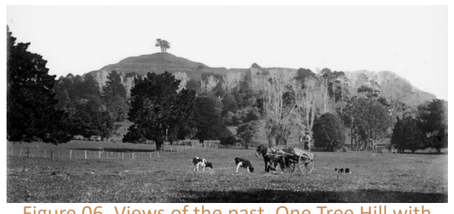


Figure 06. Views of the past, One Tree Hill with cows and horses on Cornwall Park farmland.



Figure 07. Greenlane's 1898 view, transformed from a grassland to a carriage road.



Figure 08. Queen Street, Auckland, in 1919 with the development of tramways along the times muddy road, which also included an extension to greenlane.

Between 1600 and 1700, Maungakiekie became a strategic stronghold that witnessed conflicts between two Māori tribes, the Waiohua and Ngāti Whātua. The land was sold to the merchant Thomas Henry 1845 and he retained 115 acres of the hill, known now as One Tree Hill Field. In 1853, Sir John Logan Campbell and William Brown gained the land and transformed it into what we now recognize as Cornwall Park. Remarkably, in 1901, they generously donated this land to all New Zealanders, making it freely accessible to the public.[2]

The GCSC itself is run by Te Whatu Ora.[3] It is one of the government funded health organisations that aims to provide health and medical services to the residents of Auckland, New Zealand. The GCSC dates back to 1889-1890 and was originally known as the 'Costley Home for the Aged Poor', donated and established by Edward Costley (c.1796-1883) to provide shelter and medical care for the elderly poor, providing vital support to the community.(Fig.09-10)

In 1924, the name of the institution was changed to 'Auckland Infirmary' and in 1940 to Green Lane Hospital, during which time the first main building (now the Building 7) was built.(Fig.11)
In 1958, Brian Barett-Boyes performed the Centre's first open heart surgery. And in 1962, the world's second successful heart valve replacement operation was performed here and the hospital became internationally renowned.[4](Fig.12)

Over time, GCSC has grown and expanded, and continues to play an important role in Auckland's healthcare sector, providing high quality medical care to its residents.[5] The subsequent expansion led to the partial demolition of the main Costely Home building, which has been closed for use.

In 1964, the GCSC reached an important stage of development, most notably the establishment of the National Women's Hospital. At the same time, the Staff Residence (staff quarters) and the Administration Block were built to support the day-to-day operations of the hospital and the residential needs of the staff, and a swimming pool and adjoined hall were built in response to preparations by

2 "Cornwall Park Timeline: What's On." Cornwall Park. Accessed June 22, 2023. https://cornwallpark.co.nz/history/cornwall-park-timeline.
3 "Welcome to Te Toka Tumai Auckland." Home | Te Whatu Ora Te Toka Tumai Auckland. Accessed June 22, 2023. https://www.adhb.health.nz/.
4 "First Open-Heart Surgery in New Zealand." RSS. Accessed June 22, 2023. https://nzhistory.govt.nz/page/first-open-heart-surgery-nz.
5 "Green Lane Hospital 202-214 Green Lane West, Epsom, AUCKLAND." Welcome to Heritage New Zealand. Accessed June 22, 2023. https://www.heritage.org.nz/list-details/4536/Green%20Lane%20Hospital.



Figure 09. Costley Home,Greenlane Hospital,Auckland



Figure 10. Costley Home,Greenlane Hospital,Auckland



Figure 11. Now the Building 7, built in 1924, six-storey concrete building with cantilevered balconies, image take 2023.



Figure 12. First open-heart surgery perfoemed by Brian Barett-Boyes, in 1958

nurses and other staff to provide recreational and entertainment areas for the hospital community. These facilities provide a more comfortable and enjoyable environment for hospital staff and patients[6] but no longer exists since 2017.

In 1970, the GCSC underwent a further extension which included the current Main Building, Building 4 (Fig.13).
Over time, smaller buildings such as the Creche (childcare service) were added to the GCSC in 1983 to cater for the childcare needs of the staff.
However, 1989 marked a major change for the hospital. A major organisational restructuring took place at that time, resulting in the loss of a number of departments at Green Lane Hospital[7], this transforming Green Lane Hospital into a specialist facility.

By 2004, National Women's Hospital was also relocated to Auckland Central Hospital, which meant that Greenlane was no longer a full hospital site. Instead, it was transformed into a clinical centre, now known as the Greenlane Clinical Services Centre.

GCSC is a series of buildings that has been providing health care and assistance to Auckland residents for over 100 years. A site of historical significance, closely associated with New Zealand's health and welfare history, it has witnessed many major medical breakthroughs associated with treatments and cures. However, in the context of radical technological and social changes, the building facilities and grounds have had to change accordingly to accommodate the needs of contemporary healthcare.

Building alterations and extensions at GCSC involve a number of reasons, including several key factors. Firstly, the introduction of different policies has an impact on building alterations and expansions at GCSC. Over time, new healthcare policies are developed by the government and relevant agencies, requiring more advanced

6 Hutchinson, B. R. Green Lane Hospital: The first hundred years. Auckland, N.Z.: Green Lane Hospital Centennial Committee, 1990.
7 including general medicine, surgery, geriatrics, gastroenterology and the closure of the emergency department.



Figure 13. GCSC's current main building(2023), Building 4, is a seven-storey building that houses a series of clinical departments including cardiology, diabetes clinic, ENT, audiology etc. Built in 1970.

1.2 A TIMELINE OF GREENLANE CLINICAL SERVICES CENTRE

healthcare facilities and services. This may involve raising medical standards, introducing new technology and equipment, and optimising medical processes.

The changing and increasing number of people in the surrounding has also led to the renovation and expansion of GCSC buildings. As the population grows and the structure of society changes, the need for healthcare services evolves. For example, an increasing ageing population may require the provision of more elderly care facilities and medical services, while an increasing younger population may require additional paediatric and obstetrics and gynaecology facilities. To meet the needs of the changing population, GCSC's buildings will continue to be suitably altered and expanded.

The eras map(Fig.14) compares key points in the history of healthcare in Aotearoa, health “events”, and the building works of GCSC. This diagram provides a historical perspective on the healthcare sector, showing the impact of healthcare policies and actions on the renovation and expansion of GCSC buildings. The diagram reveals how over time the country has taken a number of different policies and actions to meet the needs of the community. From 1840 to 1960, Aotearoa faced a number of pandemic and primary care challenges. From 1970 to 2009 was more focused on actions, for example the implementation of the ACC(1974), the establishment of the Health Research Council(1990), the Health and Disability Commissioner(1994), and the launching of the Rheumatic Fever Prevention Programme(2011) ect. All actions complement the functioning of the health system and provide more medical assistance to the population. to complement the functioning of the health system and to provide more medical help to the population.

Inevitably, more population will require more actions as well as space, and there is a high probability that these spaces will change in demand over time or will no longer be needed. Through eras map (Fig.15) we can observe changes between structure and healthcare. For example, during the First World War, from 1914 to

1840-1849 | 1850-1859 | 1860-1869 | 1870-1879 | 1880-1889 | 1890-1899 | 1900-1909 | 1910-1919 | 1920-1929

Healthcare in Aotearoa/Auckalnd

Structure in GCSC

Medical-related Events in Aotearoa/auckland

Costley Home(1889-1890)



Auckland Infirmary (1906)



Signing of Te Tiriti ō Waitangi – Treaty of Waitangi (1840)

Hospital institution (presumed to be military) established in Auckland (1841)

New Zealand Land Wars began (1845)

First known case of smallpox via ship landed in Lambton Harbour (1840)

First meeting of Parliament in (1854)

Medical assistance for Natives discussed in Parliament (1855)

Formation of Central Board of Vaccination for the Aborigines of New Zealand (1854)

Scarlet fever and measles outbreaks (1854)

Influx of immigrants increases hospital demand (1861)

Land given in Te Awamutu for native hospital (1862)

Discussions about a hospital for Māori in Rotorua (1862)

Typhoid appeared as epidemic disease (1860)

Influx of immigrants increases hospital demand (1861)

Māori land wars ended (1872)

Otago Medical School established under Anatomy Act (1875)

A central Board of Health for entire colony established under the Public Health Act (1876)

Administrative and financial control of hospitals taken over by central Government (1876)

Control of asylums taken over by central Government (1876)

Smallpox outbreaks – Auckland and Wellington (1872)

Whooping cough epidemic (1873)

Cromwell has typhoid outbreak (1874)

Measles epidemic (1874)

Native Schools Code teachers supplied with simple medicine (1880)

Formation of New Zealand Medical Association (1886)

Measles epidemic – Otago, Canterbury, Auckland, Wellington and Hawke's Bay (1881)

Typhoid epidemic (1888)

First political party (Liberal Party) is formed (1890)

Native Department abolished (1892)

Women's suffrage movement (1893)

Dr Walter Fell reviews quarantine regulations (1891)

Measles epidemic (1893)

Measles epidemic (1898)

Establishment of Department of Public Health (1901)

Department of Public Health takes full responsibility for Māori health (1906)

Akenehi Hei, first Māori registered nurse and midwife (1908)

First death from plague (1900)

Establishment of Department of Public Health (1901)

Native Department re-established (1906)

Establishment of Mental Hospitals Department (1908)

Tangi by-law restricting public tangi in order to contain infectious disease (1900)

Measles epidemic (1902)

Smallpox spread from Tasmania to Christchurch (1904)

Measles epidemic (1907)

Control of Māori health returned to Department of Public Health (1910)

Infectious diseases control transferred from local authorities to hospital boards (1910)

Reform Party becomes the government (1912)

Compulsory medical inspection of children in state schools (1912)

World War I (1914–1918)

Establishment of New Zealand Army Nursing Service (1915)

Proposals for complete reorganisation of Department of Health (1919)

Infectious diseases control transferred from local authorities to hospital boards (1910)

Typhoid fever outbreak (Ahipara, Te Puke, South Waikato) (1910)

Māori Nursing Service established as part of Health Department (1911)

Smallpox epidemic (1913)

Typhoid outbreak – Auckland, Raetihi and Bay of Plenty) (1914)

Poliomyelitis epidemic (1916)

influenza pandemic (1919)

First Children's Health Camp established by Dr Elizabeth Gunn to help children malnourished or suffering from tuberculosis (1919)

Division of Māori Hygiene created in Department of Health (1920)

Māori Health Councils revived (1920)

New Zealand divided into 12 Health Districts (1927)

United Party elected to power (1928)

Four deaths in six cases of puerperal sepsis in a Auckland Hospital aroused public alarm (1923)

Introduction of diphtheria immunisation (1925)

Bacillary Dysentery epidemic (1929)

Figure 14. Eras map for healthcare in Auckland, comparing key points in the history of healthcare within Auckland, within each decade, blue indicates the Epidemic that occurred, which would lead to a series of policies and vaccinations (may cause the need for more facilities and equipment); green indicates actions/events taken by the government and healthcare organisations, which are linked to different party, and epidemics in the time period; and orange indicates the timing of the construction of the GCSC. 1840-2020.

1930-1939 | 1940-1949 | 1950-1959 | 1960-1969 | 1970-1979 | 1980-1989 | 1990-1999 | 2000-2009 | 2010-2020

Old Main Building (1942)



Boiler House (1959)



Chest Annexe (1953)

The National Women's Hospital (1964-1965)
Administration (1964-1965)
Nurses' home (1964-1965)



New Main Building (1970)



Crech (1983)



Dialysis clinic (2011)



Māori Hygiene Department abolished (1931)

Reform Party and United Party form a coalition government (1931)

Worldwide economic depression begins to affect New Zealand and the Department of Health (1931)

Hawke's Bay earthquake (1931)

Labour Party elected to government (1935)

New Zealand Federation of Health Camps formed (1936)

Medical Research Council of New Zealand established (1937)

World War II (1939–1945)

Women's Health League formed by nurse Ruby Cameron in the Rotorua District (1937)

Immunisation against diphtheria (1937)

Māori Councils abolished and Tribal Executives established (1945)

National Party elected (1949)

General Medical Services Benefit established (1941)

Social Security extends to maternity benefits (1941)

Extension of Social Security benefits to physiotherapy (1942)

Health benefits extended to include artificial limbs (1947)

Medical Research Council established (1950)

Labour Party elected (1957)

Extension of the Bacille Calmette-Guérin (BCG) vaccination for tuberculosis (1951)

Start made with immunising against poliomyelitis with Stalk Vaccine (1956)

National Party elected (1960)

Department of Health sets up Māori Health Committee (1960)

Health Department reorganised into six divisions (1962)

Reconstitution of Medical Research Council, separated from Department (1965)

Replacement of eight hospital districts with two (1967)

Distribution of milk in schools ended (1966)

Health Department reorganised into six divisions (1962)

Provision of free vaccines for diphtheria, pertussis (whooping cough) and tetanus (1960)

Screening of newborn infants for phenylketonuria (1960) Cervical cancer campaign (1963)

Nursing Council of New Zealand established (1971)

Labour Party elected (1972)

Psychiatric hospitals transferred to Hospital Board's control (1972)

ACC scheme started (1974)

National Party elected (1975)

Hui of Māori Doctors (1981)

Area Health Boards established (1983)

Labour Party elected (1984)

Formation of joint Treasury and Health Department Hospital and Related Services Taskforce (1987)

National Party elected (1990)

Health Research Council established (1990)

User charges introduced to public hospitals (1992)

PHARMAC (Pharmaceutical Management Agency established (1993)

Department of Health became Ministry of Health (1993)

Public Health Commission established (1993)

PHARMAC (Pharmaceutical Management Agency established (1993)

Health and Disability Commissioner established (1994)

Mental Health Commission established (1996)

Hospital and Health Services established (1996)

Hospitals required to have a booking system for elective surgery (1998)

Focus of Patients: Labour on Health policy released (1999)

National Health Committee established (2000)

Health Funding Authority and Hospital and Health Services disestablished (2000)

District Health Boards established (2001)

Health Workforce Advisory Committee (HWAC) established (2001)

Māori Party established (2004)

Labour Party elected (2005)

Māori Health and Disability Committee (HWAC) established (2005)

National health targets introduced (2007)

Convention on the Rights of Persons with Disabilities, ratified by New Zealand (2008)

National Party elected (2008)

Free doctors' visits for under-6s (2008)

Health Workforce New Zealand established (2009)

Health Quality and Safety Commission established (2010)

National Party elected (2011)

Canterbury earthquakes (2011)

Rheumatic Fever Prevention Programme started (2011)

Smokefree 2025 goal adopted (2011)

Mental Health Commission disestablished with a Mental Health Commissioner placed in the Office of the Health and Disability Commissioner (2012)

Rising to the Challenge: The Mental Health and Addiction Service Development Plan 2012–2017 released (2013)

New Zealand Suicide Prevention Action Plan 2013 – 2016 released (2013)

National Party elected (2014)

New Zealand Cancer Plan: Better, faster cancer care 2015–2018 strategy released (2014)

Health Literacy Programmes introduced (2016)

National Health Committee disestablished (2016)

Kaikoura earthquake (2016)

Health Literacy Programmes introduced (2016)

COVID-19 pandemic (2019)





1889
Costley Home (Closed)

Costley Site expanded through land acquisition , and more structures built

Costley Home (for Aged Poor) opened (Site of 17 acres: with 3 sets of double wards, and market gardens at the rear of the site) purchased from Mr Potter Jr and William Gardener. 148 patients admitted

1906
Auckland Infirmary (Closed)

1940
Old Main Block
6-story main building completed. (demolition of the 1898 Brick Church)



1912
Original Nurses home built at Greenlane and further accomodation

1925
A new wing of the Nurses' home/facilities Building 10 has been constructed at the rear of the complex.

1958
1st open heart surgery
First trainees in school of nursing at Greenlane,
First bypass operation.

1964-1965
Original Nurses home at Greenlane Demolished, brick buildings behind Costley demolished (admin block)

National womens Hospital Opens, and new nurses home. New Admin block opened also. In this time the swimming pool and Hall were opened

1984
North Shore Hospital opened, and Green Lane Hospital transferred its major general surgery and medicine departments to the new institution.

1989
Green Lane Hospital now focuses on specialized services, as most general medicine and surgery moved elsewhere. Geriatrics, gastroenterology, and the emergency department were removed.

Auckland Hospital's ENT services shifted to Greenlane, and Gynecology services moved from National Women's Hospital to Greenlane, potentially due to cost-cutting measures.



boiler house built on site of old laundry, to supply Greenlane and in construction National Womens

1959
Boiler House

The name was changed to Greenlane Hospital.

1942



1940



1959

1996



National Women's Hospital

1964-1996

1970

1983
Crech





Administration Block

Staff Residence

1989 2001

Greenland Hospital was stripped of many services, which included the elimination of: general medicine, surgery, geriatrics, gastroenterology, and the closure of the emergency department. These services were transferred to Auckland City Hospital.

1989



Childcare for staff

Child development Clinic, Public/Family Mental Health services



New Main Block 7 Storey Building Block cardiology, diabetes clinic, ENT, audiology etc



2001

2001 2004

2005
Female Infirmary Demolished

2009
Public campaign against demolition of Infirmary

2010
Building 5 Costley Home on the Greenlane campus has been given heritage status.

2011 2017

2013
Building 10 has been demolished due to seismic risk.

2023



Stage 2 Building beside 7 Storey Building Block

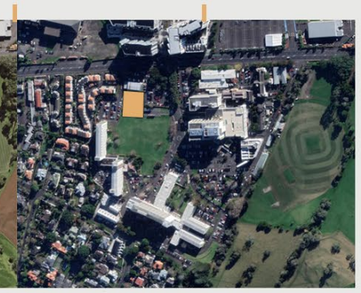
2001-2004 rebuild of crech



2004-2011



2017 remove swimming pool



2023

BUILD
REMOVED

2004
National Women's service was also shifted to the Auckland City Hospital. Greenlane was no longer a 'Hospital site' instead it became a Clinical Centre.



2011
Dialysis clinic Opened

Figure 15. GCSC building construction eras map, in conjunction with Fig.14, each period of construction change is unstoppable.

1918, the GCSC (then Costley Home) responded to a national request to provide medical care and assistance to the army, and it's now closed(2023). In addition, the gradual recognition of women's rights led to the establishment of the National Women's Hospital in 1964 to meet women's needs, also the building had been removed 2005.

As times and needs changed, the buildings underwent some re-building, removal and the transfer of some functions to other hospitals. This demonstrates the flexibility and continued adaptability required of GCSC buildings to changing healthcare needs and social circumstances. Figure 15 provides more details of the establishment and demolition of the GCSC buildings, demonstrating the changes and adaptations that took place during this process.

The planning and construction of buildings takes longer and therefore, this research project proposes and tests a modular strategy, to be continuously changed to respond quickly to the changing needs of GCSC. This strategy allows for a more flexible and constant building, ensuring that it is in line with the evolution of healthcare and population needs.

1.3 SITE ANALYSIS

Observing and visiting the site is a crucial step to undertaking an architectural design project. Through in-person site visits, we(as a lab) can gain practical information and experience to understand intuitively the condition and status of the site. (Fig.16)

Through spatial analysis and discussion using diagrams (Fig.17), we gained a better understanding of the current use and allocation of space(Fig.18).

According to Statistics New Zealand, the population of the Maungakiekie-Tamaki Local Council area is expected to increase from approximately 77,000 in 2016 to 95,000 by 2043.[8] This significant increase in population will drive rapid urban growth, while also presenting a number of challenges to the current and future development of the GCSC. This pressure is multi-faceted and involves medical technology equipment, staff shortages, cost of fees etc.

In February 2019, Chief Executive Officer of Auckland District Health Board, Ailsa Claire highlighted the need of upgrading the facility to better meet the healthcare needs of the community. She noted that hospital services have outstripped the capacity of the current infrastructure, resulting in long waiting times and inadequate facilities for staff and patients.[9]

8 "Population Estimates and Projections for the Maungakiekie-Tāmaki Local Board Area, Auckland, New Zealand." Figure.NZ.

9 Claire, Ailsa. "Future Planning for Greenlane." CEO Blog, March 3, 2019. https://adhbce.wordpress.com/2019/02/28/future-planning-for-greenlane/.

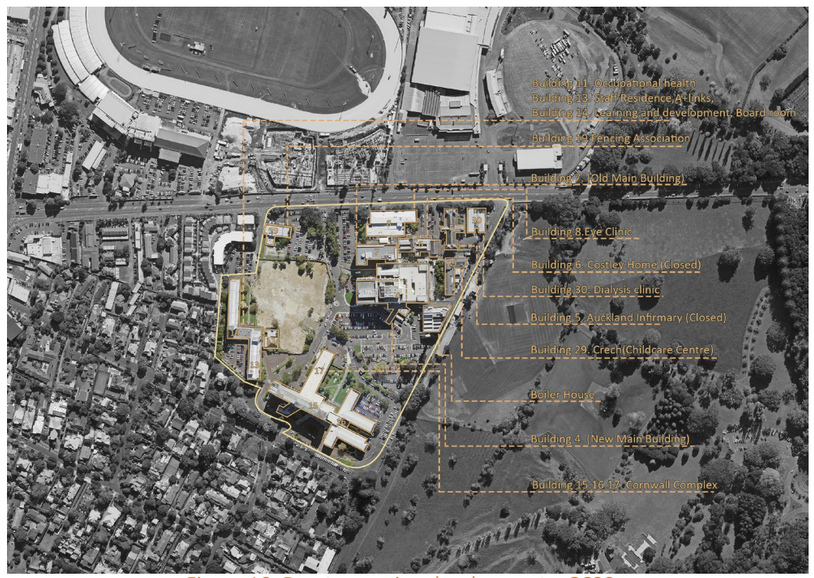


Figure 16. Due to ongoing developments, GCSC does not have a fully defined masterplan, this diagram based on site visit identification of programmes and services in 2023.

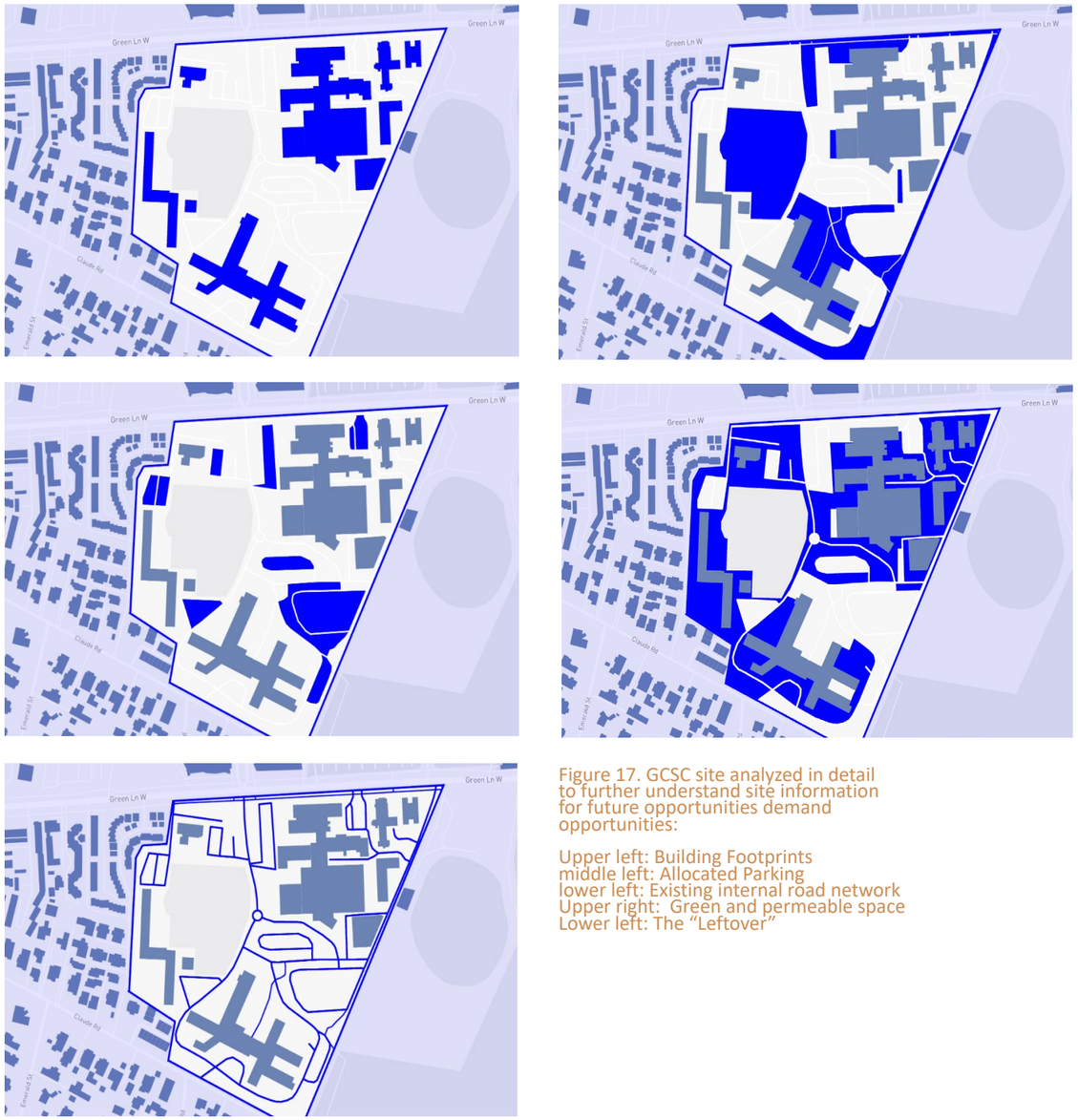


Figure 17. GCSC site analyzed in detail to further understand site information for future opportunities demand opportunities:

Upper left: Building Footprints
middle left: Allocated Parking
lower left: Existing internal road network
Upper right: Green and permeable space
Lower left: The “Leftover”



Figure 18. GCSC Site visits provide a better visualisation of the moments, over the years it can be felt GCSC is starting to get worn.

From an architectural point of view, the development of the GCSC needed to take into account the demands of surrounding population and building facilities. The design and planning of the facilities therefore requires a combination of elements, such as sustainability, energy efficiency and humane layout of the facilities.

Given that large facilities cannot instantly change substandard or unsuitable buildings, it is not easy to decommission or relocate the entire construction. This leads to the research question of this research project(Fig.19): how to reach a balance between fast renewal of future health care and effective environment comfort by using architectural strategies? By adopting a pre-fabrication strategy, we can implement building changes gradually without interrupting hospital operations.



Research Question: How can we develop architectural strategies to address the fast pace of change and renewal in healthcare buildings?
Sub Question: How might the architecture strategy of prefabrication-modular balance the quick response and comfort?

Problem

- **Times evolving**
- **Population increase**
- **Technological develoment**
- **Improvements in architecture/building**

How can architecture strayegy support rate of structure changes

Able to be:
- Comforts enviroment
- Reduced site disruption
- Maintain operational funcationality

Prefabrication

What that might look like and waht functions

- programmes
- future developments
- features

Concept thinking

Figure 19. Brainstorming and research question diagram to dissect the opportunities of architecture in the site to identify research and design directions.

1.4 PREFABRICATION

As the population grows,(Fig.20)[10] the local New Zealand community is been in challenged, this research project therefore aims to suggest how architecture can use pre-fabricated and modular strategies to address these challenges.

In prefabrication, parts of the building structure will be premade in factory, such as walls, floors and roofs, and then transported to the site for installation.
As the early Ford car lines added one part at a time to assemble the whole,[11] on-site construction relied on the skill of workers to put buildings together step by step, pre-fabricated utilises an important concept in manufacturing, which is interchangeability and increased productivity.

The use of pre-fabricated buildings can bring multiple benefits to the construction industry

- Prefabricated building components are manufactured in a controlled environment and are no longer subject to adverse weather or other site issues, thereby significantly reducing the risk of construction delays and shortening construction times. The time control helps to reduce project costs, speed up project schedules and reduce the environmental impact of construction.
- Pre-fabrication offers high quality control and accuracy. The manufacturing process can be better monitored and managed to ensure that the quality and specification of each component meets expectations. This precision helps to ensure the stability and longevity of the building structure.
- Pre-fabrication can improve safety conditions for workers. According to the New Zealand Information Centre: *"Injury claims have risen 7.5% in the past five years while costs have surged almost 38%. In that time, 29 people died on building sites…"*[12]As the constraction works of prefabrication moved from the site to a factory environment, workers on site are exposed to significantly fewer risks and hazards. This includes working at heights, handling of hazardous materials and other safety issues common to construction sites.

Also as an ageing workforce, lack of skills, labour migration and health and safety issues related to construction activities, as well as environmental pollution have become one of the reasons why prefabrication technology is seen as increasingly important in the future of construction activities in many countries.[13]

"The Government is committed to supporting innovation in off-site construction, which includes prefabrication, modular construction and other innovative off-site manufacturing technologies."[14] The New Zealand construction industry now has increasingly tended to use prefabricated, with portable classrooms and state government houses are all part of New Zealand's prefabricated building history.

Gordon Wilson noted in the New Zealand Financial Times in 1943 that the term pre-fabricated building is often misunderstood and is confused with the final building product, ignoring the role of pre-fabrication as a system. The fact is that modern prefabricated buildings has evolved to provide quality, durable and reliable building solutions.[15]

Pre-fabricated buildings are often considered to be a sustainable solution due to the strengths they offer, such as improved building quality and consistency, which helps to reduce building defects and the need for maintenance, thus extending the life of the building. But in fact, as Lloyd Alter argues in "Prefab: Green or Greenwashing?"[16]

Ensuring the sustainability of the construction industry required attention to all stages of the construction life cycle, including material selection, procurement, production efficiency, waste reuse and recycling. Sustainability is an approach that looks at the whole building life cycle, whereas designers, builders and other stakeholders should work together to achieve the objective of sustainability in the construction industry through integrated systems and implementation measures.
Sustainability is a key element in this research project, the application of sustainability can effectively provide the building with the adaptability and flexibility to respond to future changes in demand.

In addition, sustainability factors need to be considered during the use of the building, such as energy efficiency, water management and indoor environmental quality, to reduce resource depletion. Only with an integrated approach to sustainability can pre-fabricated buildings realise the full potential benefits.

10 Greenlane, Auckland, New Zealand - population and demographics. Accessed June 22, 2023. https://www.city-facts.com/greenlane-auckland/population.
11 Smith, Ryan E. Prefab Architecture: A Guide to Modular Design and Construction. Hoboken, NJ: John Wiley & Sons, 2011.
12 "Tackling the Hidden Cost of the Building Boom." ACC.
13 Bayliss, Simon, and Rory Bergin. The Modular Housing Handbook. London: RIBA Publishing, 2020.
14 "Funding Information and Opportunities." Ministry of Business, Innovation and Employment.
15 Gordon, Wilson. "Lessons in Prefabrication." New Zealand Financial Times: 139, 1943.
16 Alter, Lloyd. "Prefab: Green or Greenwashing?" Treehugger, 2007.

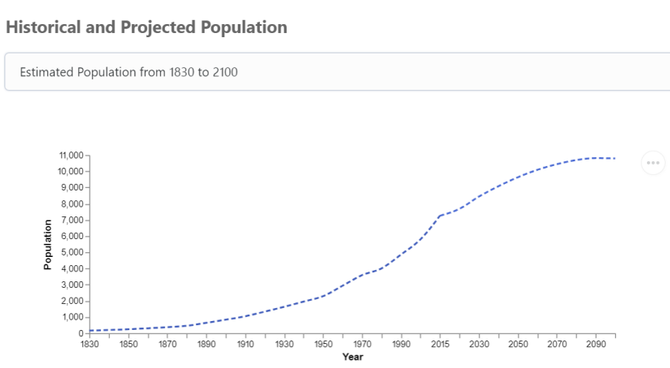


Figure 20. Historical and Projected Population to demonstrate continued growth from 1830 to 2100

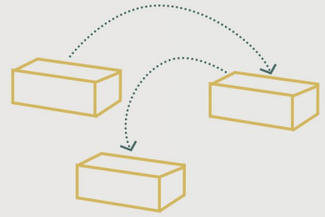
DETAILS

Pre-fabrication

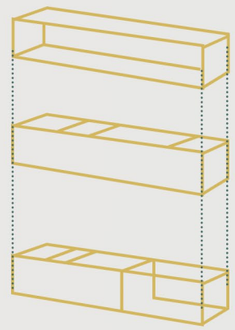
permanent
typically made from high-quality materials and are designed to be durable and long-lasting.



relocatable
quick and temporary solution, for short-term events.



whole building(modular)
involves the manufacture of complete building modules that are transported to the site and assembled into a complete structure.

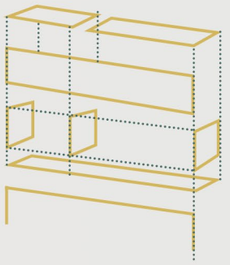


part of building(panelization)

walls

floors

roof panels



Benefits

Efficient use of materials

Improved site safety

Control building enviroment

Quality control and accuracy

Reduced construction time

ABILITYS

Figure 21. Classification and details of prefabricated elements, highlighting strengths and features for further study.

1.5 MODULARS BUILDING

"Over the past decade modular construction has been shown to be particularly well delivering greater urban intensification, enabling development on more compact, and heavily constrained sites, with the significantly shorter construction period much less disruption for existing neighbours and the wider community."[17]

Modular is a specific application of pre-fabricated construction that divides building design and construction into discrete units/blocks. Each module is typically manufactured in a factory to standardised specifications and processes. Modular can therefore be seen as a specific form of pre-fabrication, characterised by a stronger emphasis on the connection and assembly between modules, while pre-fabricated buildings more broadly include the application of a range of pre-fabricated components and assemblies.

"The core of modular construction is the off-site construction process of pre-fabricated. In a controlled depot environment, workers and high-tech automated machines build modules in many different layouts and designs, each designed to match a specific or general use case."[18] Once built in the factory, these modules can be quickly delivered to sites across the country.

In David Wallance's book 'The Future of Modular Architecture', he refers to the essence of modular architecture- stacking. *"With simple stacking, cantilevered modules, void modules, and eccentric stacking, one can create an endless series of compositions, all derived from a known number of module types and face permutations."*[19] The specific positions and types of modules are defined by functions and rules, forming a modular structure that is flexible and adaptable.

This modular building breaks down the building elements into reusable parts, each with a specific function and form. With predefined modules and rules, the design strategy can quickly respond to site and project-specific requirements to modified and extended.

People often mistakenly think that modular construction is only suitable for container homes and temporary offices. In fact, whether used for temporary or portable purposes, modular construction can achieve their objectives in a shorter period of time while minimising the impact on site.

- Temporary modular buildings are intended to provide quick, portable space solutions. However, the lifespan of a modular building depends on the structural materials used, and modular lifespans of about 25-30 years can still be achieved using steel construction, and with proper maintenance of the building systems, siding and roofing, these temporary portable modular buildings can last virtually a lifetime.
- Permanent Modular Buildings Similar to site-built buildings, permanent modular buildings are placed on a foundation and are not intended to be relocated. Their superior modular building quality allows permanent modular buildings to last 50 years or more.

Quick installation is important for healthcare facilities to have the flexibility to expand their services and capabilities. For example, in healthcare departments such as Trauma Center Winthrop-University Hospital(Fig.22)[20] and Emergency Department Extension in NHS East Sussex Healthcare(Fig.23)[21] which are entirely modular additions, the advantage of modular buildings is that they can be adapted to specific needs, providing hospitals and other facilities with convenient additions. This is particularly important for medical facilities that need to expand urgently or respond quickly to emergencies, such as natural disaster relief efforts, responding to pandemic(for example COVID-19), expanding existing buildings or adding new functions, modular buildings offer an easy transport, installation and removal strategy, meaning that meeting changing capacity needs becomes easier and sustainable.

With modular construction, modules can be delivered to site at short notice with little to no stoppage for hospital services, allow the construction of suitable buildings without interfering with site operations, thus reducing the need to block facility roads and avoiding disruptions to the medical facilities.(Fig.24)

17 Bayliss, Simon, and Rory Bergin. The Modular Housing Handbook. London: RIBA Publishing, 2020.
18 Nc. "Modular Hospital Construction: How It Works and Why It Matters." VESTA Modular, February 8, 2023. https://vestamodular.com/blog/modular-hospital-construction/.
19 Wallance, David. The Future of Modular Architecture. New York: Routledge, 2021.
20 "Winthrop-University Hospital." VESTA Modular, August 24, 2022. https://vestamodular.com/project/winthrop-university-hospital/.
21 "Emergency Department Extension: New Hospital Builds." Health Spaces, May 4, 2023. https://health-spaces.com/case-studies/emergency-department-extension/.

Based on practical experience and research data on ECOTECH (Ecotech Commercial NZ LTD)[22] and PODLIVING turnkey modular building[23], modular construction includes design of architectural drawings to the application, factory fabrication, on-site installation, about the shortest 22 to longest 40 weeks, while on-site installation in general only 2-4 weeks.

The aim of this research is to take on the role of 'designers in industry'[24] from an architectural perspective, working closely with the manufacturing and pre-fabrication fields to develop, functional and successful design solutions. The focus is on researching and exploring how modular construction can be practically applied in the GCSC, including how they fit into the site and how they take into account factors such as technology, structure, user needs, comfort experience and quick response.

22 "Build Process." ECOTECH. Accessed October 6, 2023. https://www.ecotechcommercial.com/process-1.
23 "FAQs: Modular Homes NZ." PODLIVING, February 17, 2023. https://podliving.co.nz/faqs-your-questions-on-nz-modular-homes-answered/.
24 Bayliss, Simon, and Rory Bergin. The Modular Housing Handbook. London: RIBA Publishing, 2020.



Figure 22. Concrete structure, permanent modular building, the Trauma centre winthrop-university hospital.



Figure 23. Emergency department extension modular lifting process in NHS East Sussex Healthcare

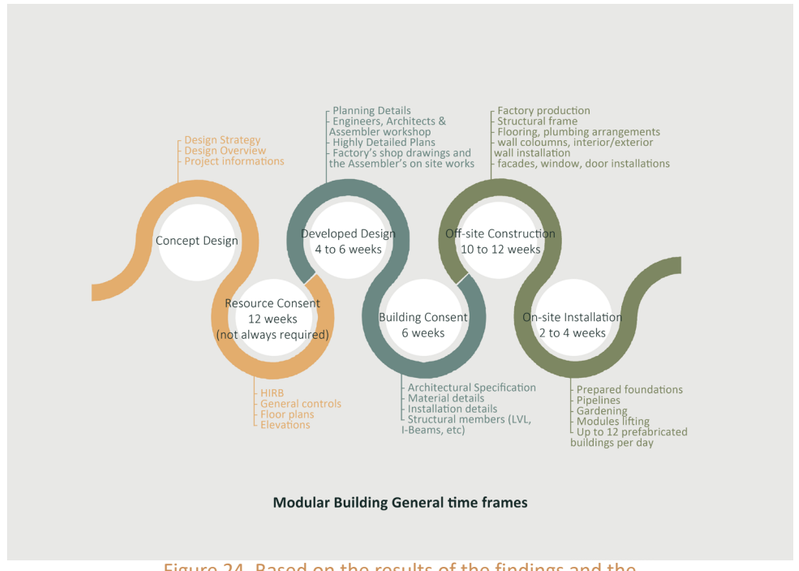


Figure 24. Based on the results of the findings and the possibility of identifying modular construction, a general timeframe for the integration of modular construction was used to analyse the modular construction approach could achieve fast construction while avoiding most on-site construction.

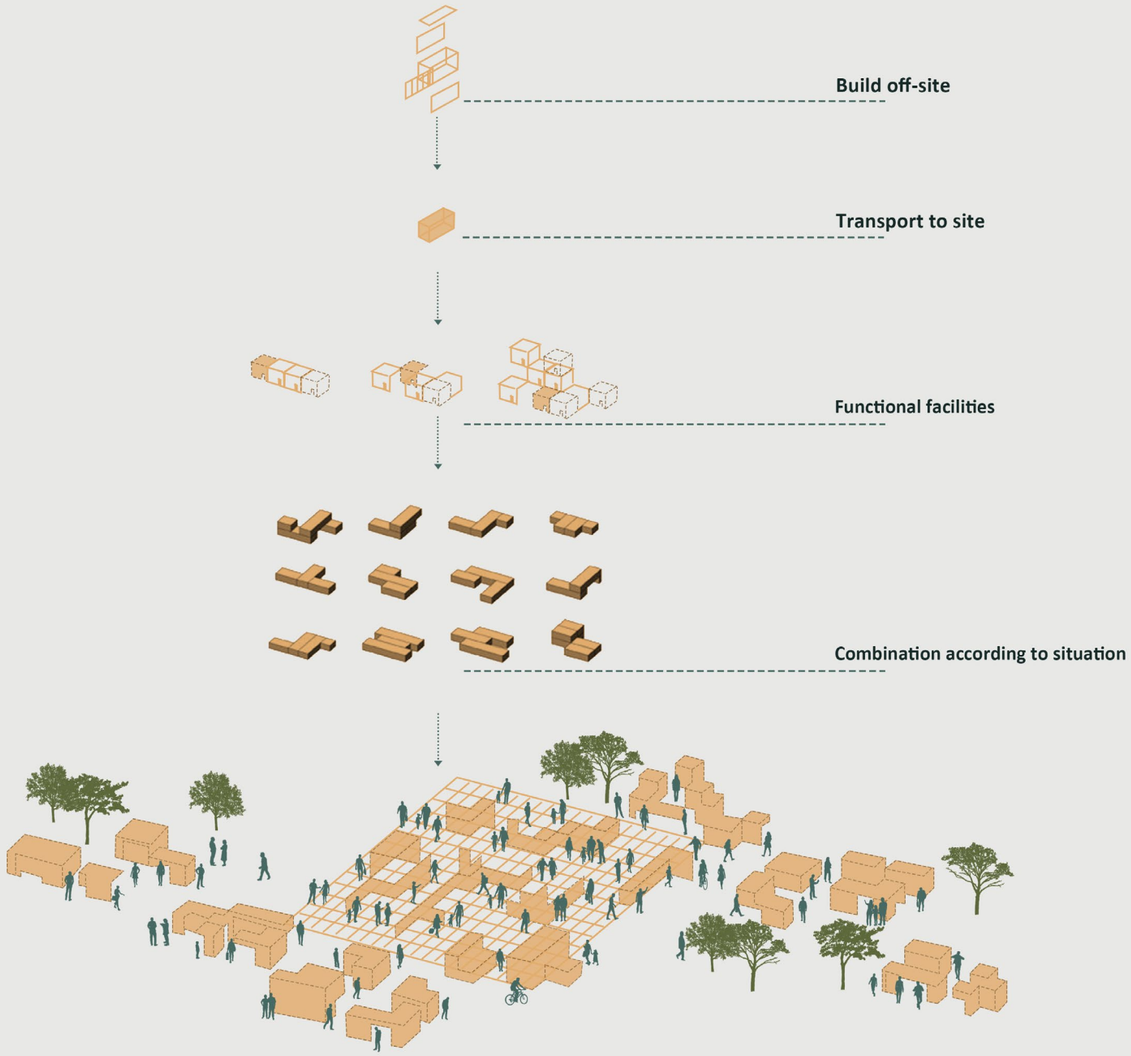


Figure 25. Diagram foreseeing the functioning of prefabrication and modularisation in the GCSC.

1.6 AMOEBA AS A STRATEGY FOR ARCHITECTURE

This project draws on the properties of the single-celled microorganism[25] amoeba, a cell known for its simplicity but high flexibility and adaptability. Amoeba can change the shape as needed and does not have a fixed morphology, has a flexible cell membrane that can change shape by way of cytoplasmic flow (Fig.26).This property allows it to extend pseudopods, move, capturing prey by surrounding and forming food vesicles. (Fig.27)[26]

This research explores the architectural potential of amoeba as a strategy to enhance and deepen the integration of pre-fabricated modular components into the existing of the GCSC campus. In this study we can consider amoeba as a rapid extension and change, brought into this project nucleus of the existing building, the membrane considered as the scope of the building, and food as the new modulars, in this concept the building can be quickly added to the existing building according to different situations and needs, or removed when it is not needed, like metabolism,(Fig.28) thus compensating for the long construction times of traditional buildings.

The concept of amoeba also emphasises wholeness.(Fig.29) Through the presence of a modular building, the entire site can form a unified and integrated concept. One of the challenges in this research design is to test whether the modular components can be better integrated with the existing site, form a whole building structure to ensure the unity and coordination.

25 Single-celled microorganisms are microbial organisms that consist of a single cell.
26 “Amoeba Eats Paramecia (Amoeba’s Lunch) [Amoeba Endocytosis / Phagocytosis Part 1].” YouTube.

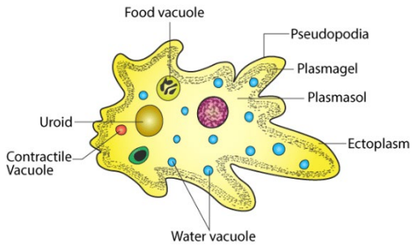


Figure 26. Amoeba icons to analyse composition and form.

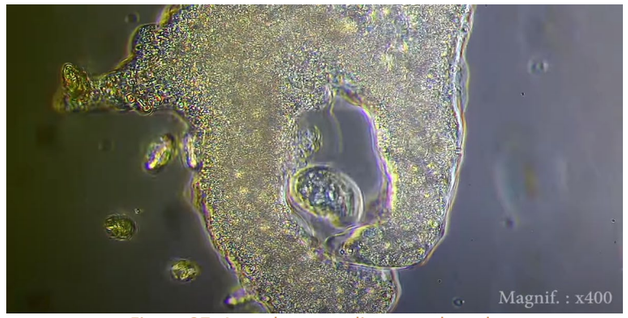


Figure 27. Amoeba extending pseudopods to enclose food for engulfment.

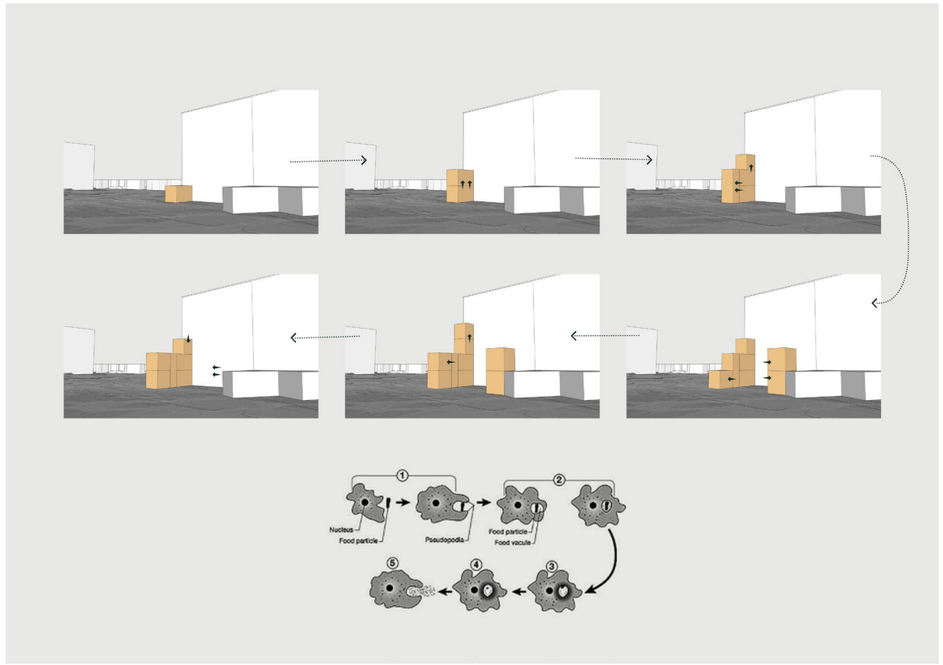


Figure 28. Strategic conceptual amoeba's biological, allowing the site to adapt flexibly.

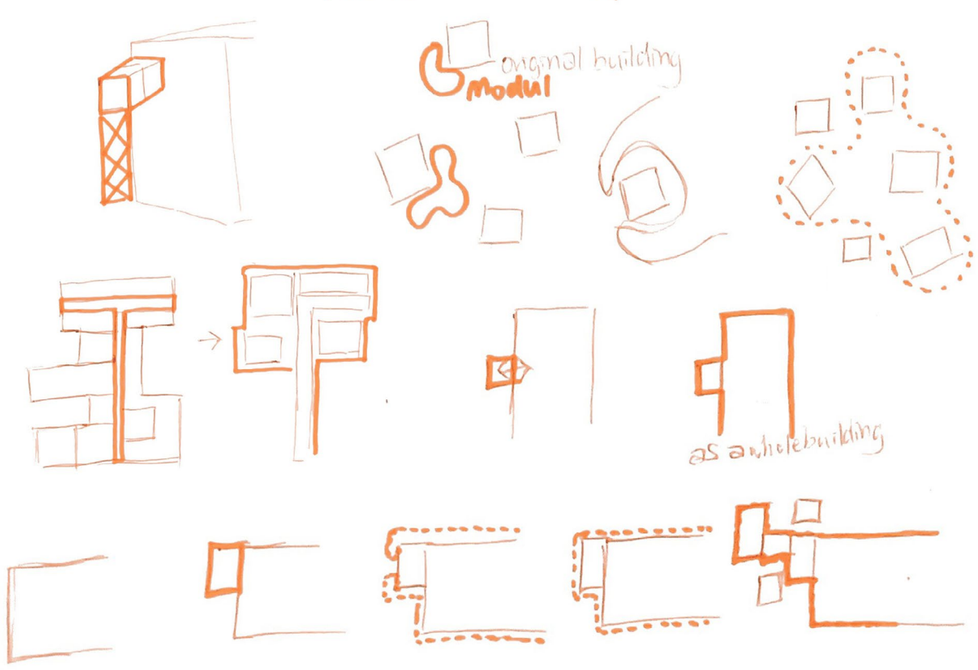


Figure 29. Analysing and researching the design of the amoeba forms strategy on plan.

The combination of prefabrication and modularity with biological processes (amoeba) further provides opportunities to introduce biophilic properties to the strategy. Biophilia refers to the deep emotional connection, the term was first coined in 1984 by Edward O. Wilson, who described the concept in his book 'Biophilia.'[27] This includes the emotional connection of humans to the natural world linked to biodiversity. Including emotional feelings about plants, animals, landscapes, natural scenery and ecosystems, a connection and closeness to the natural world is thought to have a positive impact on human mental health and well-being.

In the field of architecture, the biophilic design concept aims to improve comfort, reduce stress and contribute to a sense of well-being by combining natural elements and experiences into the built environment. However, the site visit for this research found that because of the closed space of the healthcare facility, even the waiting areas and the cafe (Fig.30-31), which are places provided for people to rest, are depressingly banal and crowded.

The use of this stratefy is not only to increase the utilisation of space, but also to try and explore what forms of modularity can be added to healthcare facilities, finding a balance of comfortable environments within the constraints of space.

There are many aspects to biophilia, and in this porject will be consider the natural light, connection to landscape, openings and thresholds to influence emotional well-being. Use elemens of greenery, vertical green walls and rooftop gardens to help improve air quality, reduce the concentration of hazardous substances in the environment and provide occupants with the opportunity to engage with the natural environment.

27 Wilson, Edward O. Biophilia. Cambridge, MA: Harvard University Press, 1984.

The use of natural lighting and textures, such as shadow cast patterns, can create a natural atmosphere in an indoor environment. Consideration of visual connections to the outdoors through the interior of a building, such as through windows or an open plan design, can make it easier for people to interact with the natural environment.

Creating an environment that goes beyond the physical health of the healthcare site from an architectural perspective will provide a comprehensive healing experience for the patients. Further improving their overall healing effect. These practical operations will be explored in the design. (Part 4&5 design explorations and design strategy).



Figure 30. GCSC Building 7 Café, set up in a corridor, crowded and dark, not a comfortable resting environment for either patients or healthcare workers.

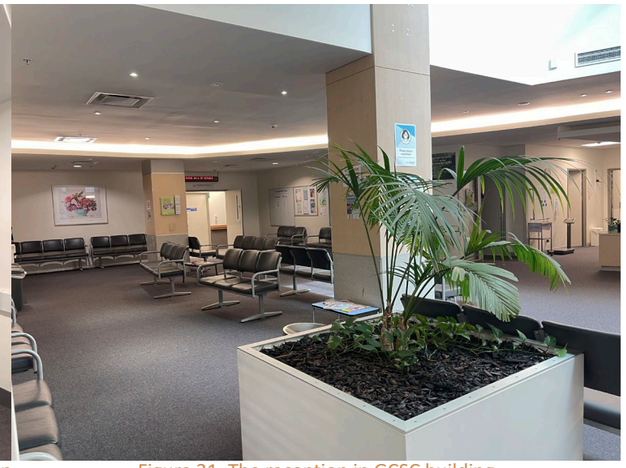


Figure 31. The reception in GCSC building 4, with waits sometimes exceeding 4 hours, not a comfortable enough waiting area for patients and their families.

PART 2: METHODOLOGY

This research project aims to explore the Amoeba Strategy, as an innovative architectural theoretical strategy, by using modular construction. This architectural strategy aims to create innovative directions in GCSC for future healthcare, striking a balance between the quick construction of adaptable spaces and the improvement of comfort in the built environment.

This project focuses on qualitative research, on the design and exploration, and uses design methods to accomplish the research and design process. This will be done firstly through Site Analysis (chapter1.3) in order to understand and identify the actual timescales of the healthcare building constructions, the analysis will be supported by the eras map (chapter 1.2) to identify gaps and holes in the history of the GCSC in order to support the need for a 'fast' building; and subsequently through a precedent study (part3) to examine the modular and prefabrication capabilities and limitations, to ensure the adaptation of modules to the Amoeba Strategy; By grasping the time scales and strategies, envision how these ideas can be practically applied to the GCSC using diagrams and modelling. This process includes understanding the connections between space, function, buildings and environment, (chapter 5.2) while visualising modular installations and structural testing (chapter 5.3).

2.1 ERAS MAP

Eras map is a research method that helps to understand how things have changed over time from a historical perspective, helps to analyze the key features of each period, the differences between eras, and shows a bigger picture of the context and identifying direction of development opportunities.[28](Fig.32)

In this research project, the concept of time is closely related to the constractions of GCSC. Therefore, the eras map (Fig.14) is used to examine the development of the building in the past, including its establishment and demolition. The construction and disappearance of each building is closely linked to the historical events and social context behind it (see Chapter 1.1-1.2). By making the eras map(Fig.15), we were able to see more clearly the large number of changes in construction is conjunction with the medical modifications. This will provide a deeper understanding to support the decision making and design process in this research project.

28 Kumar, Vijay. 101 design methods: A structured approach for driving innovation in your organization. Hoboken (NJ): J. Wiley, 2013.

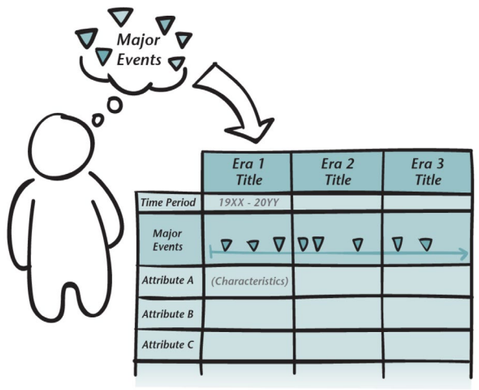


Figure 32. Eras map sample, the eras map in this project does not exactly follow the style of the sample, but the form is the same.

2.2 PRECEDENT STUDY

Precedent studies are a method to understanding pre-fabrication and modular decisions, capacities and limitations of the past design. Through in-depth analysis and research of case studies, the desirability of different design projects can be evaluated in detail.

In this research project, precedent study and research is covered in part 3, including the following cases:

- 3.1 Peter Cook, Plug-in City, Archigram : Research and understand the a modular innovative design and the need for functionality to match site conventions and needs.
- 3.2 Cedric Price & Joan Littlewood, Fun Palace : Understand the value of design strategies across eras, as well as the real-world challenges and limitations that are likely to be faced.
- 3.3 Kisho Kurokawa, Nakagin Capsule Tower: Understand the application and challenges of modular design practices and building life cycles, according to changing societal needs and environmental conditions.
- 3.4 Makers Fabrication, Warrander Studio: Studying the characteristics of local prefabricated building also explore challenge and experience of working with suppliers and builders.

The precedent study and research provides resources to inspire, reference and inform the design process, while helping to avoid repetitive mistakes, facilitating innovation and improvement.

2.3 DIAGRAMMING

Diagrams are tools that use graphics and symbols to represent and illustrate concepts, relationships and processes. They can be used to visualise data, relational models, flowcharts etc. Diagrams attempt to analyse the different stages of exploration and research, from concepts to strategic design and operational processes. This will also include using design thinking and spatial analysis to gain a deeper understanding of needs and problem solve solutions.

The diagrams allow the translation of complex concepts and data into an easily understood and communicated form for the function, layout, dimensioning and analysis of architectural spaces. Supporting the findings compelling, intuitive, and easy to assess by this method.

2.4 MODELLING

Producing a physical or digital modelling is a method of visualising and testing a design concept to assess its functionality, feasibility and user experience. modelling involves the production of preliminary versions or samples to test and demonstrate a concept or product.

In this project, modelling is used to explore the modular form, structure and installation. modelling takes the form of both physical modelling and digital modelling. The physical modelling is mainly used to test modular connections and details, while the larger scale will be completed by digital modelling. This method summarises solutions in a intuitive way and to validate the capability of the strategy through a process of reflection and experimentation. Modelling aims to help this research project gain a practical, accessible experience in the design process, leading to a better understand and evaluation of the strengths and weaknesses of the strategy, also to providing opportunities for feedback and improvement.

In the following chapters, these design methods will use to apply the Amoeba Strategy to GCSC, providing valuable lessons for future healthcare building projects.

PART 3: PRECEDENTS

3.1 Case Study 1
Peter Cook, Plug-in City, Archigram,1964

Plug-in City is a conceptual urbanism design proposed by Peter Cook of Archigram.[29] Although the project was never built, the ideas and concepts generated extensive discussion, bringing together architecture, technology and society. Plug-in City can be thought of as a fantasy city containing modular housing units that can be connected like plug-ins to a giant machine of central infrastructure.(Fig.33) In fact, the Plug-in City is not a city in the traditional sense, but a huge structure for continuous development.[30] Housing, transport, other essential facilities are built in, allows to moved and adapted by means of huge lifting machines.[31](Fig.34)

This design concept of overlaying and reconfiguring provides the city with ultimate adaptability and sustainability. As the size and needs of the population change, this giant structure can then be expanded.(Fig.35) It offers a new way of thinking that integrates the concepts of architecture and the city to create sustainable and highly flexible urban models. Although not realised, this design concept still inspires thought and exploration of urban development and architectural innovation.(Fig.36)

"We'd use the construction industry to do to the construction, but the planning would be done by the occupants of the house"[32] Crompton.[33]

The Archigram team also designed the interior with a fixed life span for the required service units, for example 3-6 years for shopping locations, 5-8 years for living rooms and bedrooms, 20 years for car barns and roads, etc.[34] This design concept allows the resident to grow and change with the house, increasing user's satisfaction.

The moving unit approach in this study abandons the common understanding of architecture as a timeless object. This has been proven through time, at least in local examples the GCSC, where lots of buildings have been gradually updated and replaced throughout time. Although Plug-in City is more of a 'Utopian', the concept of the Plug-in has been used in later modular buildings such as the Nakagin Capsule Tower (see Chapter 3.3). Plug-in City therefore also has an active contribution to this research project in terms of thinking. This extended modular approach not only allows for the construction of tall buildings on flat ground, but can also be grafted onto existing buildings. By using this technique, it is possible to effectively contribute to the continuous expansion or renovation of large facilities.

Plug-in City includes durability, sustainability, modularity, flexibility, technology and innovation, these elements are important insights into the Amoeba Strategy, despite modulars are flexibility and adaptability, the application of modularity to healthcare buildings requires thoughtful consideration of the key to functional positioning to match the habits and needs of the community, this will interfere with the visitor's approach, matching the existing building's corridors, entrances.

29 In 1961, Peter Cook, David Greene and Mike Webb founded an independent magazine in London, "Archigram", a term formed by merging ARCHItecture and teleGRAM.
30 "The Archigram Portfolio Collection." portfolio. Accessed July 3, 2023. http://www.archigram.net/portfolio.html.
31 Peter Cook. plug-in city: Maximum pressure area, project ...- moma. Accessed July 3, 2023. https://www.moma.org/collection/works/797.
32 Benedict Hobson |12 May 2020 Leave a comment. "Archigram's Plug-in City Shows That 'Pre-Fabrication Doesn't Have to Be Boring' Says Peter Cook." Dezeen, May 12, 2020. https://www.dezeen.com/2020/05/12/archigram-plug-in-city-peter-cook-dennis-crompton-video-interview-vdf/.
33 One of the Archigram members.
34 Peter Cook. "5 Plug-In." Archigram. Basel [Switzerland: Birkhauser Verlag, 1991, p.39.

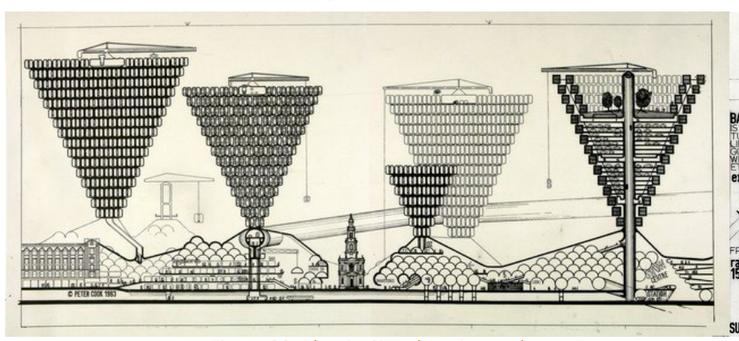


Figure 33. Plug-in City elevation and section showing effects of design.

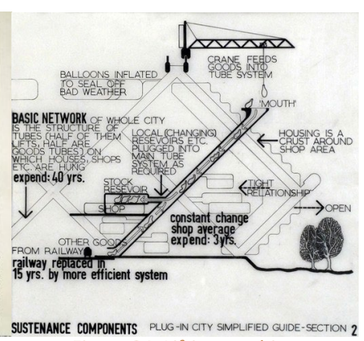


Figure 34. Lifting machine movement diagram of Plug-in City.

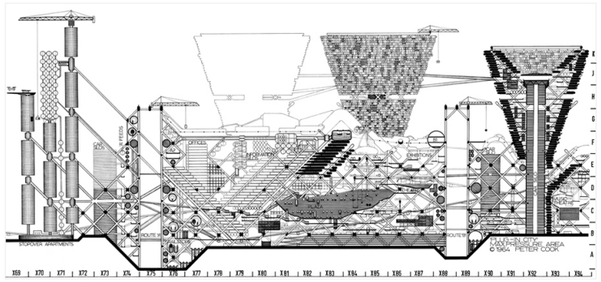


Figure 35. Giant structures with long sections of the Plug-in city.

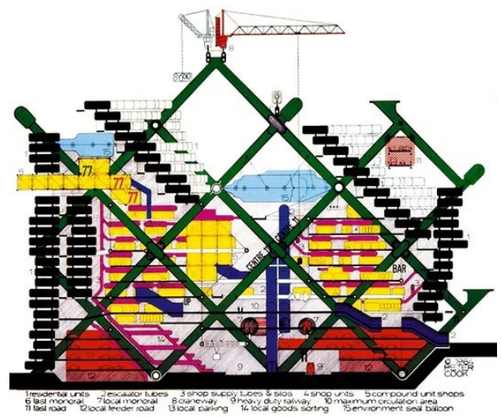


Figure 36. Typical of plug-in cities, this design allows the structure to grow and change along with the residents.

3.2 Case Study 2
Cedric Price & Joan Littlewood, Fun Palace, Lea River, London, England, Around 1965-1975

Fun Palace is a proposed prefabricated structure that can be dismantled and reconfigured to adapt the surroundings, based on the concept of a 'University of the Street'. Cedric Price (architect) and Joan Littlewood (famous director and screenwriter) collaborated on this project.[35]

In Fun Palace, a new form of theatre is proposed and aims to awaken a new consciousness in public culture. Within this framework, Cedric Price develops and refines the concept of interactive and performative architecture. In the Fun Palace, people can explore and develop their creativity and participation.[36] Although the Fun Palace was never built, it had a profound impact, and some of its ideas and shadows can be found in the Centre Pompidou, built in 1976.[37](Fig.37)

Fun Palace is encourages people to use the public spaces of the community to share, exchange and learn, inspiring self-exploration and solidarity.(Fig.38) Design work on Fun Palace was nearing completion in 1965 when Cedric Price and Joan Littlewood found the actual site for its construction on the Lea River in London. But due to changes in the London planning area and disputes between the various governing bodies, the project was eventually postponed indefinitely and announced as terminated in 1975. (Fig.39)

35 Price, Cedric, and Joan Littlewood. “The Fun Palace: The Drama Review.” Cambridge Core, September 12, 2022. https://doi.org/10.2307/1144360.
36 Schechter, Joel. “A Laboratory of Fun.” Essay. In Popular Theatre: A Sourcebook. London: Routledge, 2003.
37 “Our Building.” Centre Pompidou. Accessed August 23, 2023. https://www.centrepompidou.fr/en/collection/our-building.



Figure 37. Pompidou Centre, can see some of the ideas inspired by Fun Palace.

This precedent is a innovative and forward-thinking project that insight the Amoeba Strategy, that seeks to break the limits of traditional architecture and inspire engagement, but also faces to the real-world challenges and constraints. In the design of strategy, the key is not only the embodiment of a different aesthetic, but significantly the possibility of practising and reflecting on strategies, and the insights that can be gained from it in terms of its adaptability to the eras.

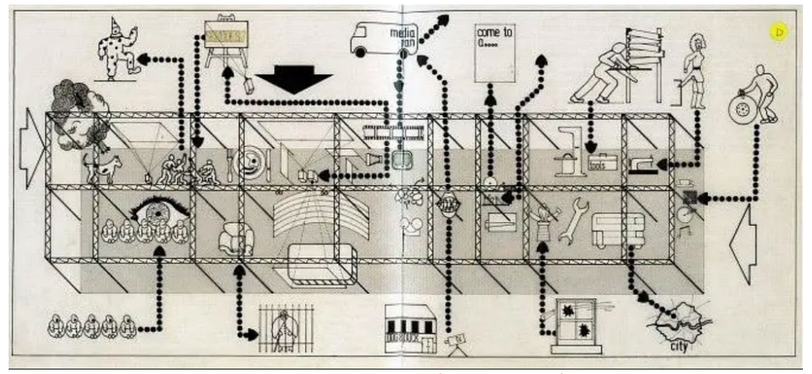


Figure 38. Envisioning the events taking place in Fun Palace.



Figure 39. The closest imaginable view of the Fun Palace as it was built.

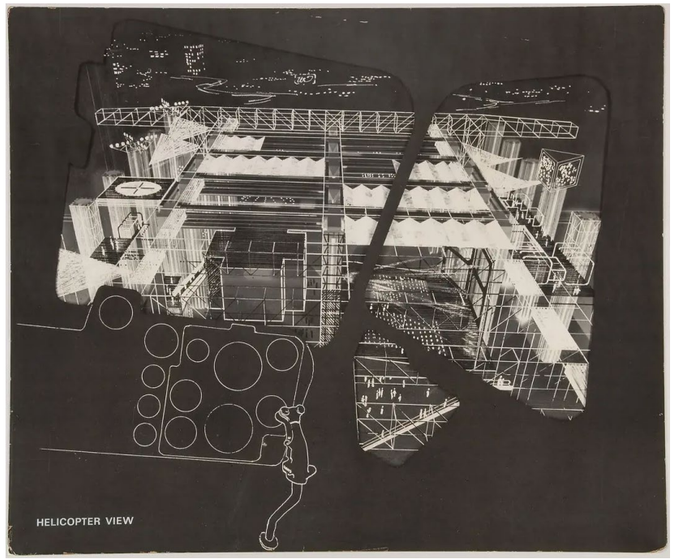


Figure 40. An air view of the Fun Palace shows that the architecture has been kept simple, with the design focusing on the concept and functions.

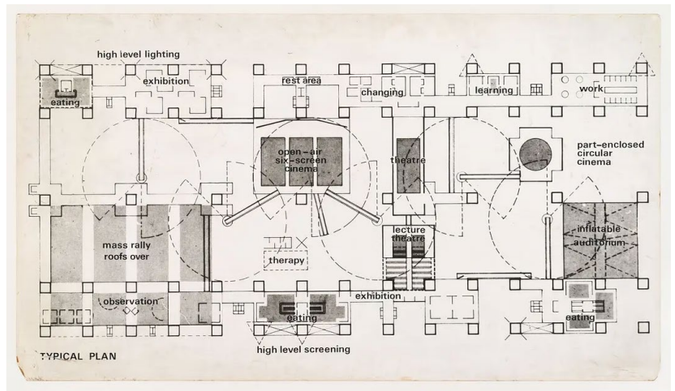


Figure 41. Building elements such as stairs and decks that change according to the needs.

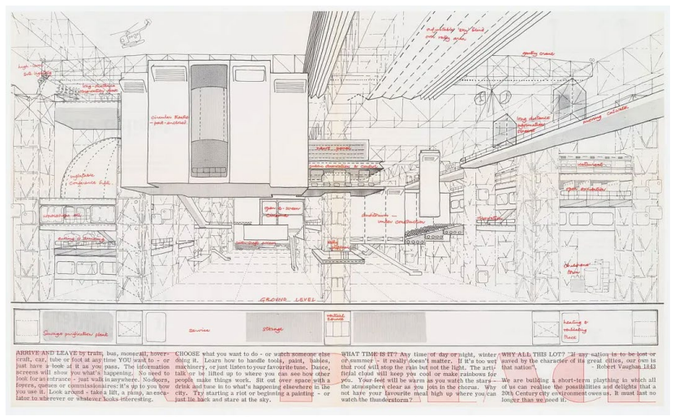


Figure 42. Interior rendering of Fun Palace, a better visualisation to explore.

3.3 Case Study 3
Kisho Kurokawa, Nakagin Capsule Tower, Ginza, Tokyo, Japan, 1972-demolished 2021

Kisho Kurokawa was one of the first architects of the post-World War II revival in Japan and a leading figure in Japanese 'Metabolism' movement.[38] Integrating small residential units into one large building block, Nakagin Capsule Tower is a modular building that provides accommodation for those who need to work in the busy business district during the working week but would return home on weekends. The building, made up of 140 capsules stacked around a central core and unique spiral staircase, was a total of 14 storeys high. Each capsule module, fixed to the concrete central core structure by four high tension screws,[39] measured 4 x 2.5 metres.(Fig.43)

All components were made in a factory in Shiga, Japan, and transported to the site by truck, then the capsules were installed by crane and fixed to the concrete core shaft.(Fig.44)
However, the building has been put to the test over time, and problems such as water leaks and broken pipes, makes the building has gradually become

38 The 'Metabolism' was introduced in 1960 and emphasises adaptable, growing, interchangeable architectural design.
39 “Nakagin Capsule Tower.” Kisho Kurokawa. Accessed July 3, 2023. https://www.kisho.co.jp/page/209.html.



Figure 43. Nakagin Capsule Tower located in Shimbashi.

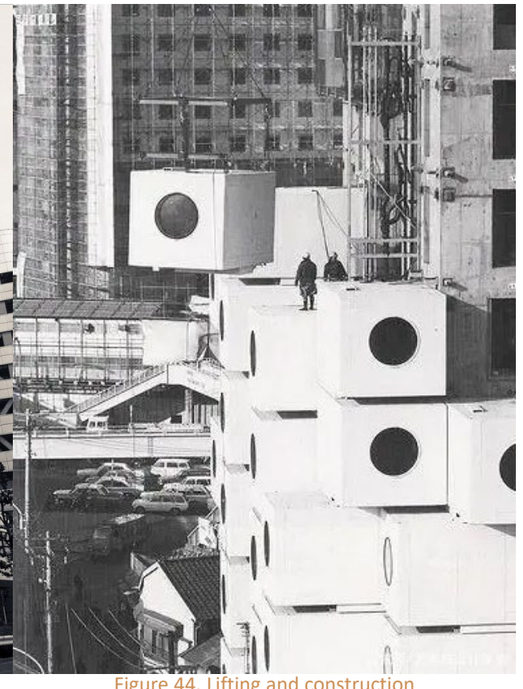


Figure 44. Lifting and construction of capsule towers, 1970.

structurally unstable and does not meet current seismic standards. As a result, this building faced demolition. Although the tower was originally designed with interchangeability, with all features and fittings being manufactured and pre-assembled in the factory and the building itself being able to undergo 'Metabolism'[40] this feature has unfortunately not been utilised to date.

This project is historically important and experimental in real-world, inspiring further ideas and practices of what modular architecture can be, it demonstrates the potential and possibilities of modulars, while reminding us of the importance of considering maintenance and adapting to future changes in the design and construction process.

40 damaged capsule modules can be replacing with new components

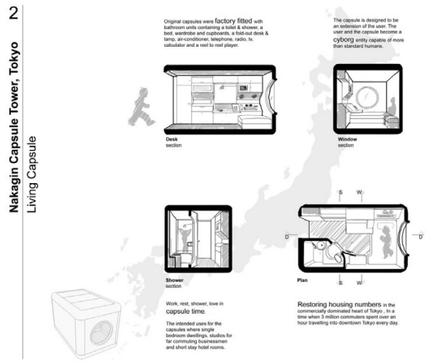


Figure 45. Detail drawing of interiors.

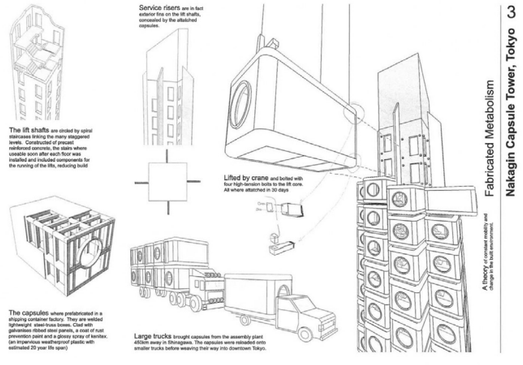


Figure 46. Detail drawing of transportation and installation.

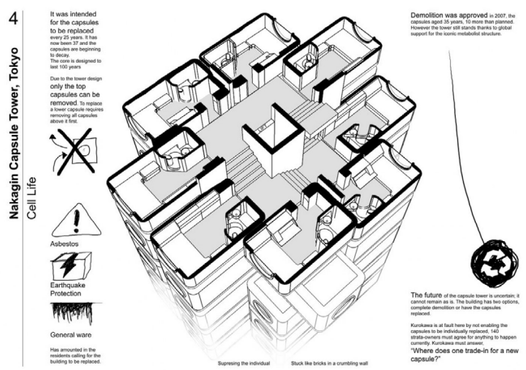


Figure 47. Detail drawing of corridor and connections.

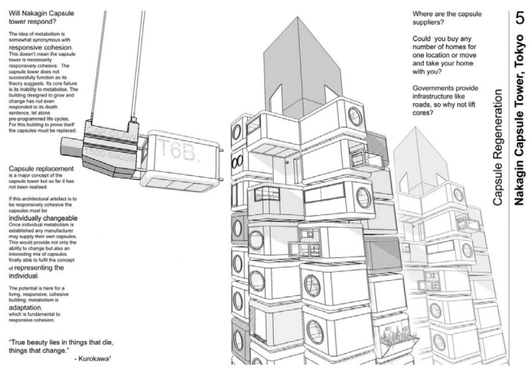


Figure 48. Detail drawing of regeneration.

While demolished in 2021, due to the specific of modularity, some of the capsule units were shipped to new locations for reinstallation, while other restored modules were sent to museums around the world for exhibition. This reflects the sustainability of modular architecture and its potential adaptability in the face of urban development and constraction changes.

The design of the Nakagin Capsule Tower places emphasis on the concepts of sustainability and recyclability to provides sustainable solutions. However, in practice this has not really been fully utilised. This is an essential issue that pre-fabricated buildings and modularity need to face, even the designers have set aside space for replacement and renewal, the actual use may not exactly match the expectations. As another example, 'The Cloud'[41] in Auckland was erected as a temporary structure in 2011 but still exists today, and the 'Cardboard Cathedral' in Christchurch[42], by Shigeru Ban began as a temporary cathedral but eventually became a permanent structure.

In summary, the construction and decommissioning of the Nakagin Capsule Tower demonstrates a complete life cycle of a modular building. This precedent study provides an insight into the future direction of modularity, the life of modulars much depends on the design, including the choice of building materials, space efficiency and recycling possibilities to meet changing social needs and environmental conditions.

41 "The Cloud." Aucklandnz.com. Accessed July 6, 2023. https://acb.aucklandnz.com/meet/plan-your-event/venue/queens-wharf-the-cloud#:~:text=The%20Cloud%20was%20erected%20as,of%20Aucklanders%20and%20visitors%20alike.

42 Dennis, Anthony. "Budget Shortfall for Christchurch's Tubular Cardboard Cathedral." The Sydney Morning Herald, February 8, 2013. http://www.smh.com.au/travel/travel-news/budget-shortfall-for-christchurchs-tubular-cardboard-cathedral-20130208-2e3o5.html.

3.4 Case Study 4
Makers Fabrication, Warrander Studio, Governors Bay, Canterbury, New Zealand, 2011

Warrander Studio(Fig.49-50) is a prefabricated studio designed by Makers of Architecture as a transitional home for a client whose house was damaged by the 2011 in Canterbury, New Zealand earthquake. The building is the first complete Cross Laminated Timber (CLT) residence in New Zealand, designed and fabricated using Building Information Modeling (BIM) and Numerical Control Cutter (CNC) precision fabrication techniques.[43]

This project is a structure consisting of prefabricated wood panels that were fabricated off site and assembled on site. The construction of the project was completed in total of two months, and the structure was assembled in three days. The accuracy of the system allowed for accurate costing and pricing, and reduced material waste through digital optimization.[44] Due to the limited material storage space at this project site, and the fact that access to the site was limited by a long driveway.[45] Creating a transportation challenge, to overcome the access aspect, this project used a large overhead truck to unload the building components at the end of the driveway and in sequence, each panel was lifted behind a smaller hiab, transported to the site, and then installed.(Fig.51-52)

43 Foote, Justin. “Building in the Digital Age.” Architecture Now. Accessed April 20, 2023. https://architecturenow.co.nz/articles/building-in-the-digital-age/.
44 “Warrander Studio.” Makers of Architecture, May 24, 2021. https://www.makersofarchitecture.co.nz/project/warrander-studio.
45 “Warrander Studio: How to Prefab.” OffsiteNZ. Accessed April 20, 2023. https://www.offsitenz.com/how-to-prefab?pgid=kug7grg1-6a8bcd54-c356-4af3-b4f4-84ca4abceb80.



Figure 49. Warrander Studio, night.



Figure 50. Warrander Studio, day.

An important inspiration for this project was to provide a practical perspective on the operation of prefabrication locally in New Zealand as well as the technical implementation, i.e. the experimentation and innovation of digital fabrication. This process allows for a very high level of accuracy for the building element, ensuring ease of assembly on site.

This project demonstrates the benefits of speed of construction, customization and sustainability. However, the research in this project also provides a glimpse into potential drawbacks such as size limitations and uncontrollability associated with customization and transportation. Currently presets are more focused on housing locally in New Zealand, this project research will explore whether prefabricated can achieve a place in popular usage trends in large institutions such as hospitals.

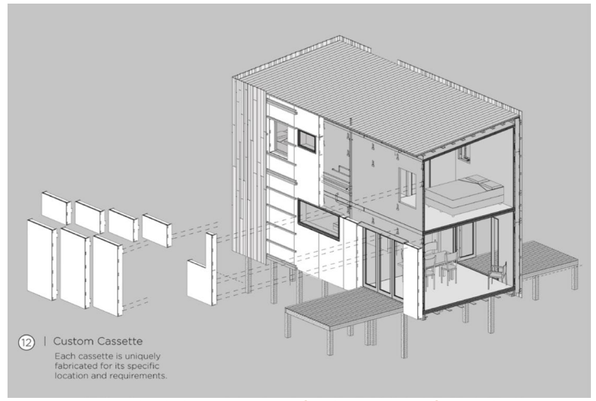


Figure 51. Detail drawing of extension prefabrication.

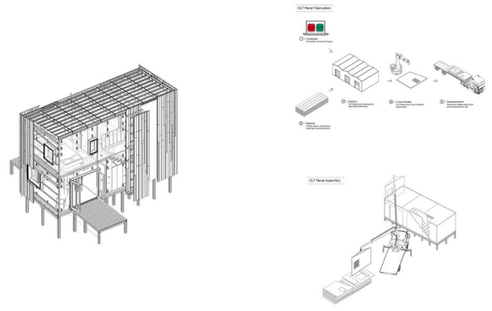


Figure 52. Detail drawing of cassette assembly.

PART 4: DESIGN EXPLORATIONS

The aim of this research project is to propose a design strategy that would enable rapid change in the GCSC and compatible with the needs of the healthcare services and biophilia, to find a balance between the physical as well as the mental in the healthcare environment.

Given that the main purpose of this design is to propose a strategy, it will not be a complete planning of every detail and function, but focusing on the current challenges and needs to be faced, set a generalised direction for the future development. This chapter will focus on the exploration of a prefabricated modular Amoeba Strategy for GCSC using the design methods. The explorations will consider the retrofitting of the existing building structure and the three different services that can be provided on GCSC in the current period.

4.1 AMOEBA STRATEGY

Rather than developing a 10 year masterplan, which would become out of date, the ‘Amoeba Strategy’, provides built infrastructure that can rapidly change in size and shape, responding to the emergent needs of the GCSC site delivery.(Fig.53)

The 'Amoeba Strategy' is a strategy of rapid installation using modular blocks that are built off-site and moved inside as required, and then combined in different blocks and layouts, contributing to replacement(metabolism). This strategy is highly adaptable and aims to reserve additional space for the future development of the clinic’s services and growth in demand.

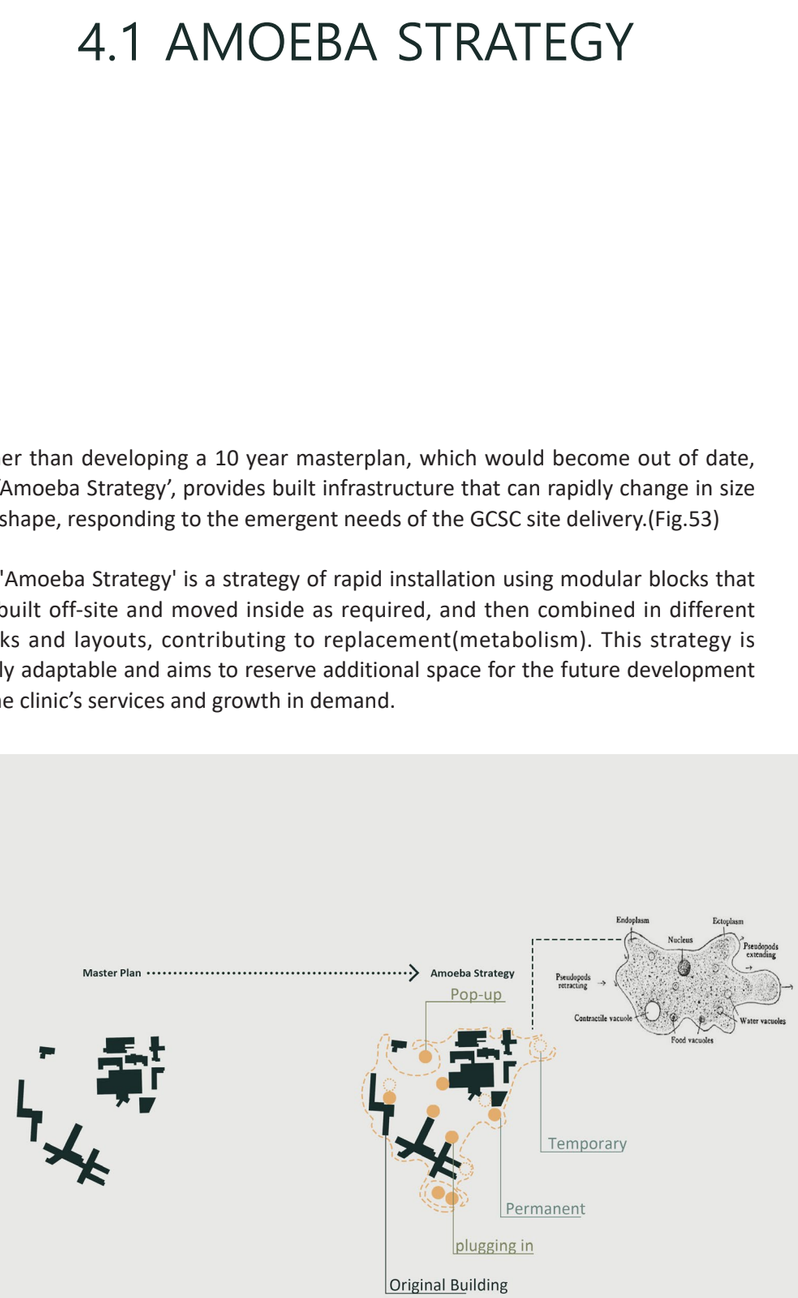


Figure 53. Masterplan to Amoeba Strategic Plan Map, including ideas of temporary, permanent, plg-in, pop-up designs.

4.2 HEALING BUILDING/ STRUCTURAL RETROFITTING

After site visit and historical research of GCSC, the era map(Fig.14) helped to explore and find many of the buildings were constructed more than 50 years ago, however, the site structure life cycle is about 50 years (including foundations and load-bearing members, which are basically the same life span as the building).[46] While we can see that the current GCSC buildings are constantly being remodelled and restored to ensure safety and accessibility (Fig.54), the on-site construction has cause site safety issues and addition to noise, dust, traffic, and long time construction. Therefore, in addition to the proposed planning changes in this design strategy, the modular can be utilised to improve the overall performance, and resilience of the existing building by installing reinforced and upgraded modular construction. It is similar to adding 'Membran'[47] to extend the life of the building and connect the new modular with the existing building as a whole, to achieve the effect of 'healing building'.(Fig.55)

46 Smith, Ryan E. “Chapter 8 Sustainability.” Essay. In Prefab Architecture: A Guide to Modular Design and Construction. Hoboken, NJ: John Wiley & Sons, 2011.

47 The membrane of the Amoeba, which wraps around the entire creature, serves to support the interior to form a whole.



Figure 54. GCSC buildings being remodelled and restored.

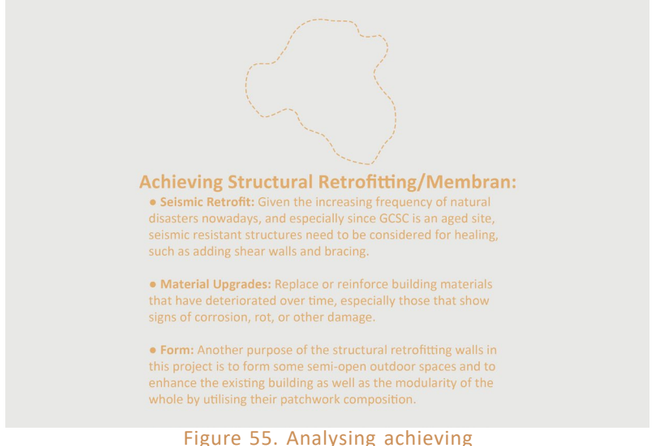


Figure 55. Analysing achieving structural retrofitting/membran.



Figure 56. Physical models provide insights into the structure and shapes.

This research project focuses on proposing strategy level of design, to realise structural retrofitting in addition to requires cooperation between engineers, contractors and other related professionals is crucial.

In the design of Structural Retrofitting, both physical and digital modelling simulate and test ideas. Physical models gain some valuable insight into the structural and shape aspects.(Fig.56) In the digital modelling phase, digital modelling helps to simplify the complexity and focuses on preserving the support structure to better harmonise work with the modular block.(Fig.57) Together, these two approaches helped to continuously refine the design and ensure its practical feasibility.

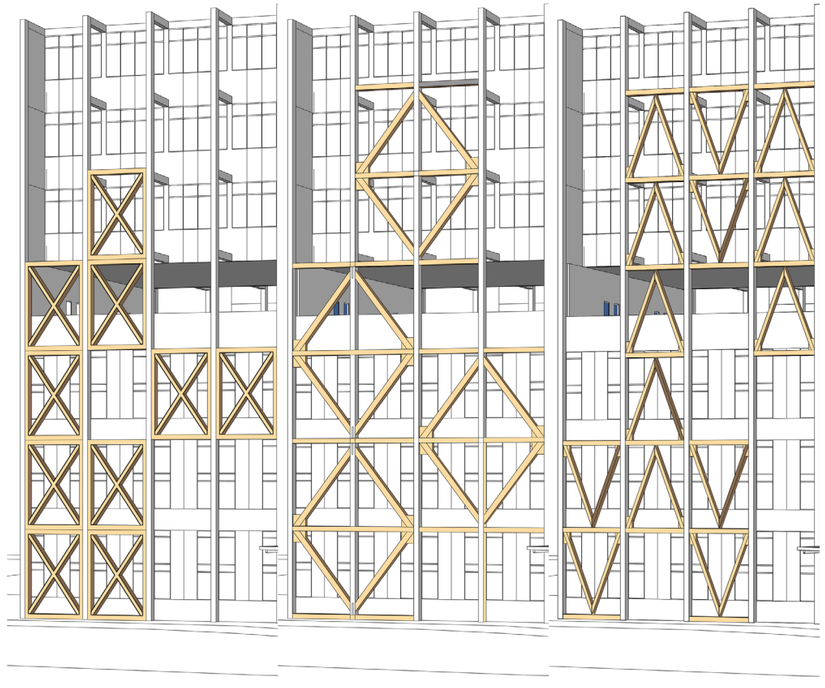


Figure 57. Digital modelling in conjunction with the size of the GCSC site, helps to anaysing and develop.

4.3 MODULAR SERVICES

The adoption of a modular technology requires consideration at every stage of the project life cycle. This chapter will explore the process the installing of modular elements/components and the factors that should be considered in assuming that this strategy is implemented at GCSC during the project delivery. The term 'installation' in this project includes all on-site and off-site assembly activities, so that the feasibility of the practice can be tested during the design process. Therefore, careful planning and execution of strategy, design, factory fabrication, transportation, installation and field assembly details are required, (Fig.58) which indirectly affects the design and therefore the installation is critical in modular design.

The process of installing modular elements/components begins with modular design and factory fabrication, utilising Building Information Modeling and Computer Numerical Control precision manufacturing techniques.

And the design to factory fabrication needs to be considered including, the volume unit of the building according to the transportation, as well as the unity and applicability of the building through a series of accessories such as additional fittings, balconies, roofs, floors, staircases, and elevators (Fig.59) With the fittings, the modular system can be varied as much as creativity allows.[48] (More design details will be given in chapter 5.1)

48 Wallance, David. “Chapter 6 The Intermodel Modulat System.” Essay. In The Future of Modular Architecture. New York: Routledge, 2021.

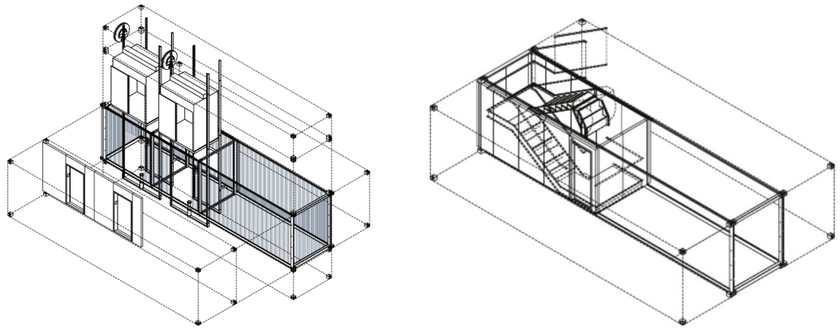


Figure 59. Additional fittings of lifts and stairs as a reference to help with kit development.

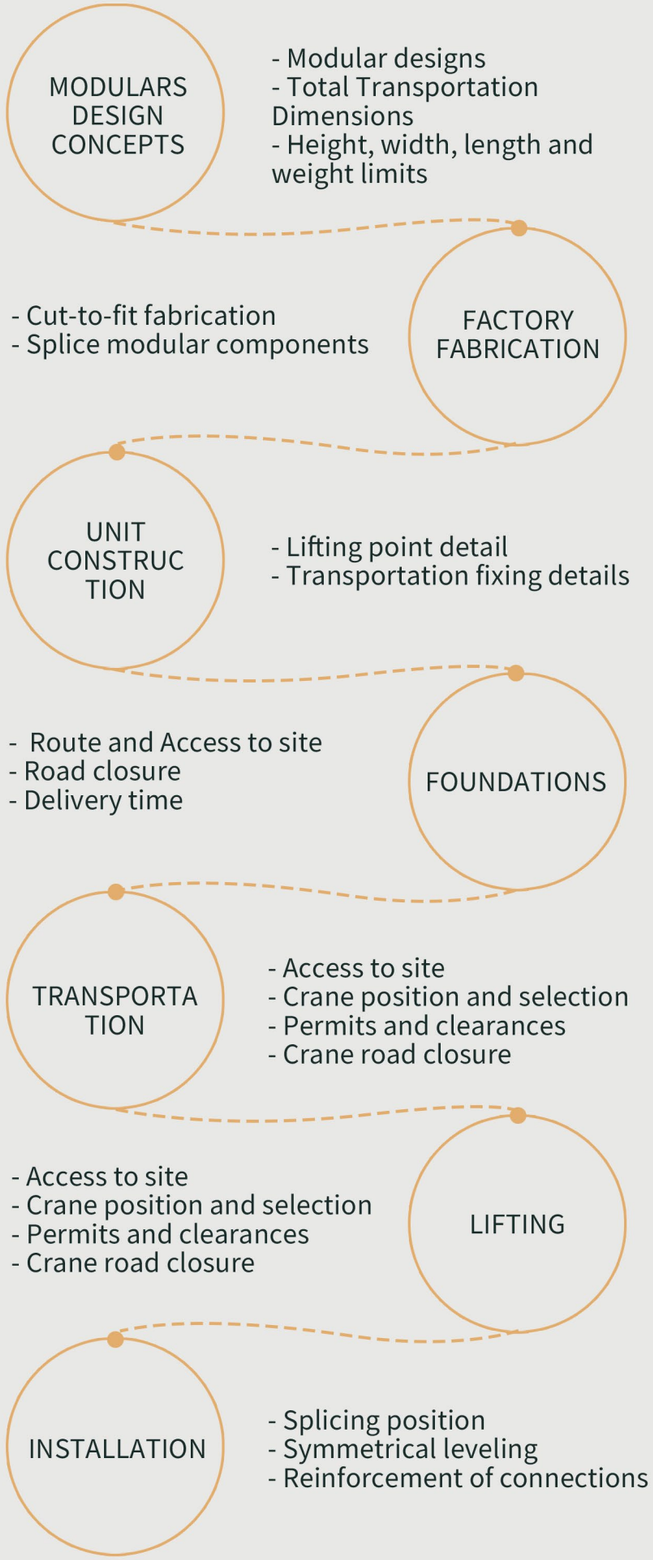


Figure 58. Research and analysis of installation and assembly processes for apply and refine the Aomeba trategy design.

Typically, the loads generated during transportation are the biggest damage of a modules' life cycle.[49] This requires careful identification of the loading and unloading points of modules to be transportation. Most of the time the mean transportation of modules are trucks, therefore All modularizations should follow the maximum transport data for NZTA trucks (vans): maximum height: 4.25 m, maximum width: 2.55 m, maximum length: 20.0 m.[50](Fig.60)

Whereas a reserved foundation needs to be poured prior to the entry of the elements, which is the only installation process for modular buildings that requires on-site.(Fig.61) They are intended to spread the load over the entire structure, thus alleviating the need for load-bearing on the perimeter walls of the modules[51] and create foundations on uneven ground.

49 Paraforos, D.S., C. Dodds, J. Romero, L. Malgaca, T. Gillespie, and D. Cao. "Dynamic Loading on a Prefabricated Modular Unit of a Building during Road Transportation." Journal of Building Engineering, March 28, 2018. https://www.sciencedirect.com/science/article/pii/S2352710218300196?via%3Dihub.

50 "Vehicle Dimensions and Mass." Waka Kotahi NZ Transport Agency. Accessed August 25, 2023. https://www.nzta.govt.nz/vehicles/vehicle-types/vehicle-classes-and-standards/vehicle-dimensions-and-mass/.

51 Smith, Ryan E. "Chapter 7 Assembly." Essay. In Prefab Architecture: A Guide to Modular Design and Construction. Hoboken, NJ: John Wiley & Sons, 2011.

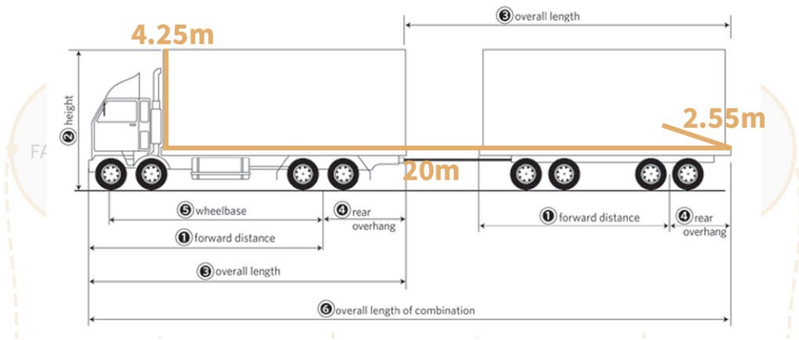


Figure 60. Transportable data diagram for sizing modular designs.

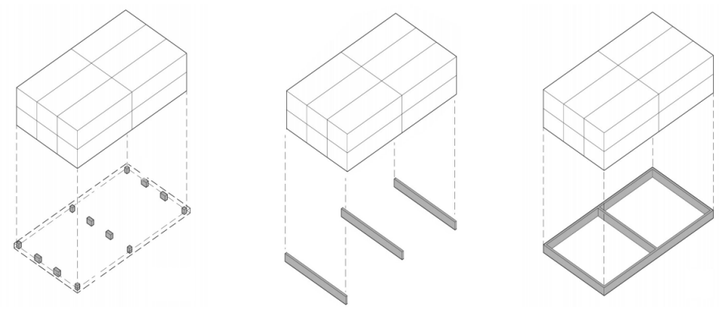


Figure 61. Three types of foundations, left: piers, Middle: linear stem wall, right: full stem wall.

Once the elements/components arrive on-site, they are ready for installation, including lifting, positioning, adjusting, connecting and stitching.(Fig.62-63)

Prefabricated and modular elements need to be designed to accommodate lifting points/pick points.[52] They are generally designed by engineers to match the weight distribution of the elements and are structurally sound enough to avoid breaking mid-span during lifting.[53] The backside of the wooden modules may be at risk of cracking during lifting, so a steel frame base or concrete structure is a better choice for this project.
The crane used in the lifting process is usually planned by the project contractor. In most cases, components will be lifted from trailer to planned location and then guided by workers to the position for attachment.(Fig.64)

Joints/connections are appearance and depends on the system used. In this design screws joints will be used, to achieve a dismantlable effect, which is conducive to recycling. The modular design will minimise the number of joints in the building system, thus reducing the points of failure in the building.

Overall, the module and integration of the installation provides an integrated approach across off-site and on-site processes. The findings emphasise the importance of precision fabrication, accessory versatility, and adaptability to a wide range of conditions, requiring design and reality to work in tandem with each other.

52 Smith, Ryan E. “Chapter 7 Assembly.” Essay. In Prefab Architecture: A Guide to Modular Design and Construction. Hoboken, NJ: John Wiley & Sons, 2011.
53 Smith, Ryan E. “Chapter 7 Assembly.” Essay. In Prefab Architecture: A Guide to Modular Design and Construction. Hoboken, NJ: John Wiley & Sons, 2011.



Figure 62. Sample of the process lifting the module by the crane through the belt.



Figure 63. Sample of how the installer defines the position of the module during lifting with the guide rope.



Figure 64. Sample of the installer adjusting placement of the module during the lifting process.

Looking ahead, modularization can be leveraged to further enhance healthcare infrastructure.(Fig.65) Initially, Chapter 5 of this exesiges will focus on refining the design of the reception, smoking zone, and mental health services based on GCSC's current status.

Future development services

2023

2033

2043

current strategy

non-clinical services

future medical institutions

Reception

Smoking area

Mental Health

Whanau Room (Family Space)

Office/Meeting Room

Cafe

Corridor

More services

Figure 65. Diagram analysing the future development of the Aomeba Strategy, which different functions can be added or removed at different period.

Module Study 1: Waiting for Health/Reception

Reception areas play an important role in hospitals to ensure the successful running of the hospital. Currently GCSC's main reception is located in the middle of the building in Building 4,(Fig.66) the interior of the building is protected from the sun and rain but its relatively confined and depressing, due to the Auckland's healthcare system results, the visitors are normally reckon to a long waits, making a comfortable 'waiting for health' environment is immediate in GCSC. Therefore, the analysis of diagram aided lists of requirements and considerations for a reception, making it easy to focus on the design process.(Fig.66)



Achieving Waiting for health/ Reception:

- **Guidance:** Receptionists provide information about the hospital, services, visiting hours and the location of departments within the hospital. Therefore the location needs to be built in such a way that it is easy to give directions.

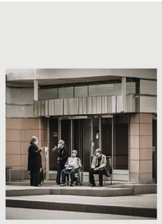
- **Comfort:** Sunlight, comfortable seating, and air circulation should be considered in the design.

Figure 66. Photograph of the waiting area in the diagram and analysis list and needs to achieveing waiting for healthcare/reception.

Module Study 2: Smoking Zone

Although Auckland is a city reduce of smoking, Ara Manawa revealed that there are still many visitors in GCSC smoke around the campus due to stress or habit. Thus, there should be smoking areas for the environmental impact and comfort of the campus.

This ensures that smokers smoke in a controlled space to protect the health of everyone in the facility. And this facility is intended to be a temporary facility that will be removed or converted to other services when smoking is banned in the future.(Fig.67)



Achieving Smoking Zone:

- **Air circulation:** Smoking areas should ensure that smoking areas are located away from main entrances, exits, windows and other non-smoking areas of the hospital to minimise the opportunity for smoke to enter the interior of the hospital.

- **Seating and Resting Facilities:** In a hospital environment, some smokers may be patients or family members who may require additional rest and reflection, so shading and protection from the elements need to be included in this feature.

- **Information and Signage:** Provide clear signage near smoking areas to indicate the location of smoking areas and to prevent smokers from smoking in non-smoking areas. Include health education materials near smoking areas to provide information about the dangers of smoking and to promote cessation resources and support.

Figure 67. The view of smokers in healthcare facilities in the diagram, list and needs of achiving smoking zone.

Module Study 3: Mental Health Services

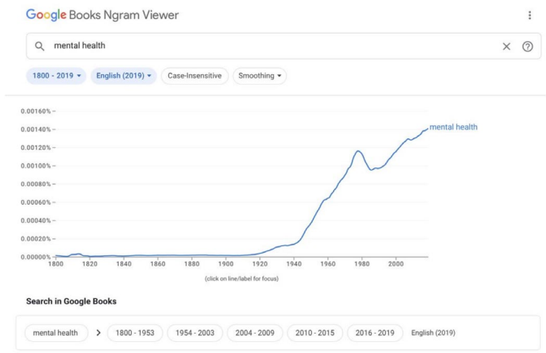


Figure 68. Mental health-related searches have risen sharply over the years.

According to Ara Manawa's staff description, GCSC provided mental health services for a period of time during covid-19, which was uniformly well received. However, the service was removed due to some force majeure factors, but with the increase in mental health issues such as anxiety, depression, mental illness, etc. Therefore more mental health services are needed to meet the demand. (Fig.68)

In a high-pressure, stressful environment such as a healthcare facility, where both staff and patients need more support, thus mental health issues can have a positive impact on physical health. (Fig.69)



Achieving Mental Health Services:

- **Privacy and Confidentiality:** treatment and counselling rooms should be soundproofed.
- **Multi-functional spaces:** Mental health services facilities may need multi-functional spaces for different types of therapy, such as individual counselling, family therapy, group therapy, etc.
- **Easy access:** The facility should be located in an easily accessible location for patients to come to.

Figure 69. View of the patient's stressful feelings shown in diagram, list and needs for the achiving of the modular mental health services.

By organising the Module Study's research in the form of a diagram (Fig.70), this project was able to advance design thinking and spatial analysis. In this process, the potential and needs of modular design is clearly identified,(Fig.71) by incorporating these needs to plan where and how the modularity would be assembled.

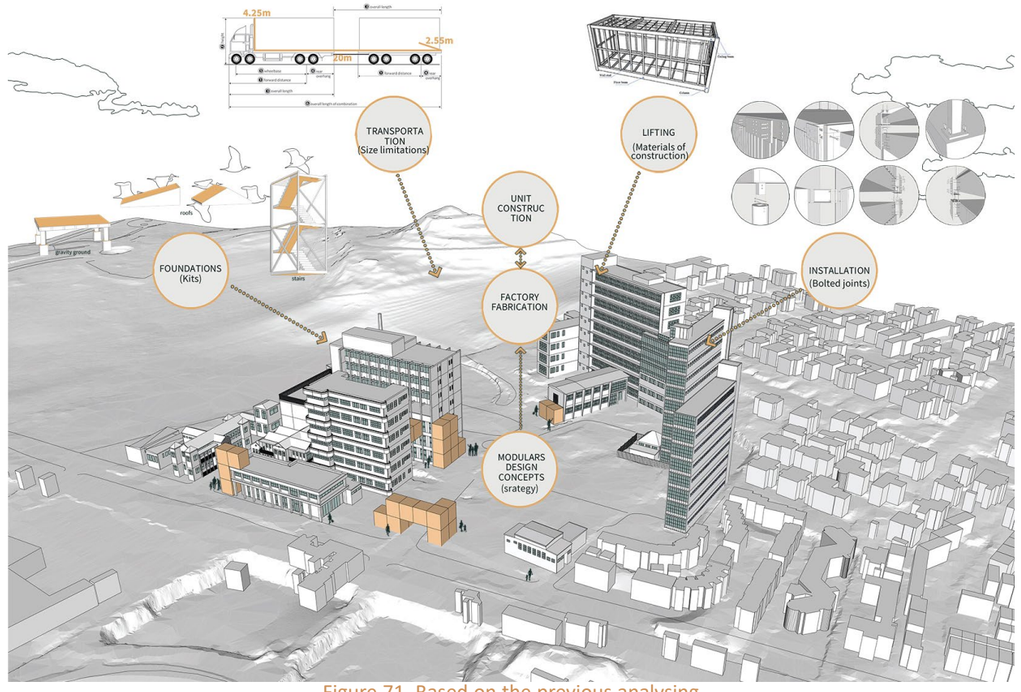


Figure 71. Based on the previous analysing and research, the integration of the system to achieve the GCSC modular design.

close to the entry on a open-space location

Smoking Zone

- Smoking areas should be located away from the main entrances and exits of the hospital to ensure good air circulation.
- Provide seating and resting facilities for smokers, some of whom may be patients or family members who may need extra rest and reflection.
- Mark the location of smoking areas to prevent smokers from smoking in non-smoking areas.
- Set up as a temporary structure that can be moved or converted to other services in the future.



Surrounded by greenery as well as open space with street frontage for easy access

Mental Health Services

- Treatment and counseling rooms should be soundproofed to protect privacy and confidentiality rooms.
- such as individual counseling, family therapy, group therapy, etc, of different types of therapy.
- Facilities should be located in areas that are easily accessible.
- Ensure that the environment is comfortable, sunny, and private to give patients a more comfortable experience.

Eye clinical

Car parking

Current reception, Indoor enclosed space

Building 4, Main building

Located in the center of the site for easy orientation to different directions

Waiting for health/ Reception

- Information on the location of departments within the hospital.
- The location should be easy to point the way.
- The design should take into account sunlight, comfortable seating and air circulation.

Figure 70. Design thinking and spatial analyses with an eye to the current needs of GCSC, design process takes into account the existing buildings.

4.4 Modular Form

This chapter will integrate the design explorations above to further design the modular form. This will help to ensure the strategy and design better meet the requirements of the healthcare facility during the implementation.

Starting by imagine user's perspective and feeling of the space by sketching and digital modelling(Fig.72-73). To experience the space is used, thus contributing to the development and optimisation of the architectural form.

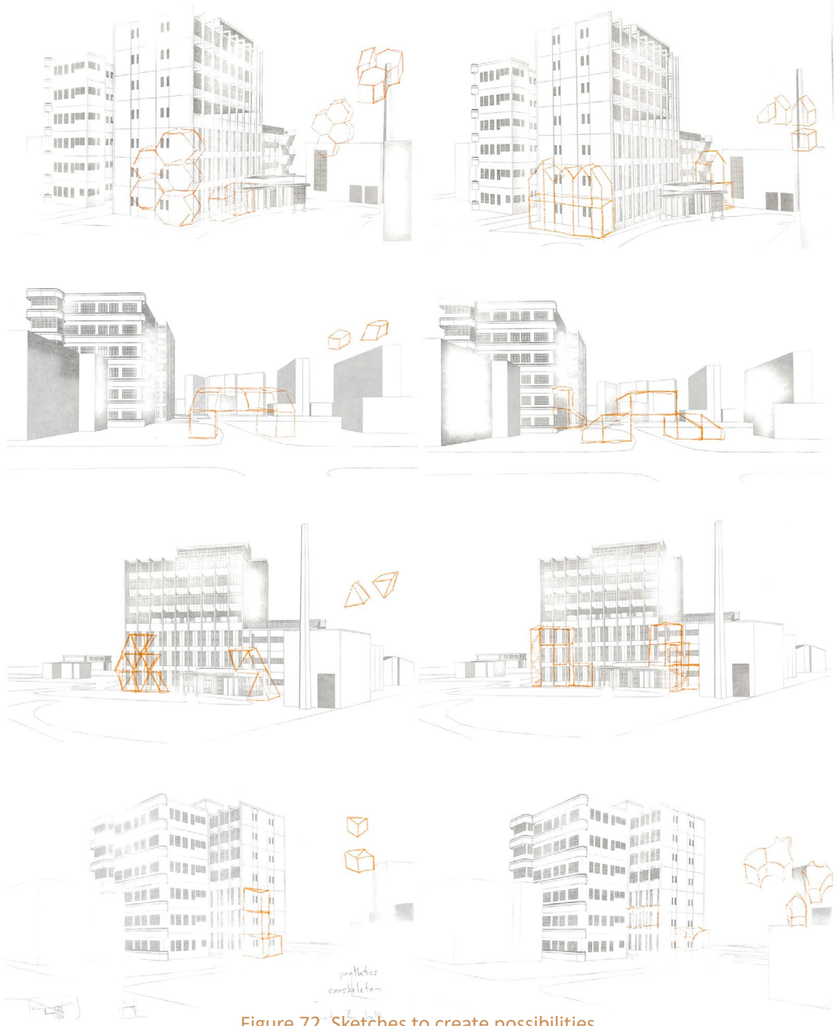


Figure 72. Sketches to create possibilities modulars form matching the GCSC.

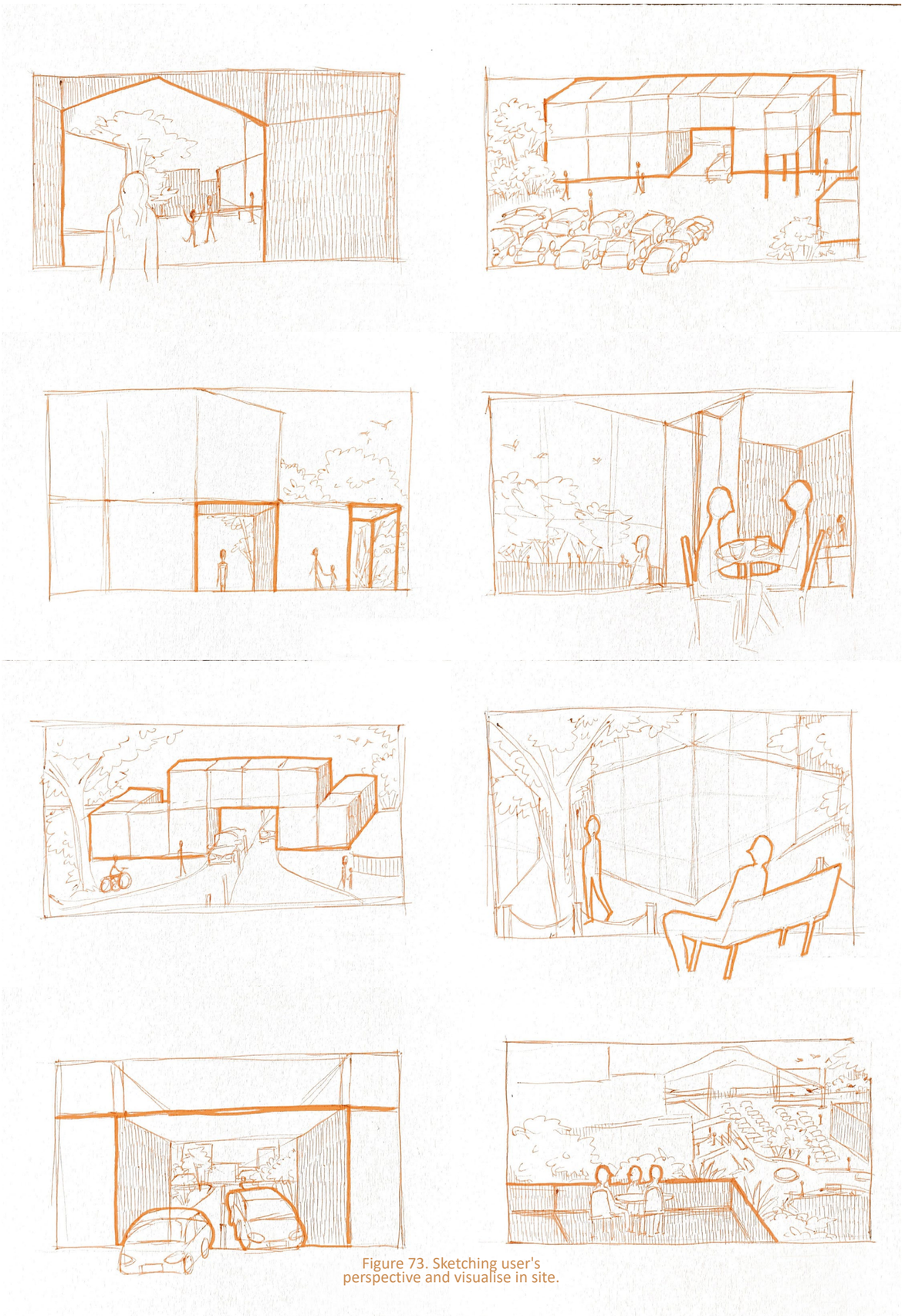


Figure 73. Sketching user's perspective and visualise in site.



Figure 74. Further refinement based on sketches and forms through digital modelling collaborate with GCSC site.

(Fig.74-75)Digital modelling process to replicate the dimensions and spatial proportions of GCSC. This method driven different design solution to perspective. By starting with a basic square module, progressively explored and creatively adapted the shape to better fit between the modularity and the site model to optimise the space and forms.

By developing three different design scenarios and studying them further, considering the requirements and limitations of installation and splicing (see chapter 4.3). During this process, the square module(Fig.76) did not reflect well the biological elements of amoeba nor support biophilia. On the other hand, the triangular solution, while creating a unique space, was less utilised(Fig.77).

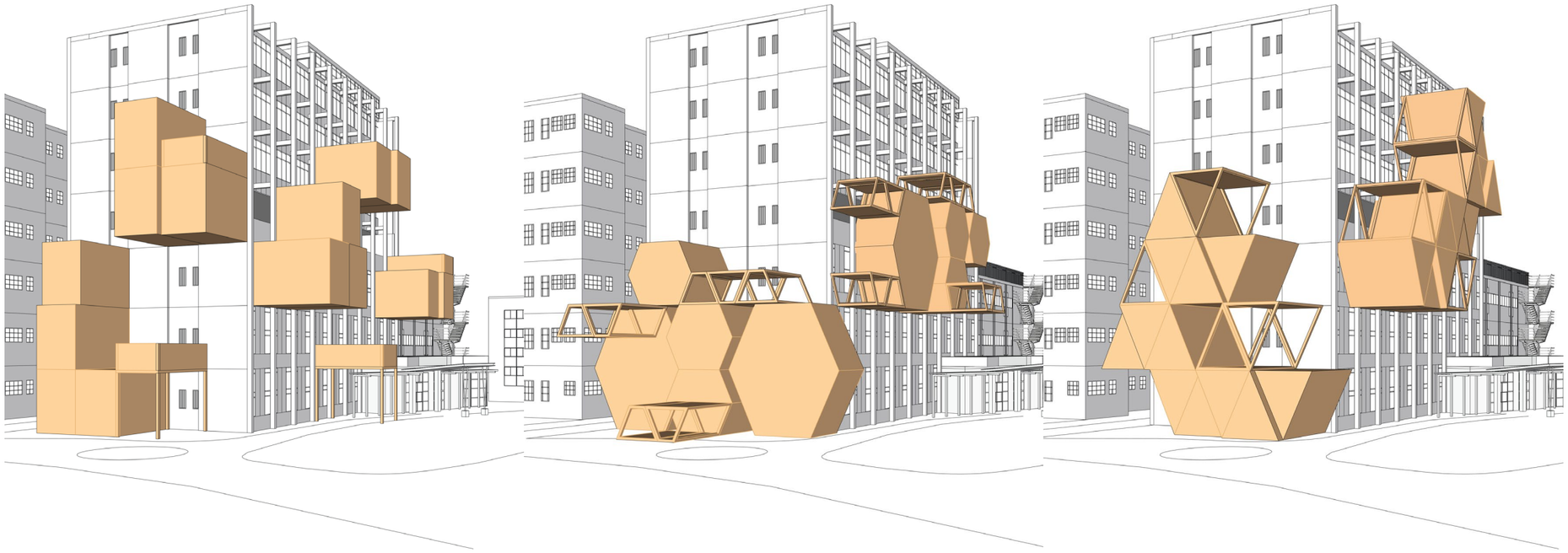
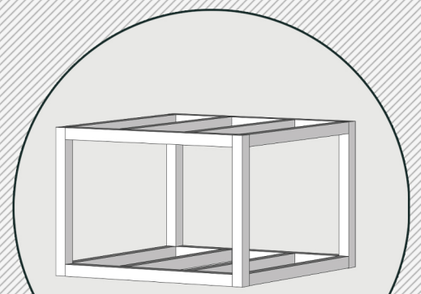
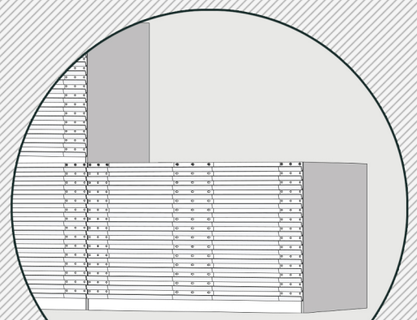


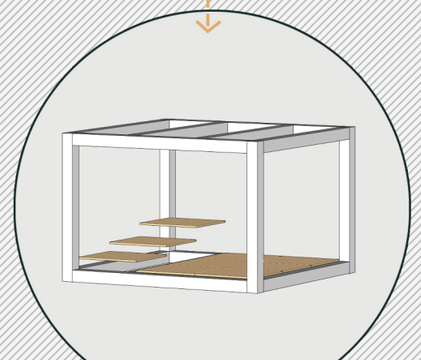
Figure 75. Different sets of modular forms to match GCSC site dimensions.



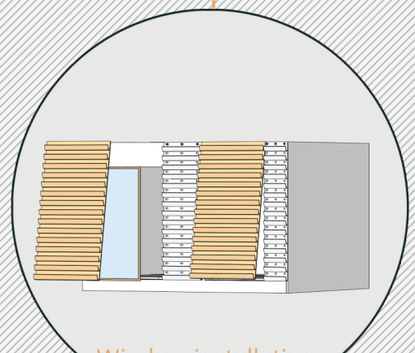
Structural frame



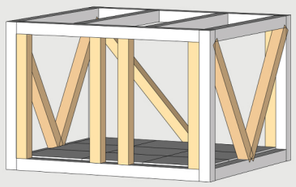
Ready to transportation



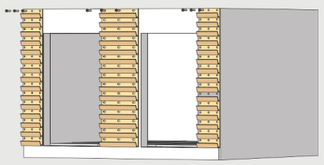
Flooring



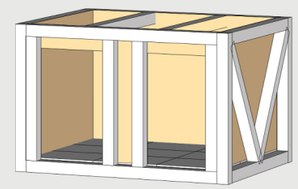
Window installation



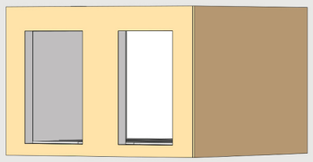
Wall columns



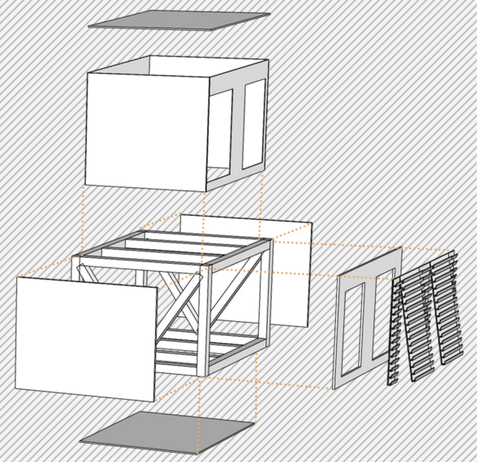
Facades



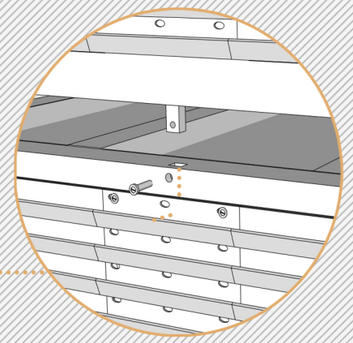
Interior installation

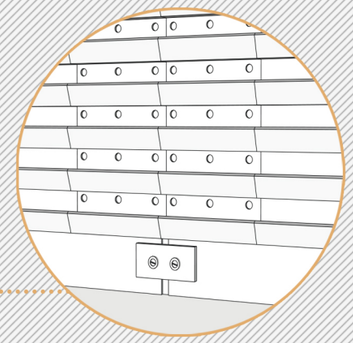


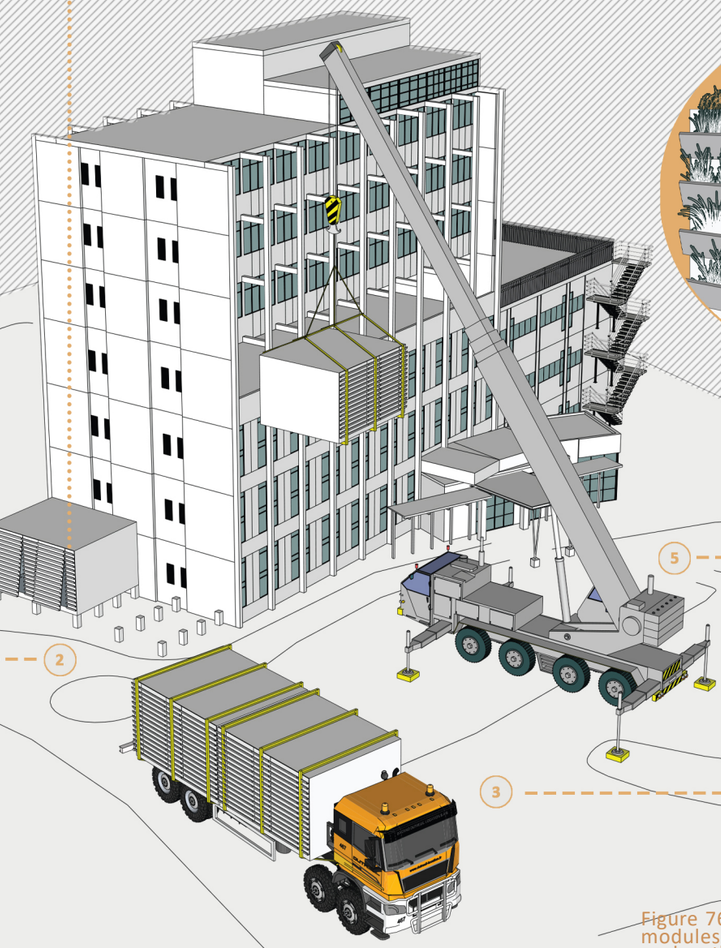
Exterior installation



Factory made 1







Placement Modular

Irrigation foundations

4

2

3

5

Crane placement

Transportation

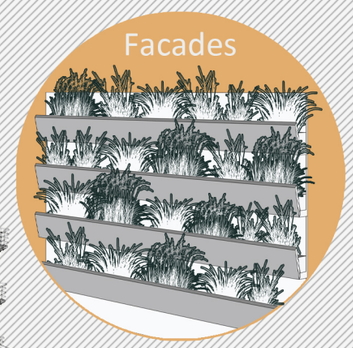
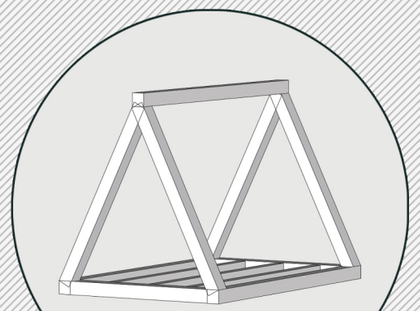
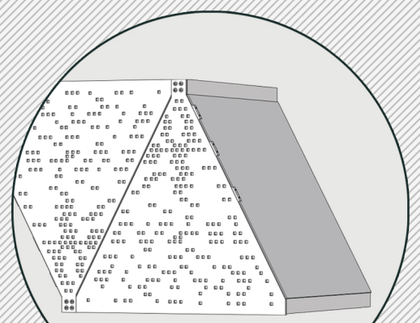


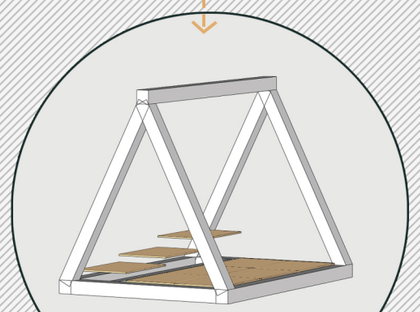
Figure 76. Testing drawings of the square modules, with the installation process to analyse the connections and structures, and conceptualize facade as a vertical plant wall.



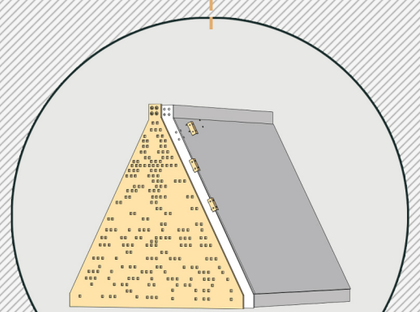
Structural frame



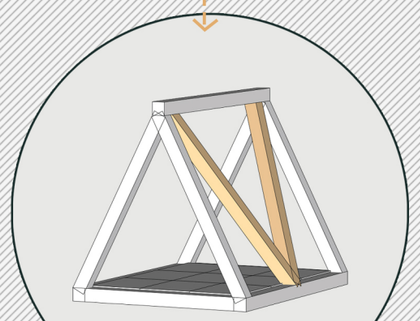
Ready to transportation



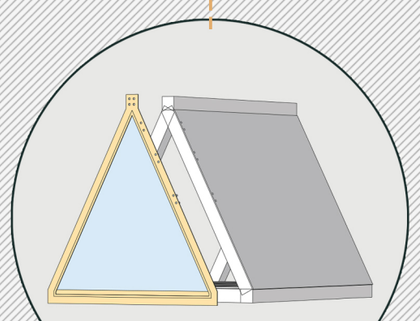
Flooring



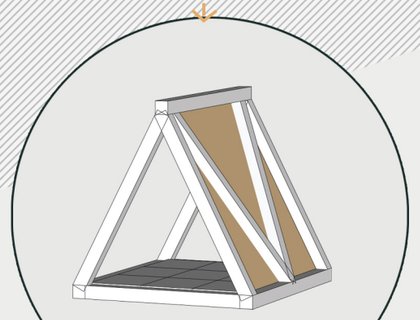
Facades



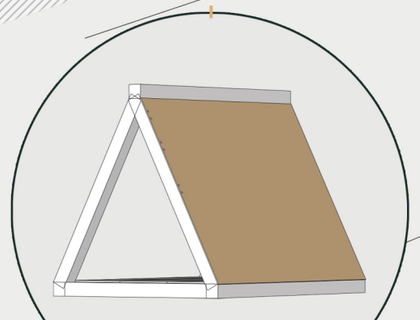
Wall columns



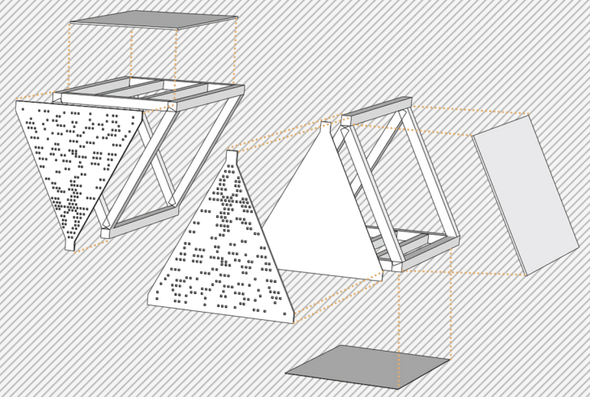
Window installation



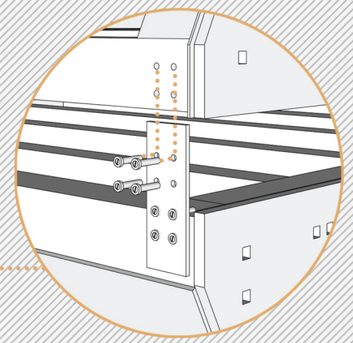
Interior installation

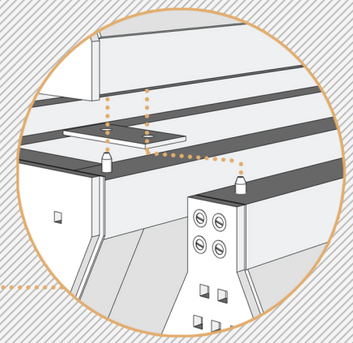


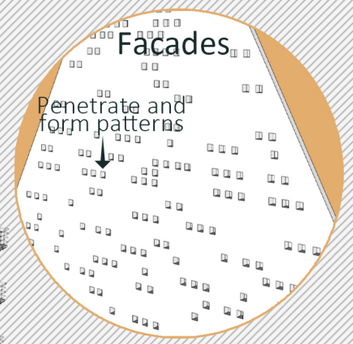
Exterior installation



Factory made 1

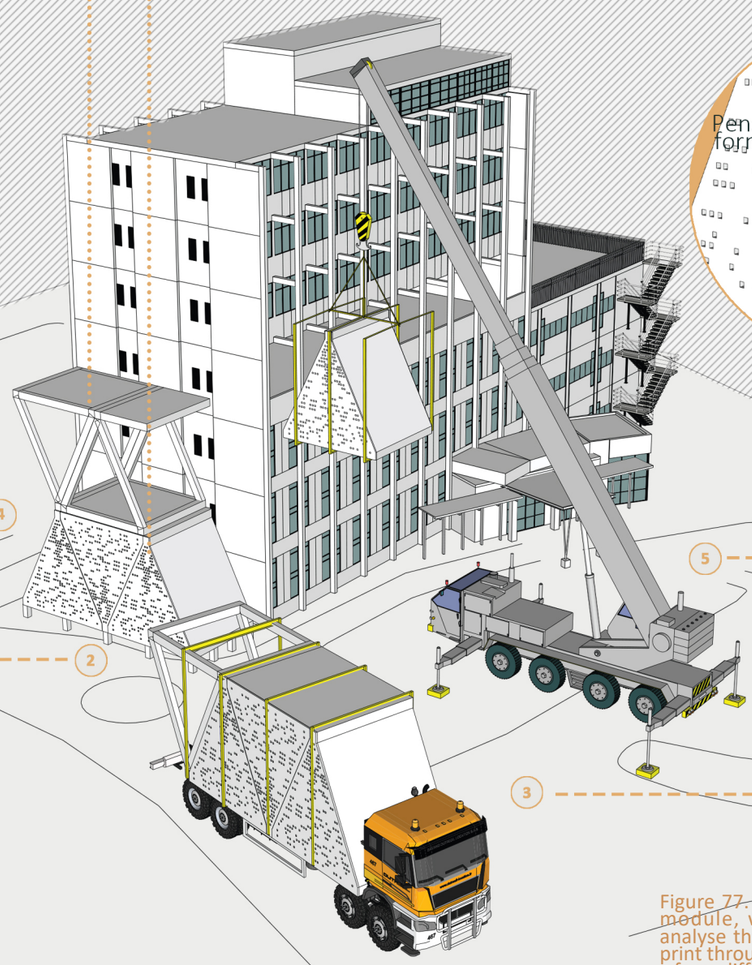






Placement Modular

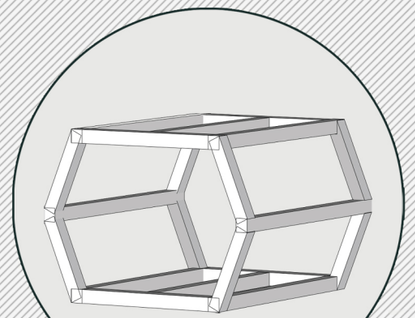
Irrigation foundations



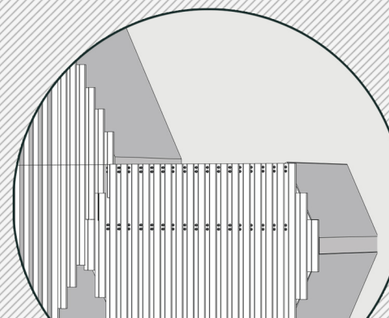
Crane placement

Transportation

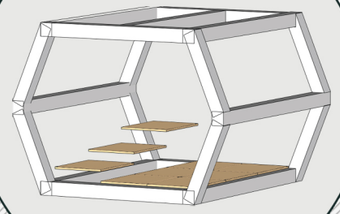
Figure 77. Testing drawings of the triangular module, with the installation process to analyse the connections and structures, and print through patterns on facade, shadow will form different shapes in different sunlight.



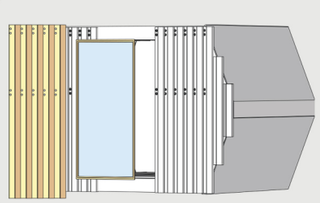
Structural frame



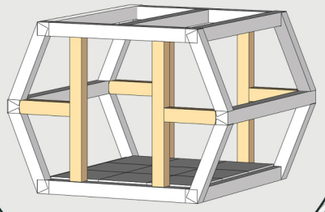
Ready to transportation



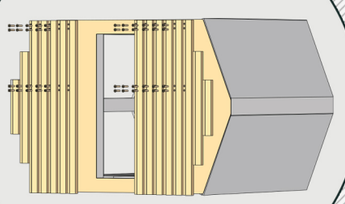
Flooring



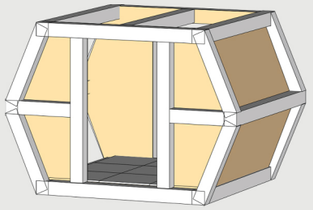
Window installation



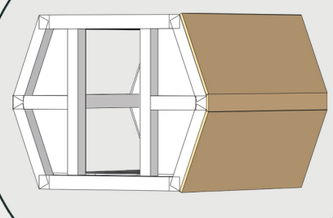
Wall columns



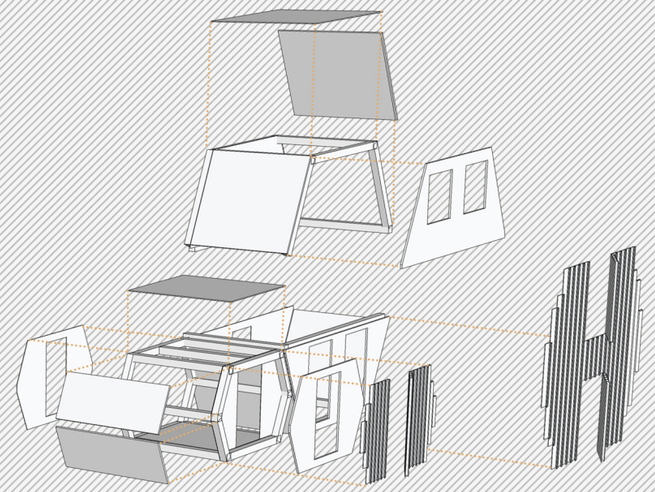
Facades



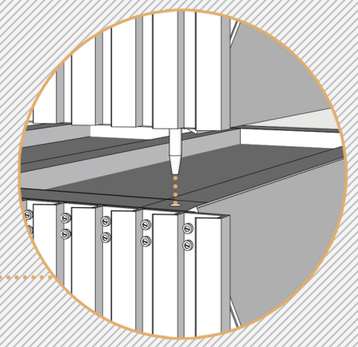
Interior installation

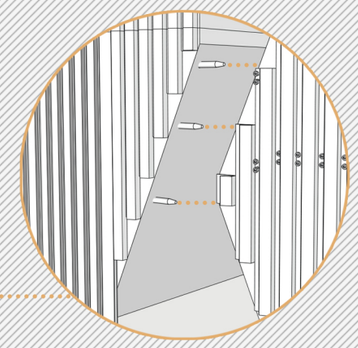


Exterior installation



Factory made 1



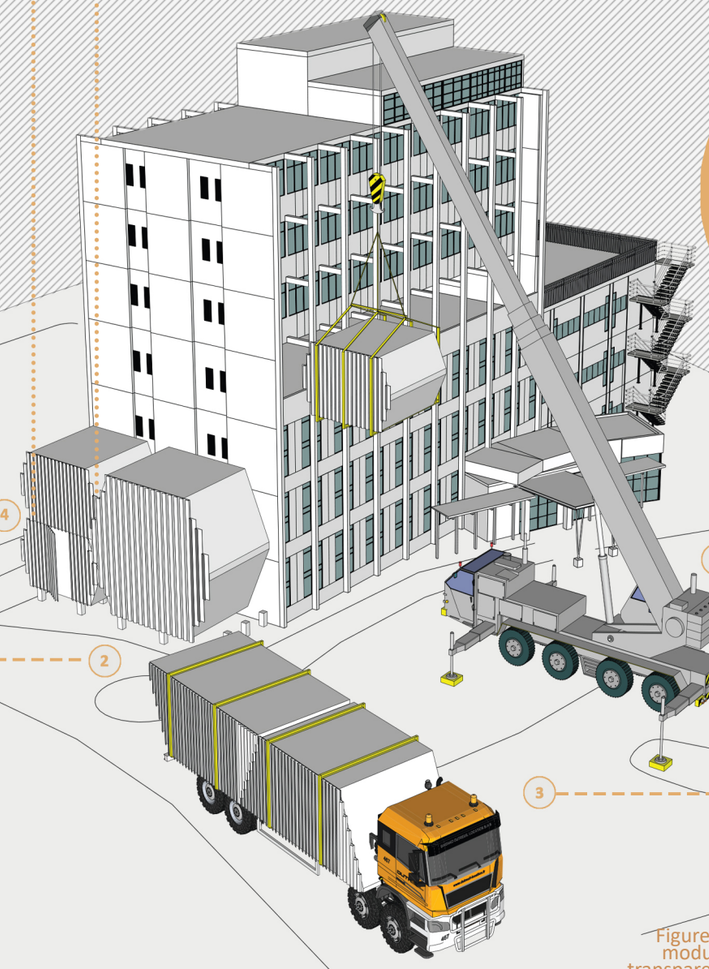


Facades

Breathable

Placement Modular

Irrigation foundations



Crane placement

Transportation

Figure 78. Testing drawings of the hexagonal modules, with the installation process, and transparent facade creates air and light circulation.

After comprehensive consideration, the use of hexagonal modules(Fig.78) is the solution that best fits the Amoeba Strategy. This modular structure highlights the natural elements and blends nature with human innovation, while the hexagonal shape, like a beehive, offers extreme flexibility. This flexibility allows for the creation of more usable space by stacking modules, which makes the hexagonal solution an appealing and practical option.

Integration of form and site, functionality, floor plan (see chapter 4.3) and began planning on a large scale. (Fig.79)

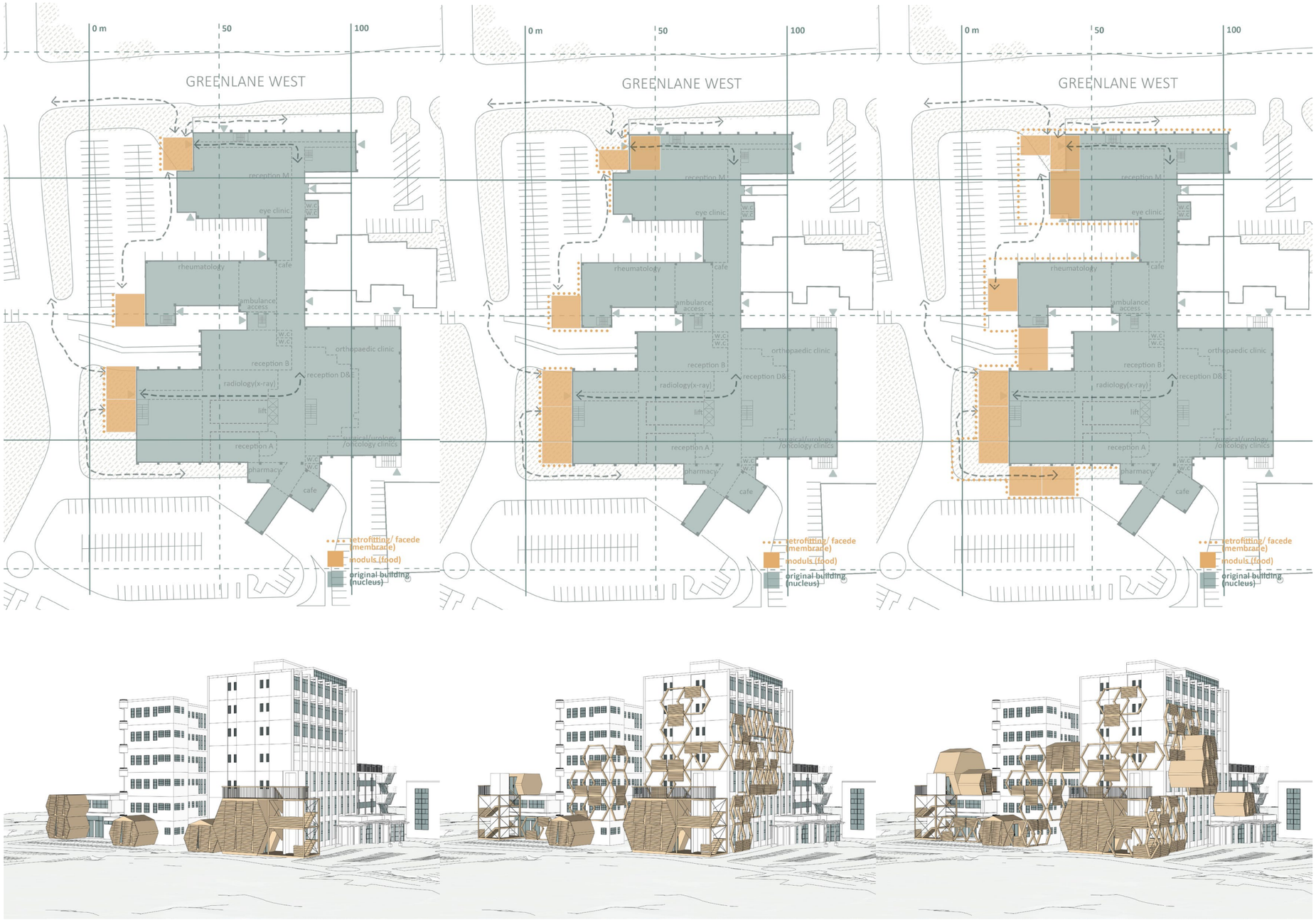


Figure 79. using the structural retrofitting wall (see chapter 4.2), to integrate the existing building with the modulars to create a complete design of Amoeba Strategy.

PART 5: DESIGN STRATEGY

5.1 KIT OF PARTS

Given the previous series of background studies (part 4), a series kit of parts in addition to the modular units need to be designed to better support the operation of the system. These kits will be factory into complete units and then transported to the site in a pre-fabricated form, similar to the way Lego blocks are assembled.

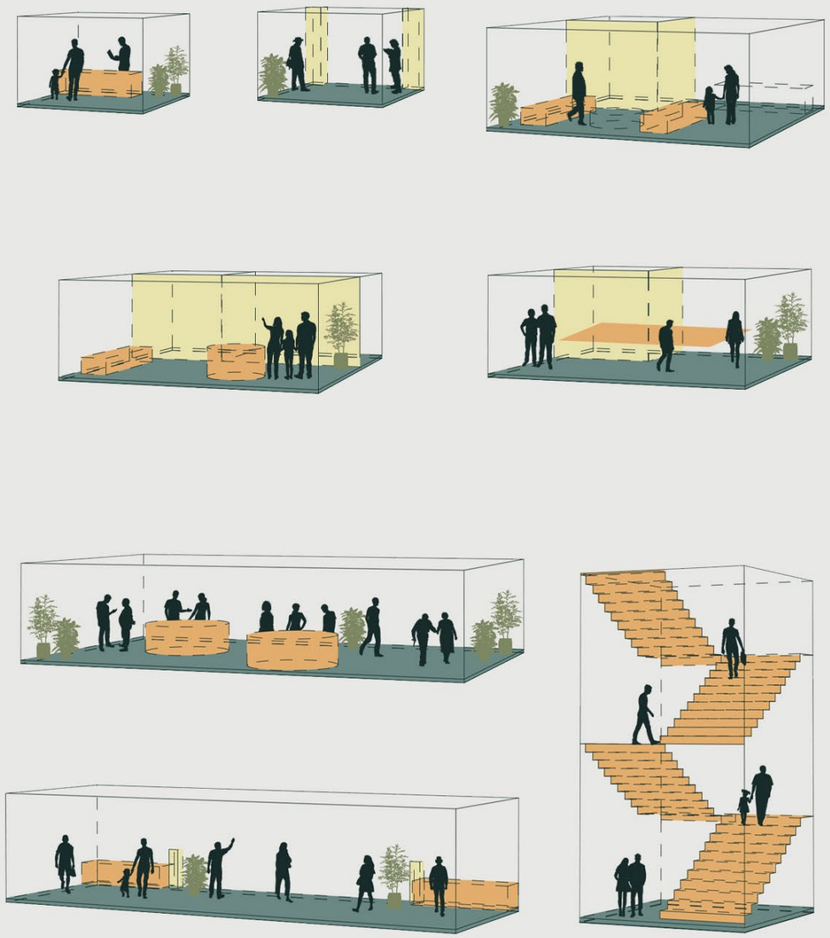
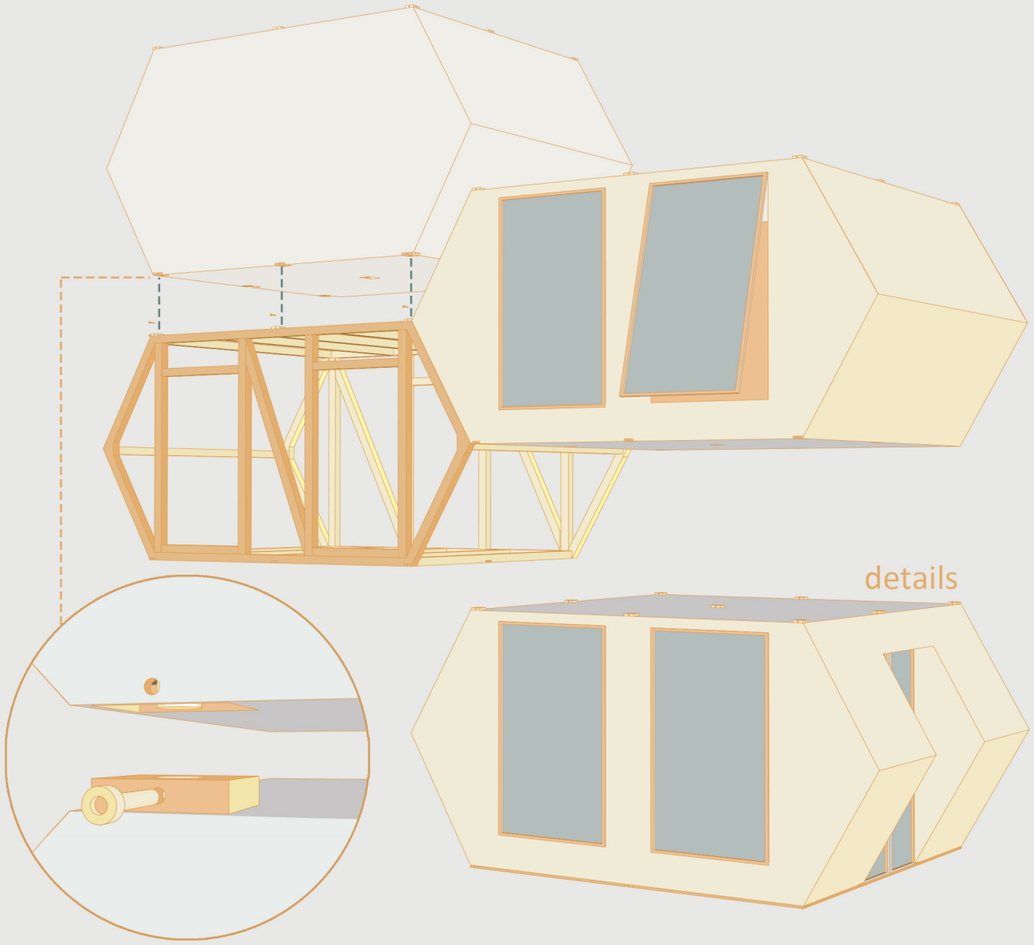


Figure 80. The design of the kits starts with the creation of the concept and the functioning of the modules in keeping with the system of interoperability.

(Figure. 81) Kit of parts modular rooms: Two different sizes of modular rooms have been set. One size is approximately the size of a standard room, while the other is a double storey of modular, which form the main part of the modular system. Both types of modules can provide additional space as needed, either as a temporary or permanent space. The interior layout will change flexibly according to the needs of different periods to better meet diverse uses.



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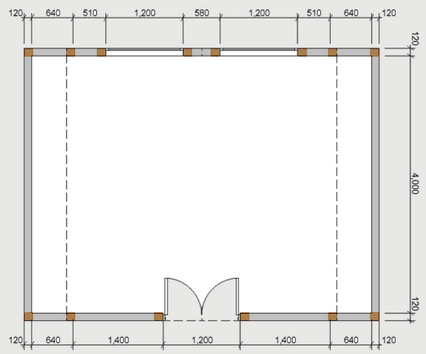

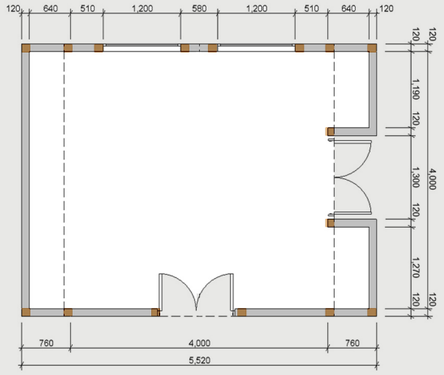

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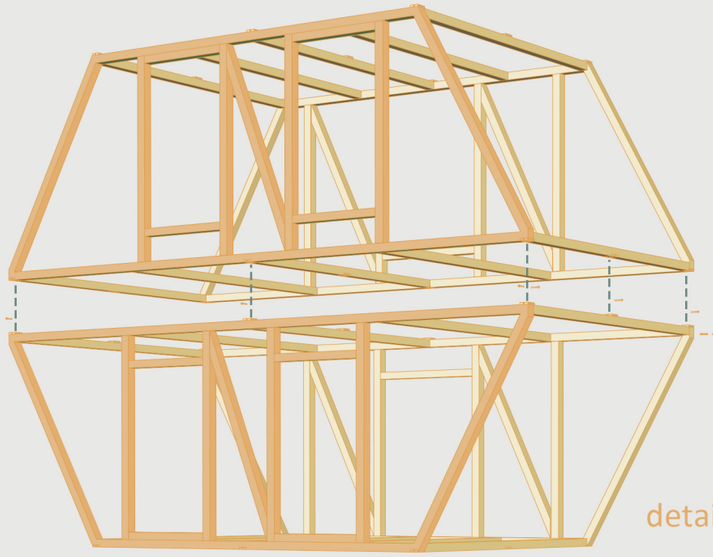

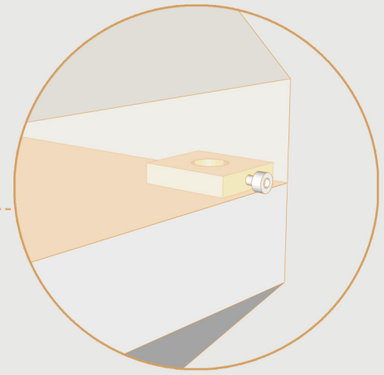

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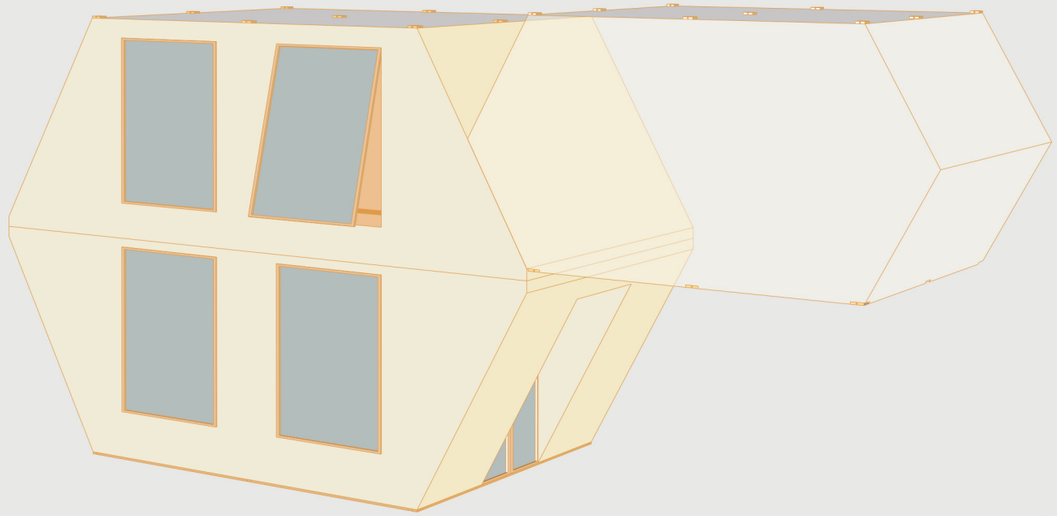
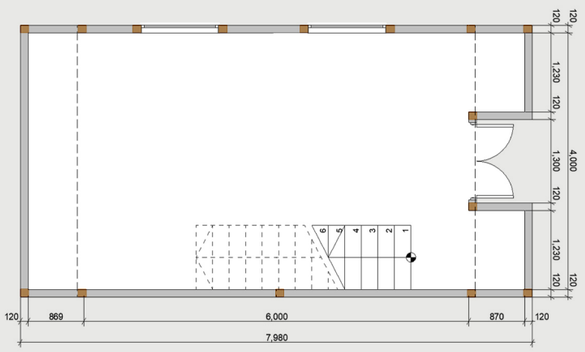
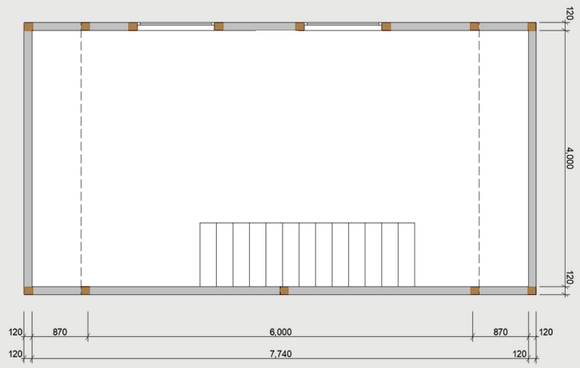
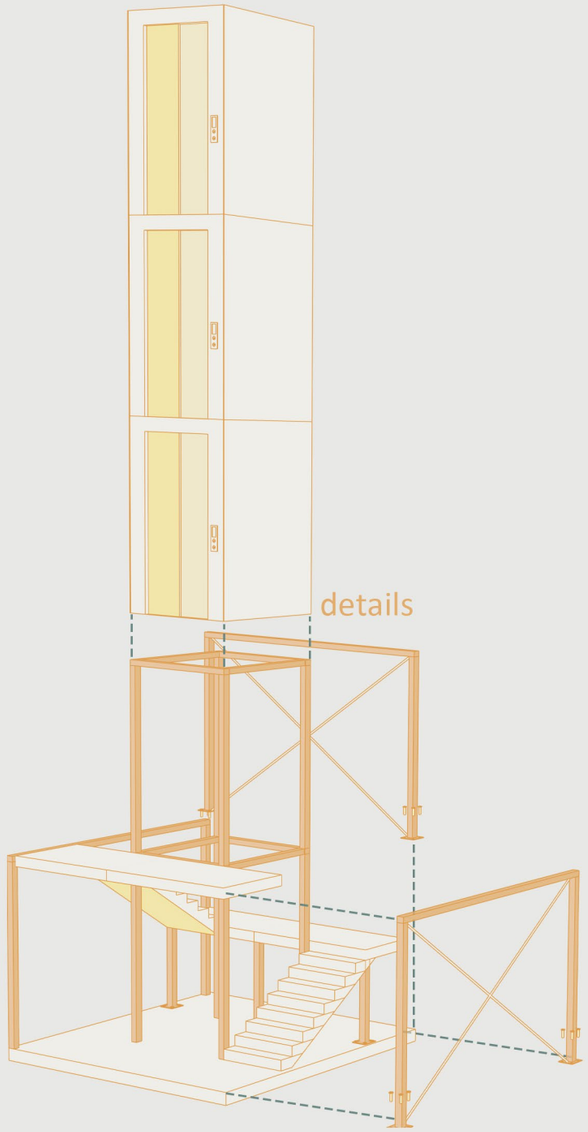






plan

(Figure. 82) Kit of parts Staircase: Staircases provide easy access to the exterior of the building as well as an elevator provides a comfortable way for disabled visitors to move around the building, offer convenience and safety for all types of visitors.



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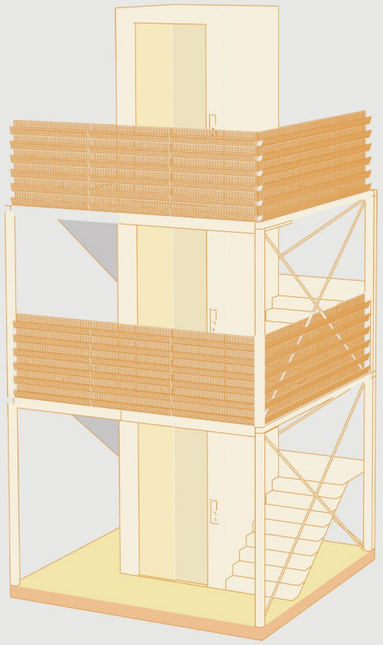
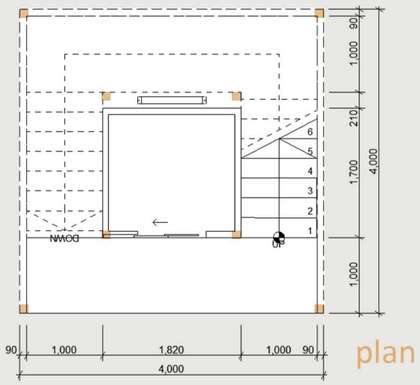
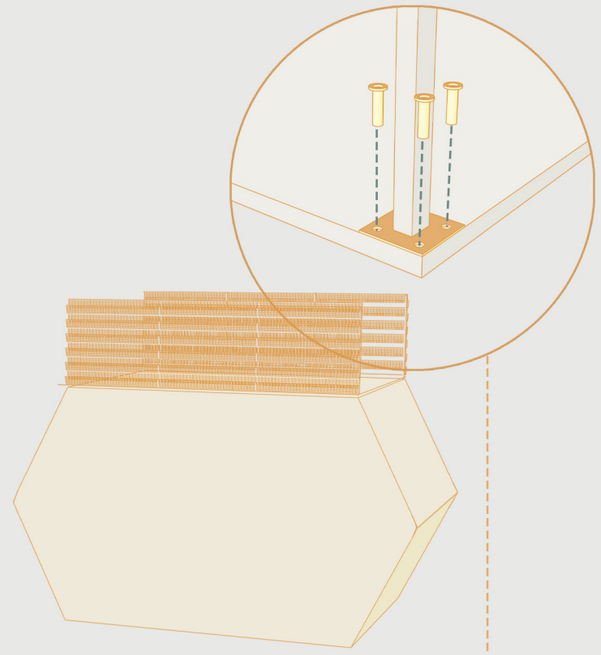
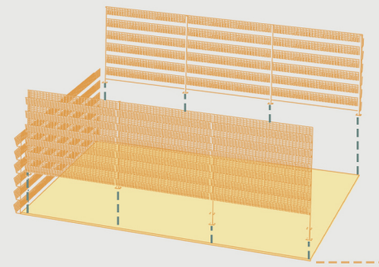




plan

(Figure. 83) Kit of parts Outdoor Balconie: The balconies typically consist of handrails and outdoor flooring to ensure the safety and comfort of the user. They providing an opportunity to interact with the enviroments, enhancing the quality of the GCSC.





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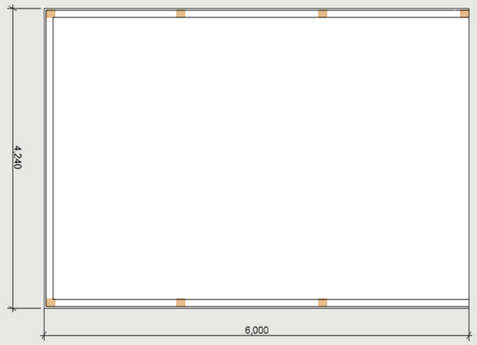
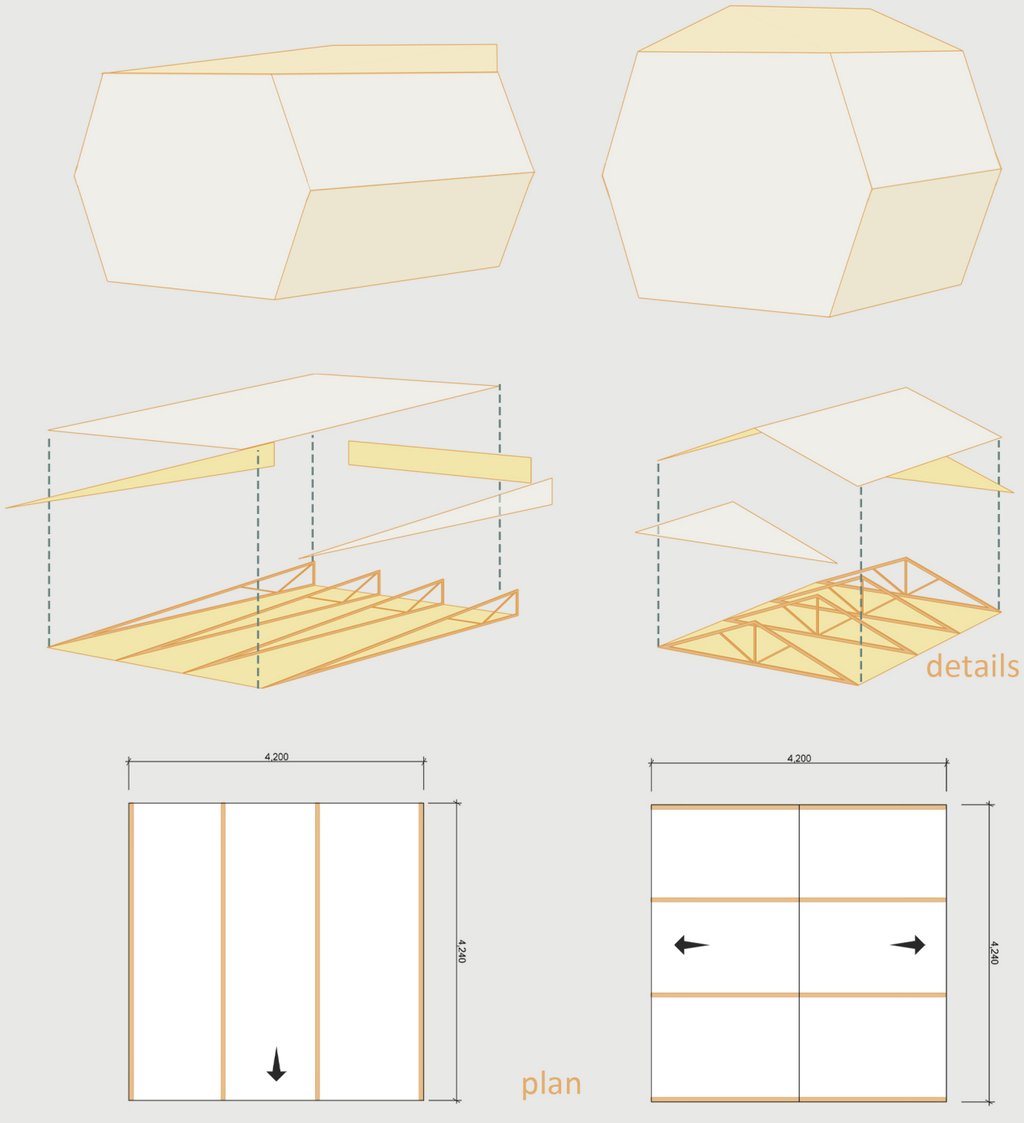
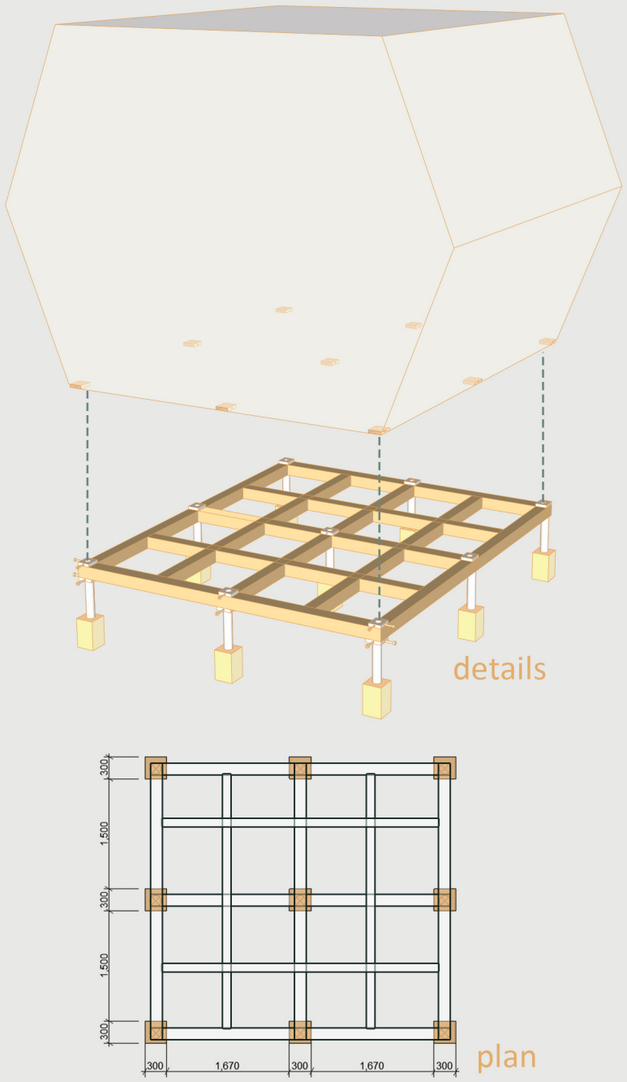


plan

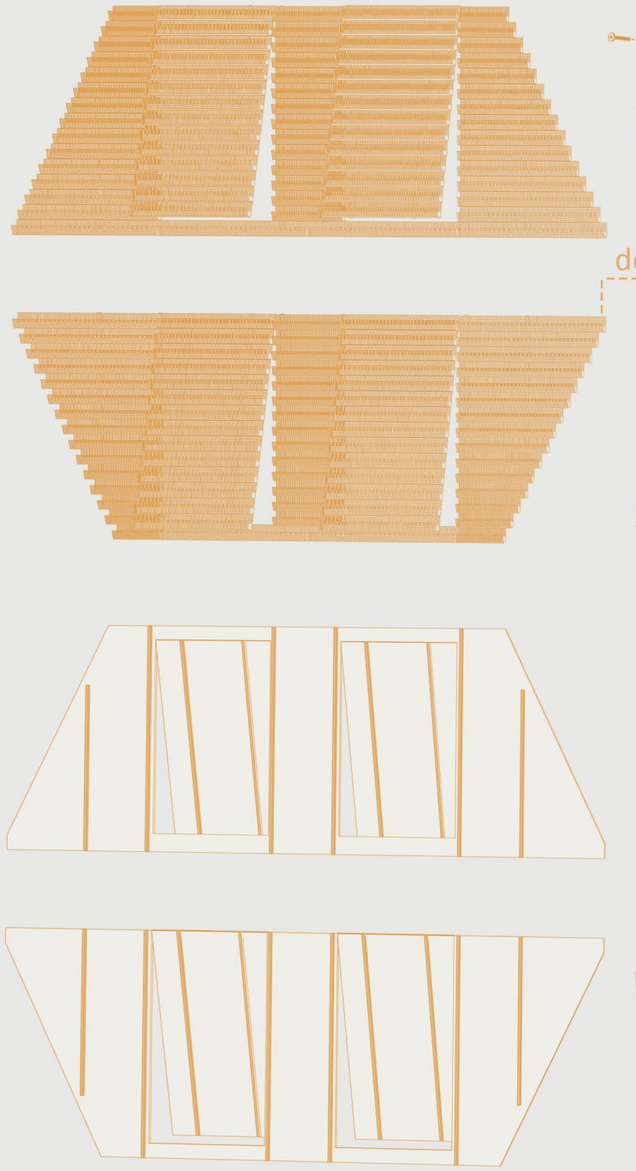
(Figure. 84) Kit of parts Roofs: Roofs play multiple roles in the portion of the building that does not have a balcony. They are designed as effective drainage systems to ensure that rainwater drains away quickly, preventing waterlogging and damage to the building structure. In addition, roofs are designed as part of a rainwater collection system, storing rainwater in suitable containers for further recycling, for example to plants on facade.



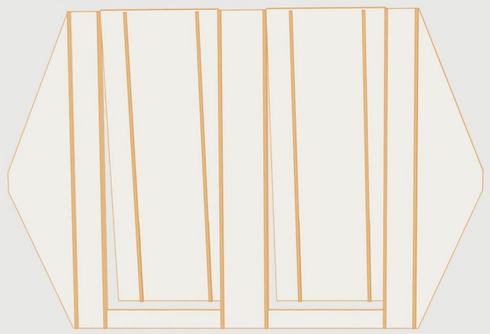
(Figure. 85) Kit of parts Foundation: The pier foundations (See Chapter 4.3 for details) is reduces the environmental disturbance of the foundation as it usually requires less excavation and earthworks. When selecting the type and layout of piles. (A detailed analysis by an engineer is required to ensure suitable for the specific geographic, and this design is merely suggesting methods that can be used in conjunction with this strategy.)



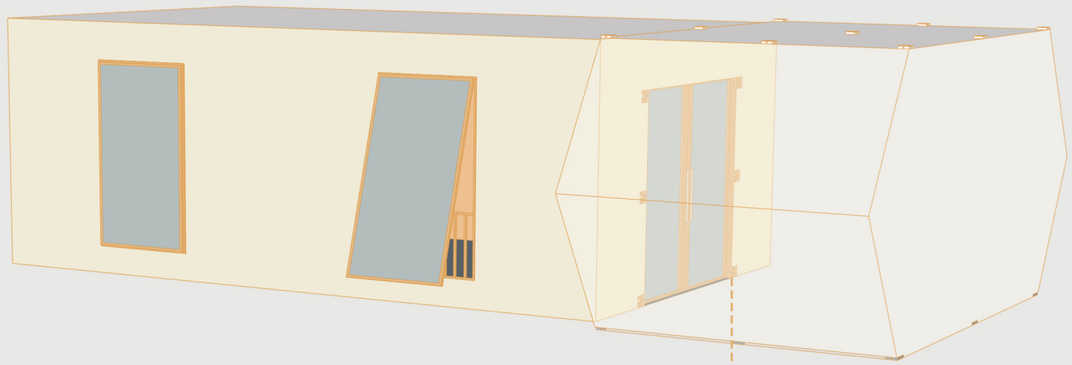
(Figure.86) Kit of parts Facades: In order to provide a comfortable and pleasant spatial environment at GCSC, the facades are designed as vertical greenery. These facades will be pre-fabricated in factory and then installed on the required sections after all on-site construction procedures are completed. To ensure that these greenery are properly nourished by the rainwater harvesting system is utilised on the roof to recycling and reuse the rainwater.

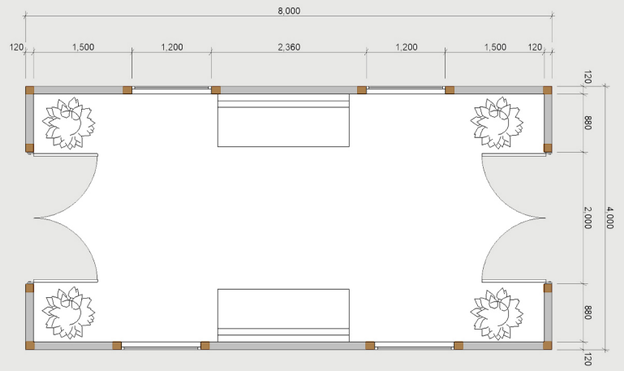






(Figure.87) Kit of parts Corridors: The main purpose of corridors is to connect the existing buildings to each other or to link with the modulars, providing a quick and easy way to move between buildings. This is particularly important in bad weather, and the corridor can also be used to accommodate additional functions such as rest areas or viewpoints.





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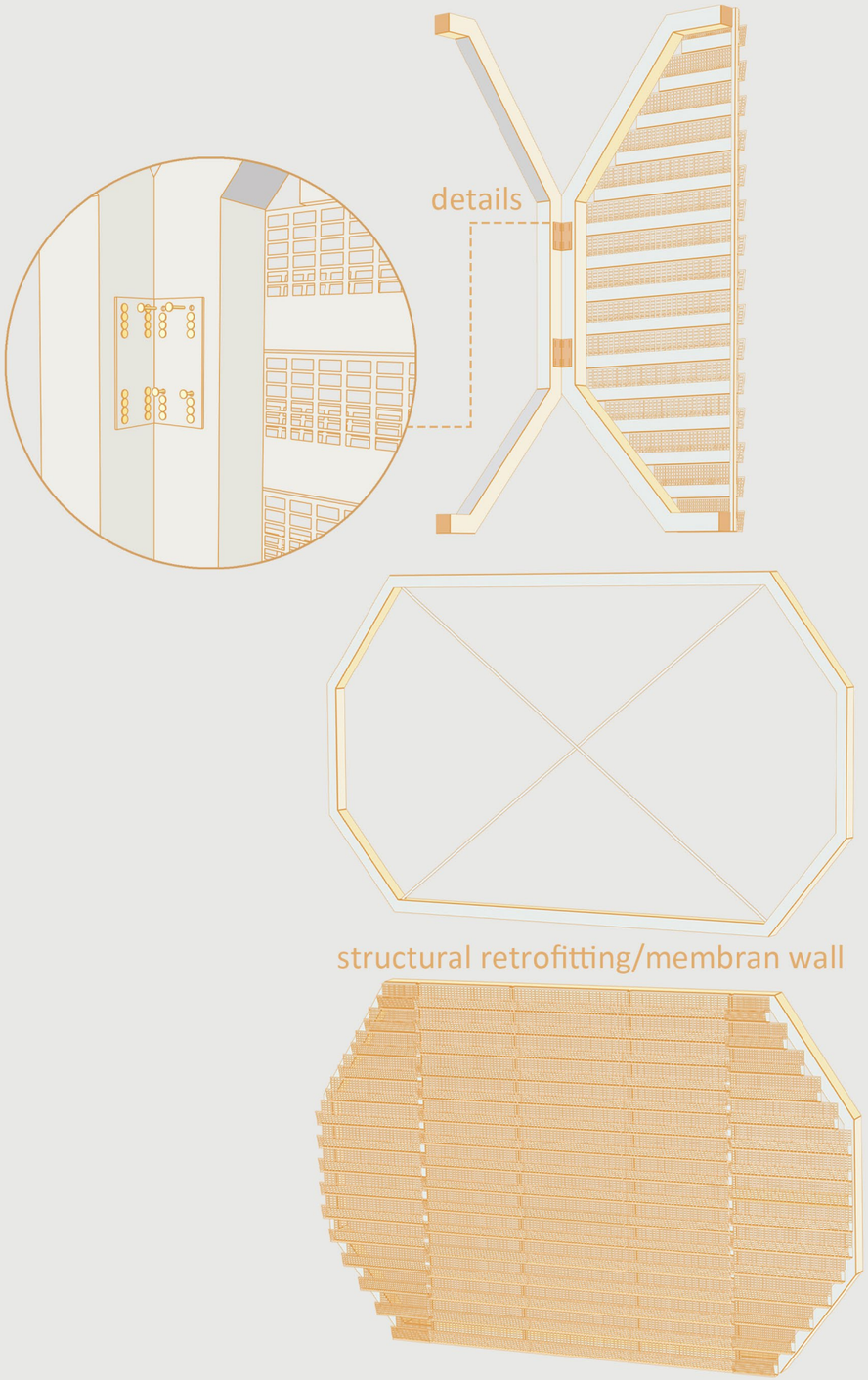


Figure 88. structural retrofitting/membran wall installation and details, the form of the membran wall is designed to fit other modularly into a stylised, can be used to form outdoot space, corridors, support structures for healing buildings etc.

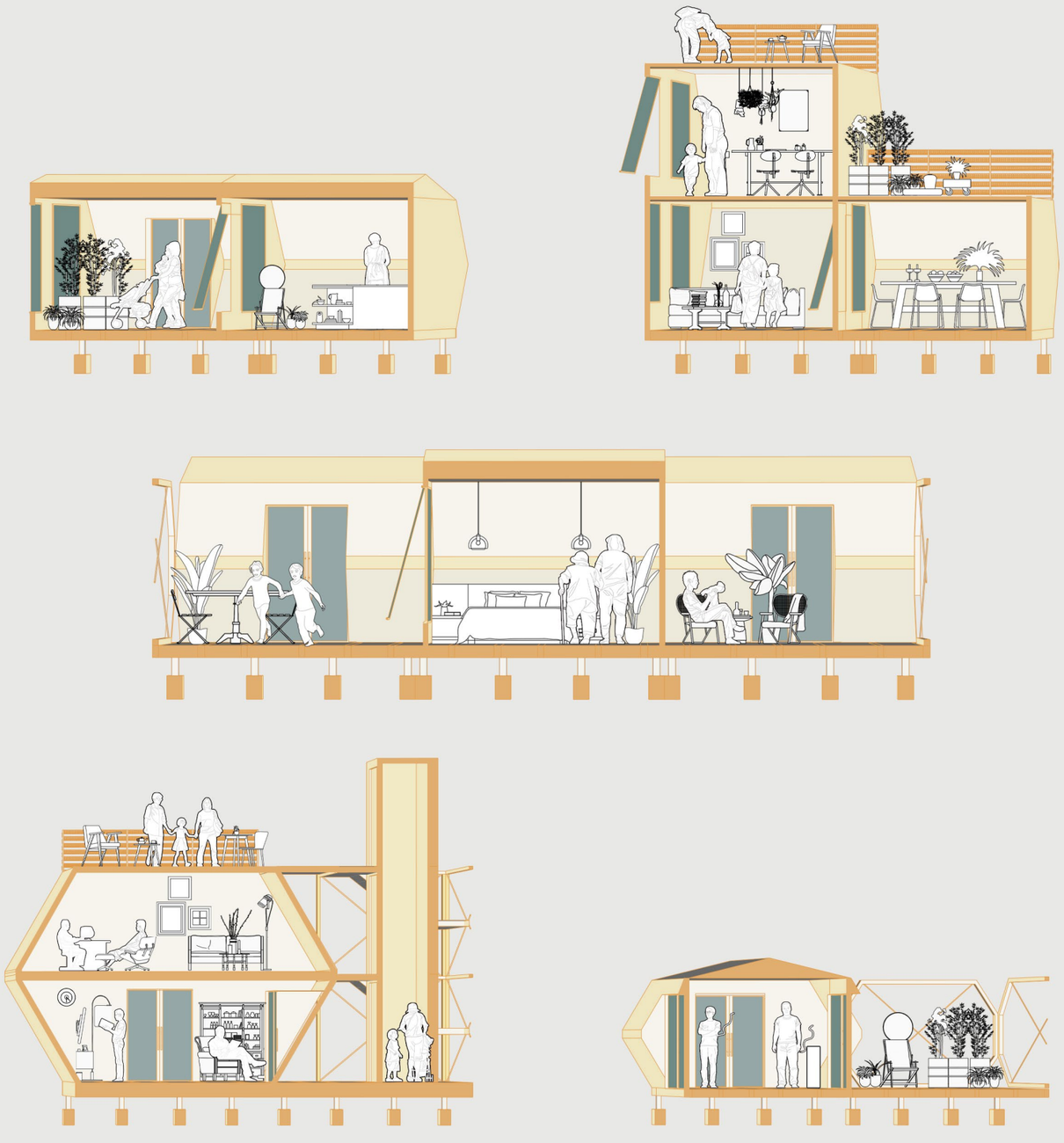
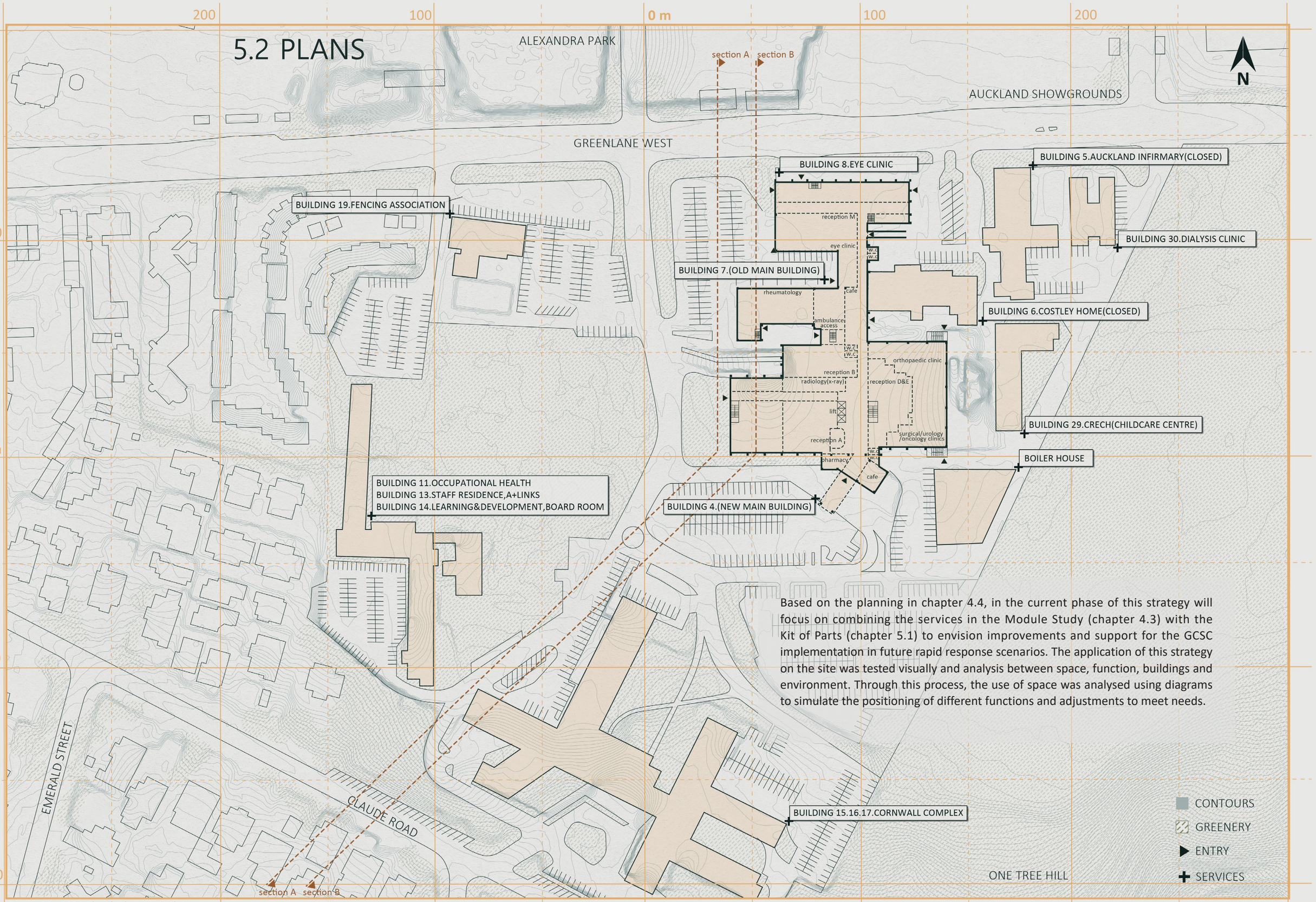


Figure 89. The effect of different modules connected together, based on the kit of parts, Aomeba Strategy can achieve different combinations to achieve different functions.

5.2 PLANS



Based on the planning in chapter 4.4, in the current phase of this strategy will focus on combining the services in the Module Study (chapter 4.3) with the Kit of Parts (chapter 5.1) to envision improvements and support for the GCSC implementation in future rapid response scenarios. The application of this strategy on the site was tested visually and analysis between space, function, buildings and environment. Through this process, the use of space was analysed using diagrams to simulate the positioning of different functions and adjustments to meet needs.

Figure 90. GCSC Plan and services daigram, building4 indoor plan based on site visit.

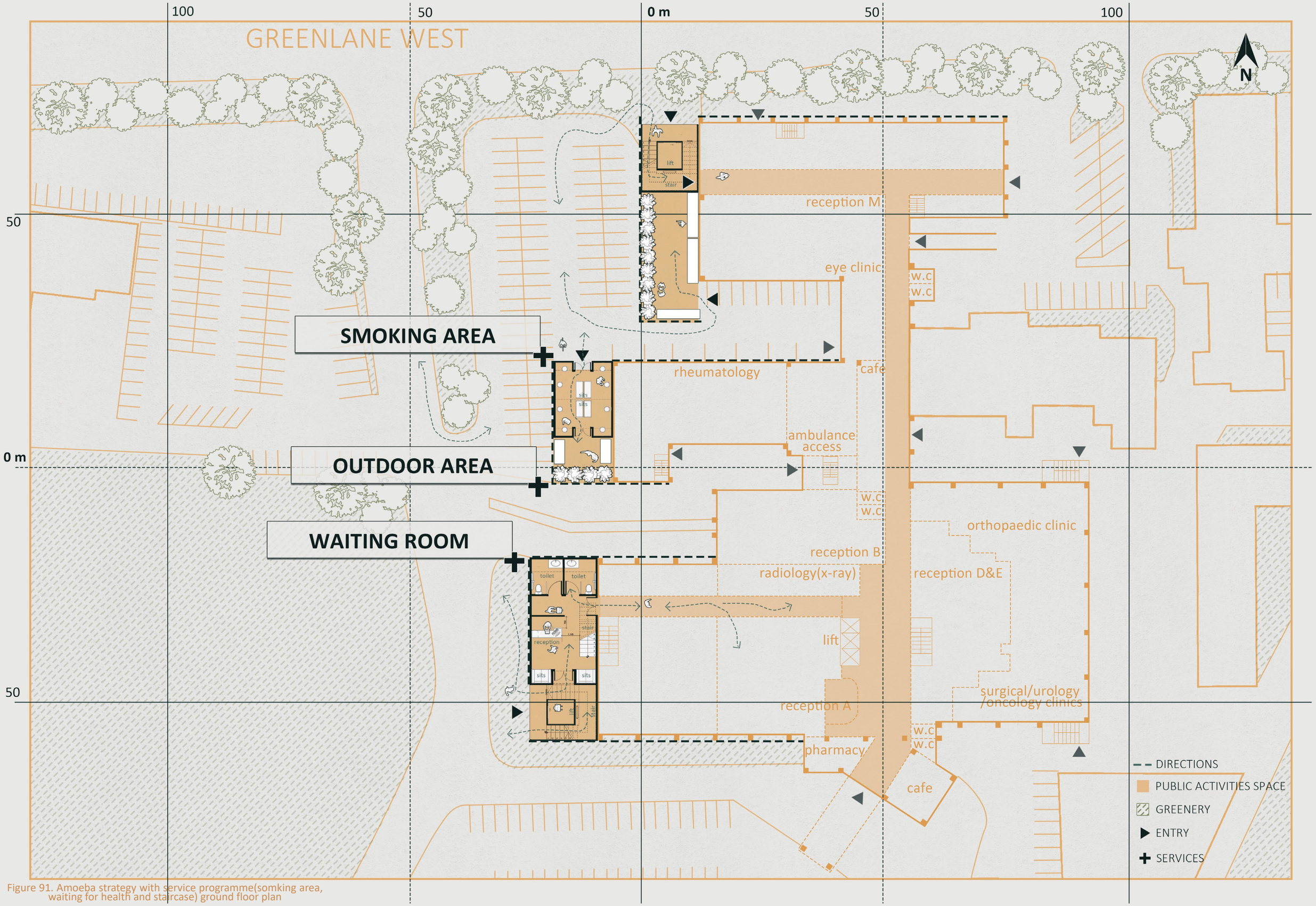


Figure 91. Amoeba strategy with service programme(somking area, waiting for health and staircase) ground floor plan

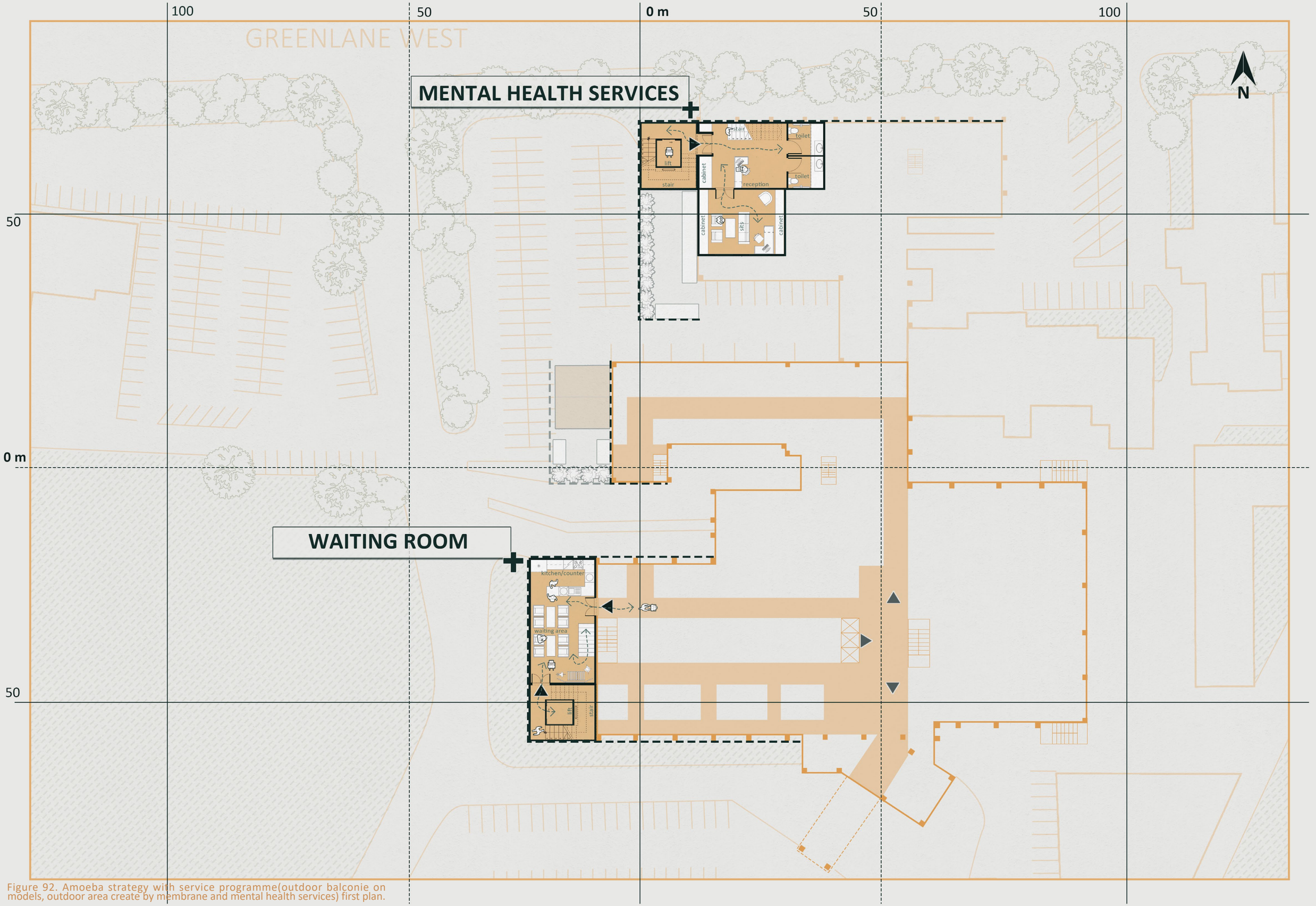


Figure 92. Amoeba strategy with service programme(outdoor balconie on models, outdoor area create by membrane and mental health services) first plan.

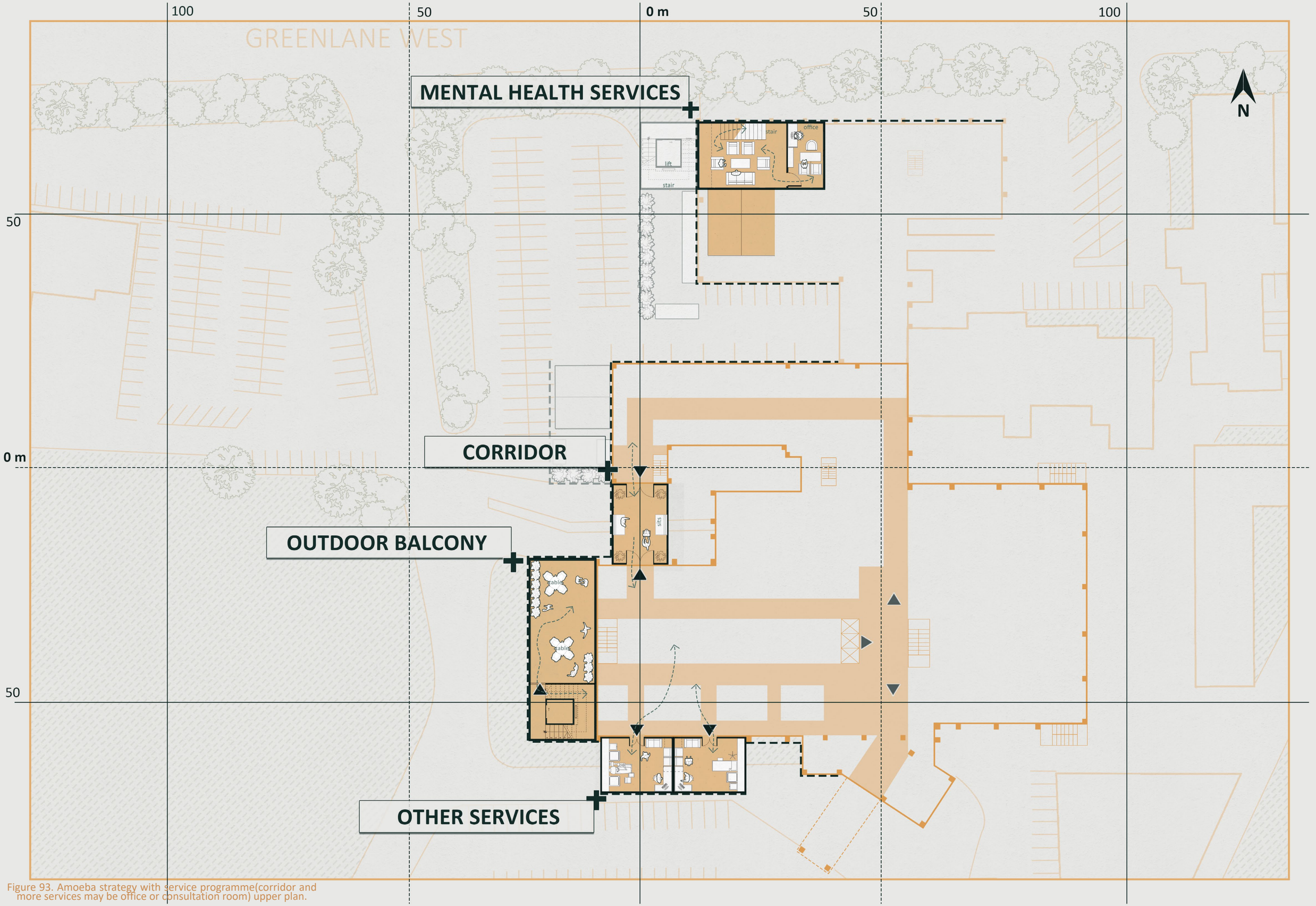


Figure 93. Amoeba strategy with service programme(corridor and more services may be office or consultation room) upper plan.

5.3 MATERIALS AND INSTALLATIONS (DETAILS JOINTS DRAWING)

Based on the in-depth research and investigation in chapter 4.3, the application of the concept of modular installation will be tested and diagram to prove the feasibility of this strategy and analyse the prefabricated structure in this chapter. (See figure 92) The use of materials in the formation of the structure is essential.

"When we talk about modular construction materials, we're referring to the bones of the infrastructure."[54] Both interior and exterior finish materials are customizable and completely dependent on the designer's adoption and design.

In this design, steel or metal frames will be used for the construction of the modular infrastructure structure. Steel structures are often associated with large construction projects and buildings that require a long service life.

54 Nc. "What Materials Are Modular Buildings Made of?: Construction: Vesta." VESTA Modular, November 20, 2020. https://vestamodular.com/blog/modular-building-construction-materials/.

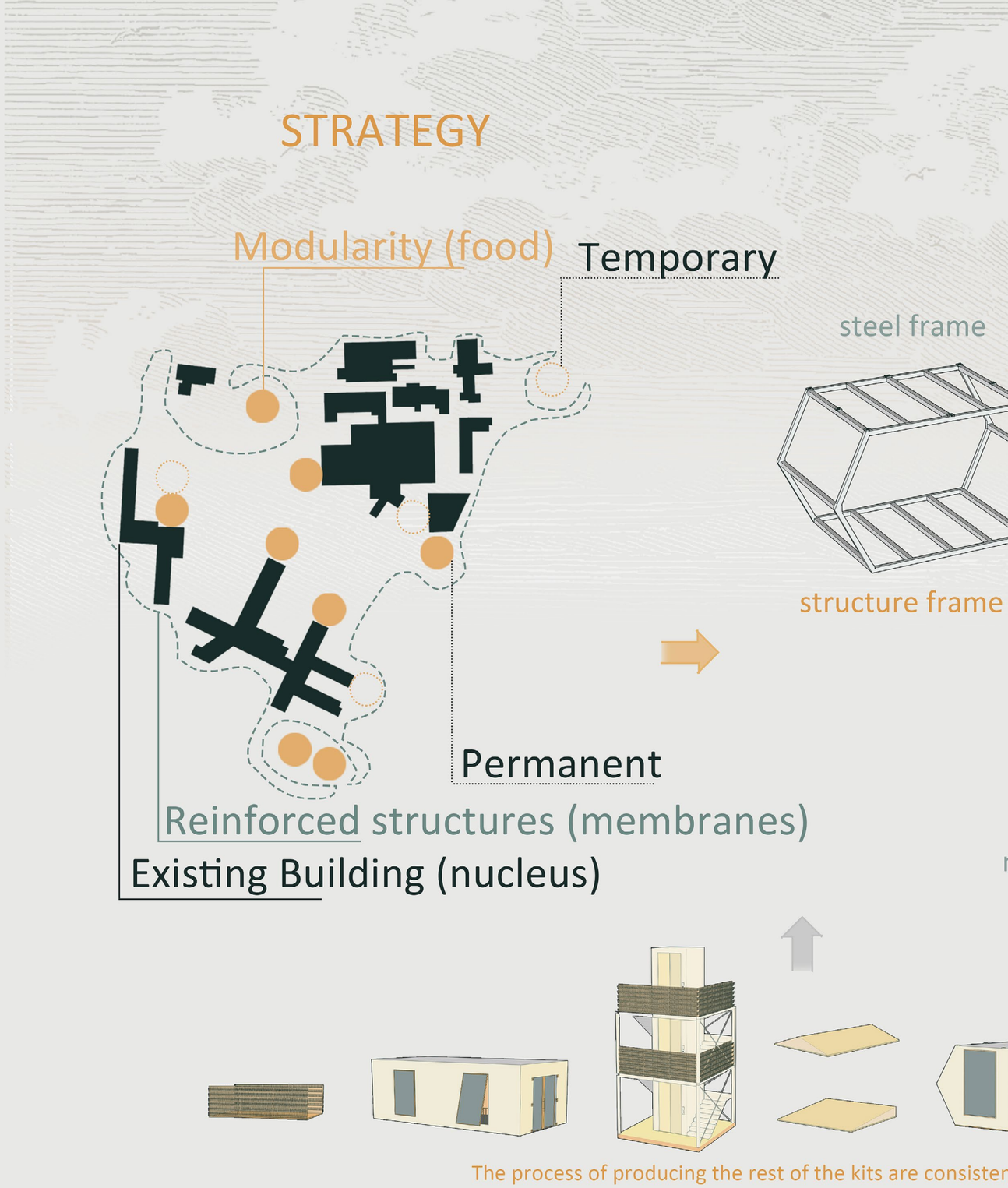


Figure 94. Amoeba strategy diagram, including off-site, on-site build and installation details.

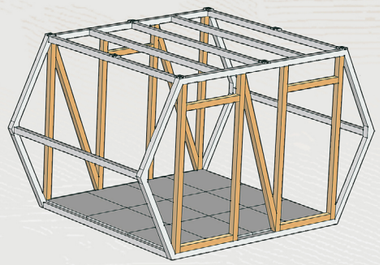
FACTORY FABRICATION

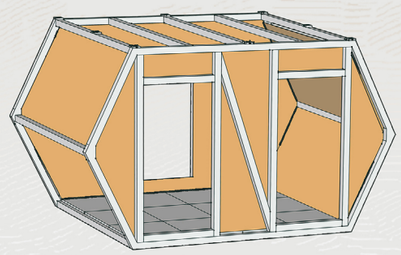
high quality works in save and control enviroment

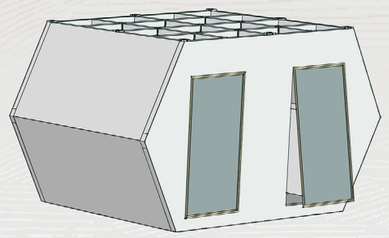
wood bracing

insulation and plaster board(gib board)
scraw and paint cover

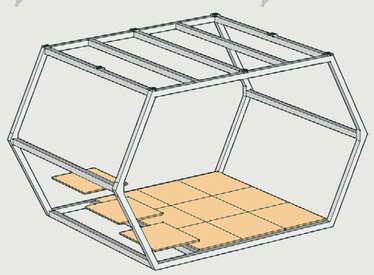


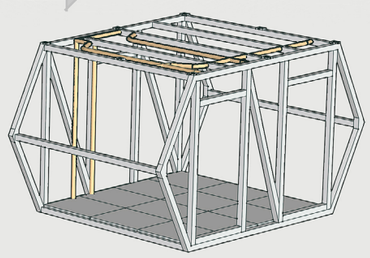


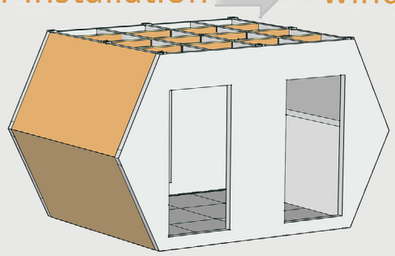


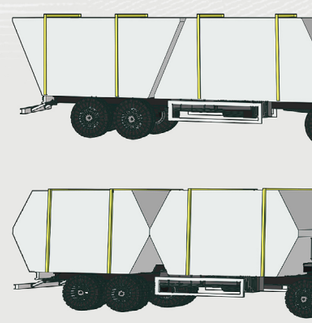


flooring → sub framing → pipes → interior installation → exterior installation → window&door installation → PACK & TRANS







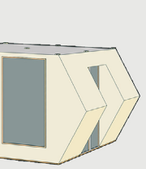


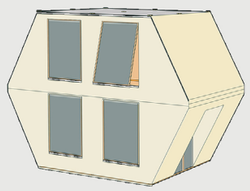
non slip safety vinyl flooring

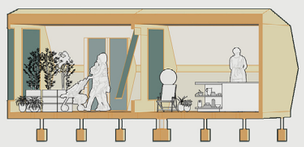
water and electricity reserved
connection for on-site installation

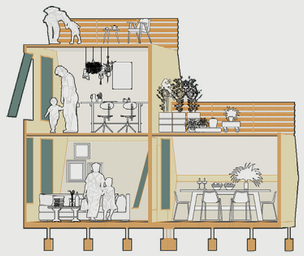
fibre cement board and silicone sealer

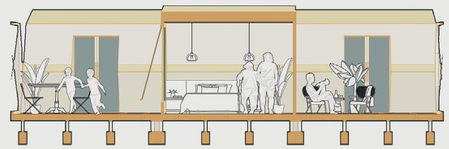
to site installat

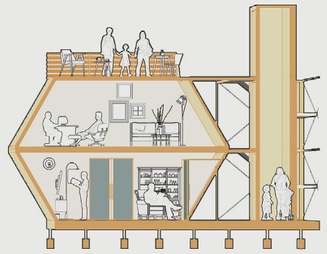


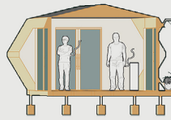












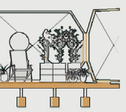
nt.

Form different combinations with kits for different needs and periods of time.

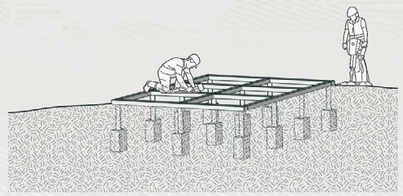
SPORT



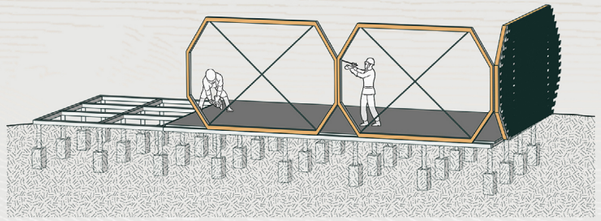
ion



POP-UP on ground installation



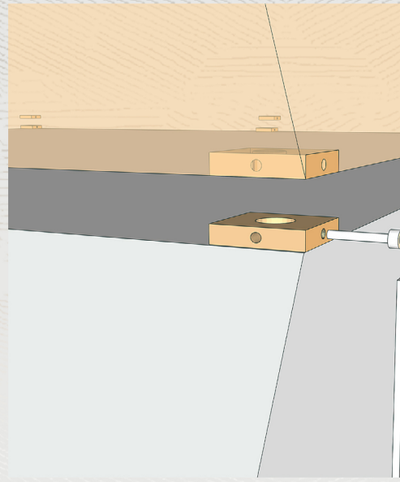
piers foundation



garden&landscape

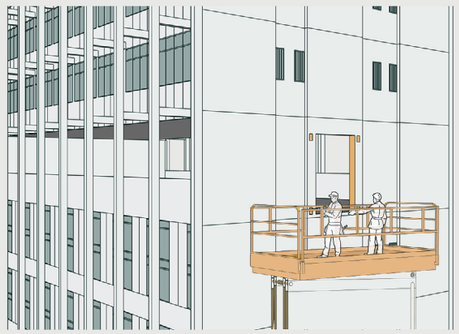


modular on top

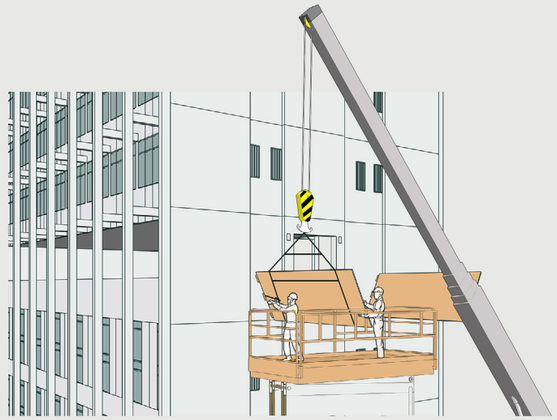


PLUG-IN on original building

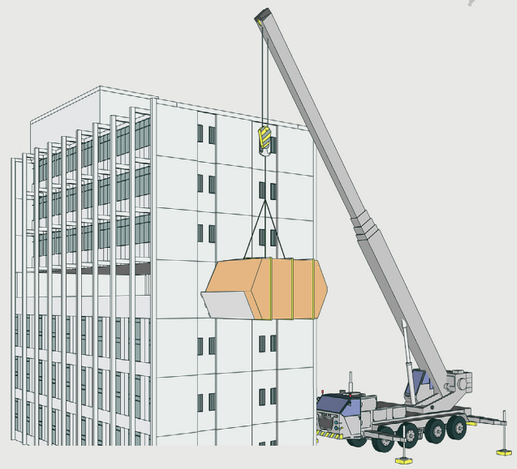
remove section of wall



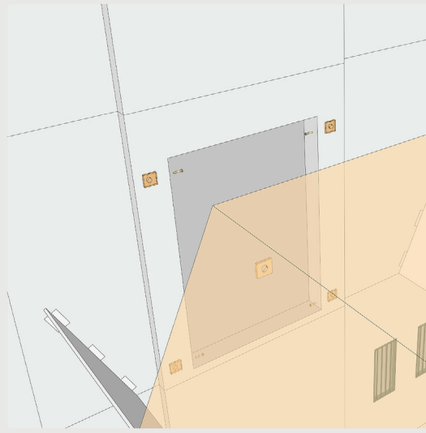
joint&support



modular build in



joint on original bu



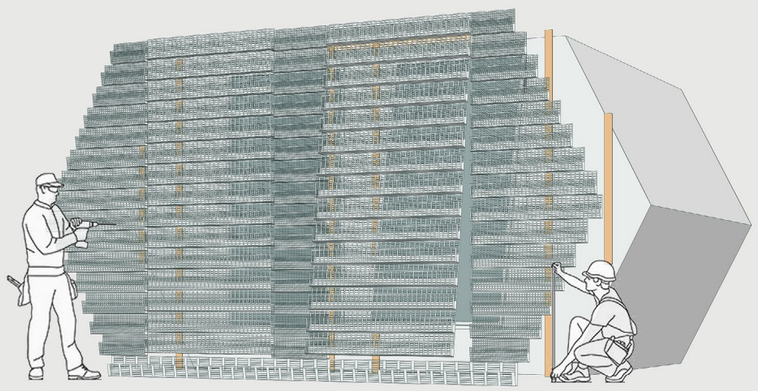


detail

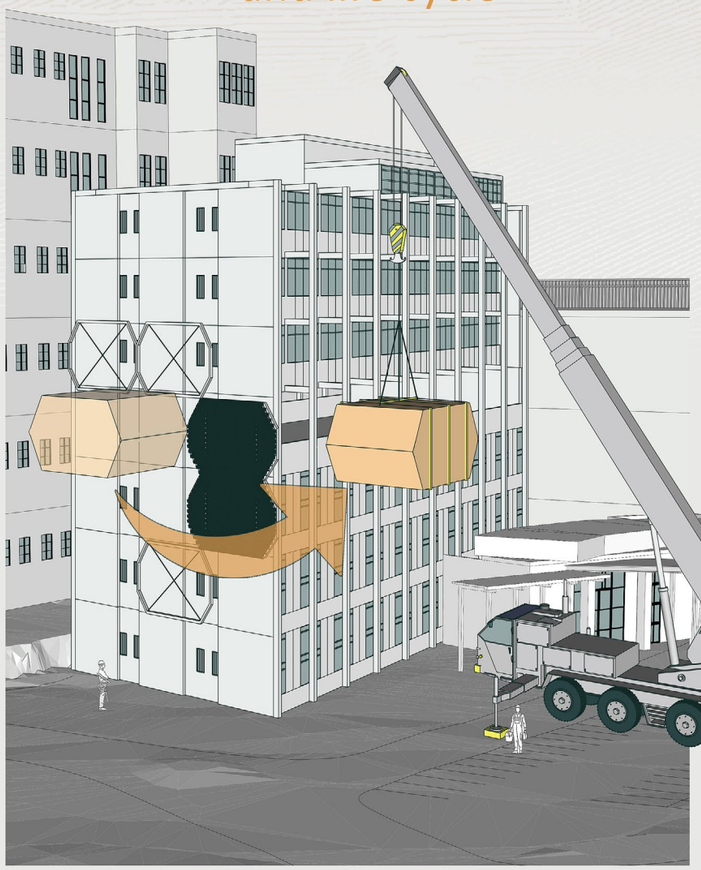


uilding

FACADE



Extended building use
and life cycle



could be remove in future

The advantages of using steel structures are non-combustible, and be connected with screws. This can give the module ability to reduce damage that can be caused by a fire and is easily achieved by removing, replacing.

After all the module kits have been completed for different periods and requirements, they will be transported to the site. In this design strategy, there will be two installation methods, on ground modulars(pop-up) and modular on existing buildings(plug-in); these different installation methods will be placed appropriately on the site according to their functions. Finally, the process will be completed with the installation of the facade. In the future, as healthcare needs change, the modulars can be easily moved to different locations within GCSC, or even relocated to other sites to temporarily support the needs of other facilities.

5.4 PERSPECTIVES



Figure 25. The Amoeba strategy implements on CCSC site, includes mental health services on the left, smoking area in the centre, waiting for healthcare service on the right, and structural retrofitting walls integrates the added modules into the whole perspective.



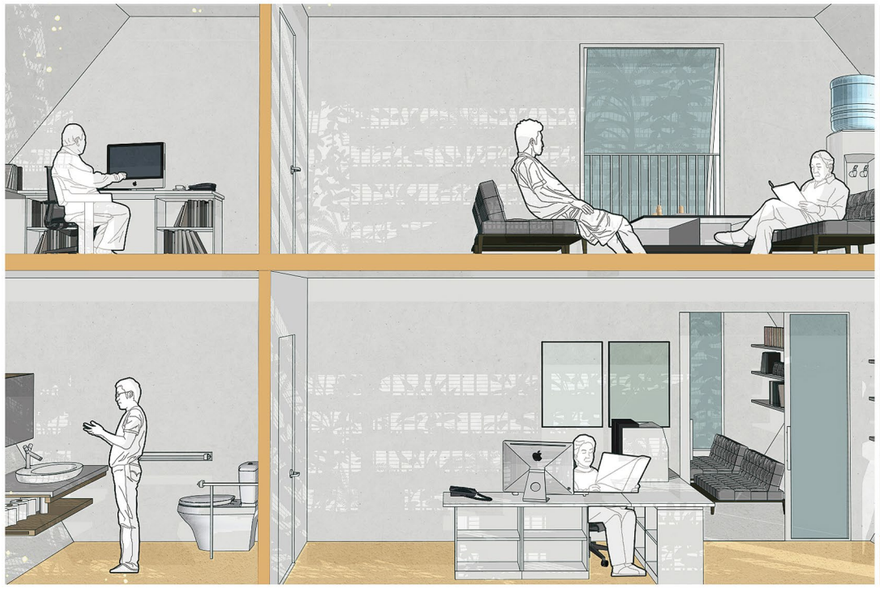
Figure 96. The semi-outdoor corridor under the staircase, formed by structural retrofitting walls, which creates different patterns of shadows in different seasons and under different sunlight, creating a biophilia lively atmosphere for GCSC environment.



Figure 97. The outdoor balcony facing Maungakiekie (One Tree Hill) perspective, the staircase with lift helps accessibility, where anyone can relax and improve well-being.

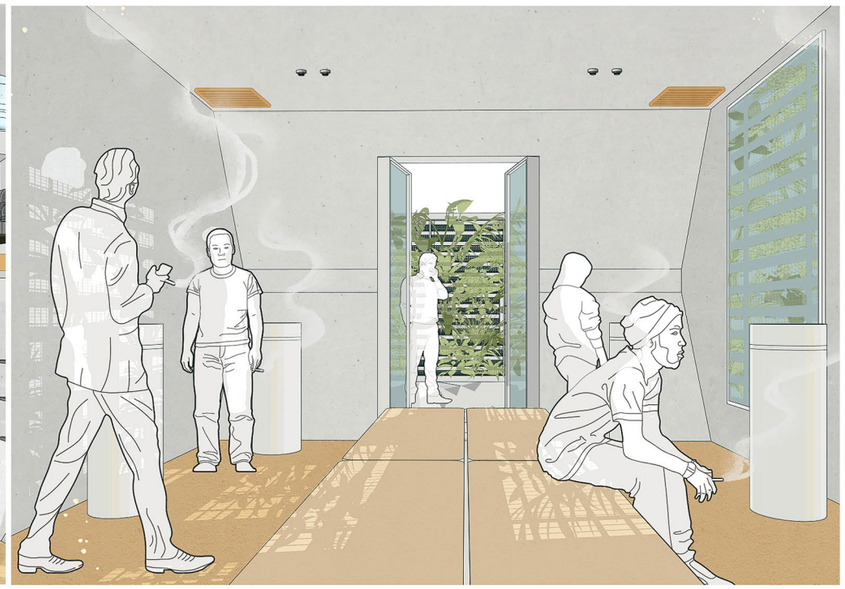


Figure 98. The staircase and structural retrofitting walls comprise a perspective of the resting spaces, including some imagery of what could be to create a comfortable environment: there could provide a playful environment for children waiting(an alternative to updating the esiting Creche), or a reading space surrounded by a greenery.



MENTAL HEALTH SERVICES ROOM

Figure 99. The perspective view of the section shows how the inside of mental health service is organised, including lower right reception, lower left toilets, upper right waiting area/multiple meetings, upper left office and stairs on the other side of this view.



SMOKING AREA

Figure 100. Smoking area perspective(temporary module), facade patterns creates sunlight in to the smoking area and relative privacy, providing a cosy and non-depressing environment for resting.



WAITING ROOM

Figure 101. Interior perspective of waitting for health, allowing patients and their families to wait here, including a range of facilities such as a kitchen, children's table and chairs, creating a comfot space for waitting.

5.5 FUTURE AGENDA
-ELEVATION-



This research project has focused on the form and function of modularity as equipment and needs are constantly adapted and updated based on changes at GCSC. While this exegesis have focused on non-clinical services, but if modularity needs to be applied to heavy medical equipment, other multidisciplinary needs to collaborative and coordinated designs will be required to meet additional needs. The main aim of this exegesis is to propose the utilised and potential of Amoeba Strategy.

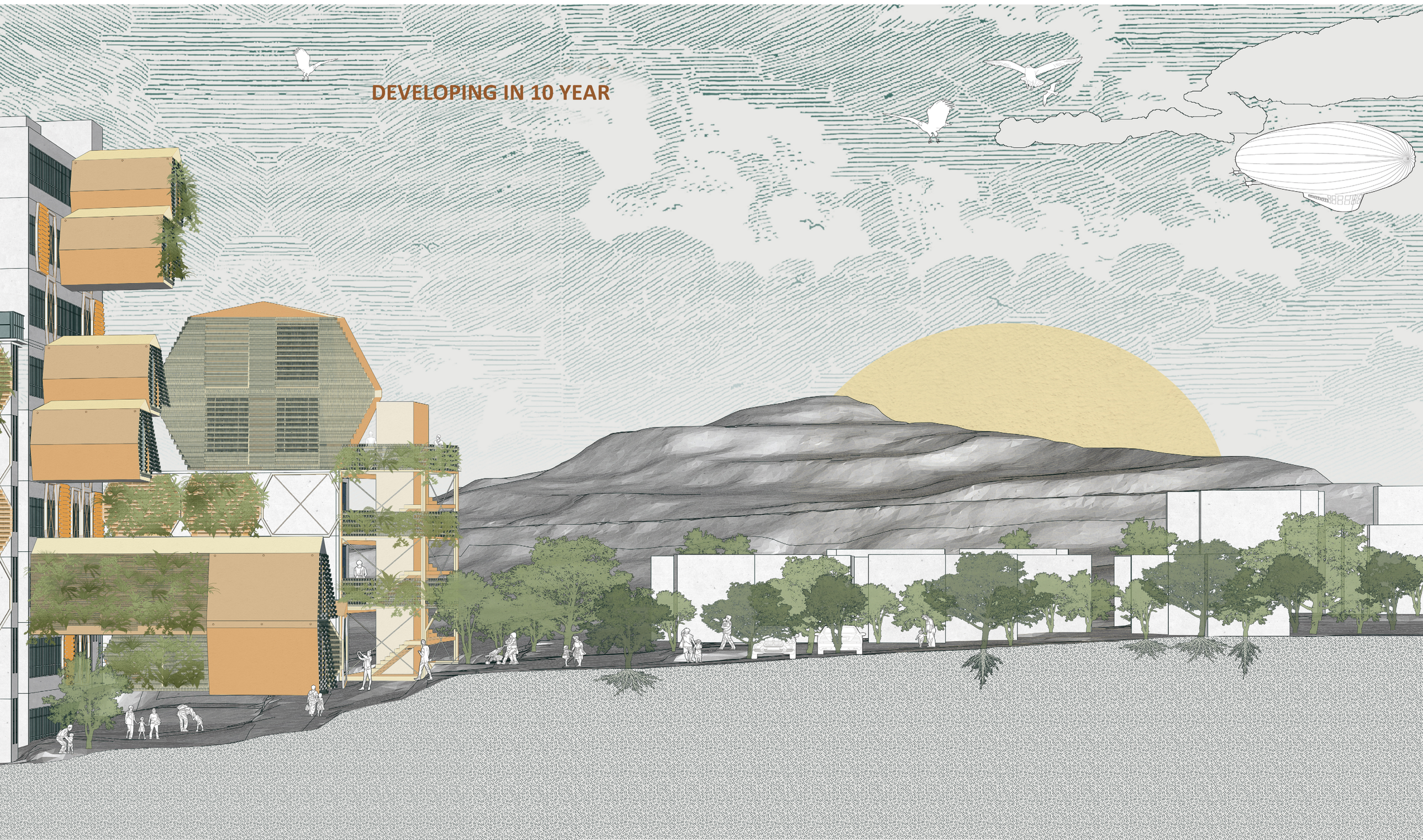
This design approach has a wide range of future collaboration and coordination opportunities because it can be applied to a wide variety of healthcare facilities and can be customised and improved over time. The potential and possibilities for future development realised through the Amoeba Strategy through assumptions and research show in diagram (Fig.100).

Figure 100. Imaginary diagram of future development in GCSC of the moeba strategy, including more service installed and the new research project.

DEVELOPING IN 5 YEAR



DEVELOPING IN 10 YEAR

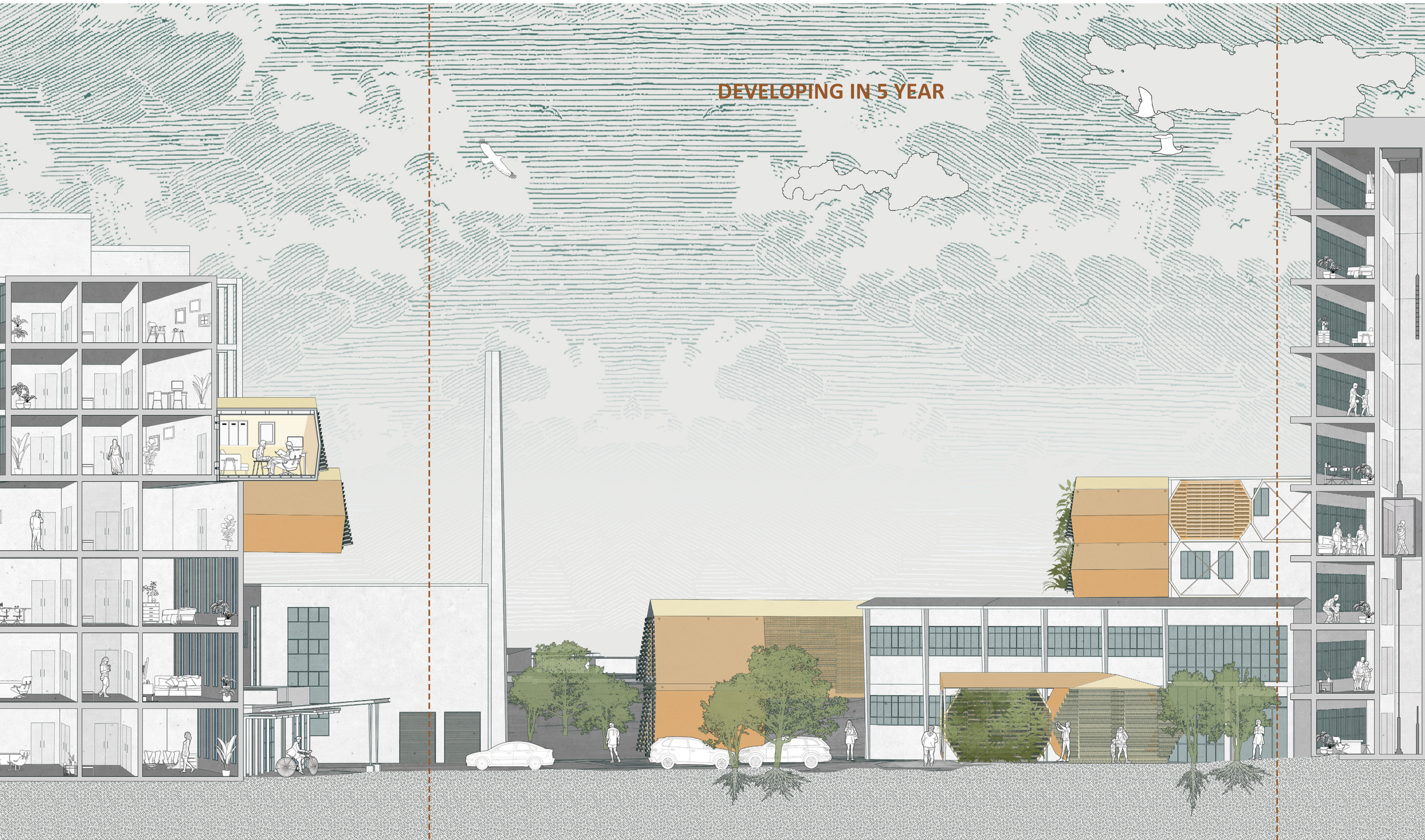


-SECTION-

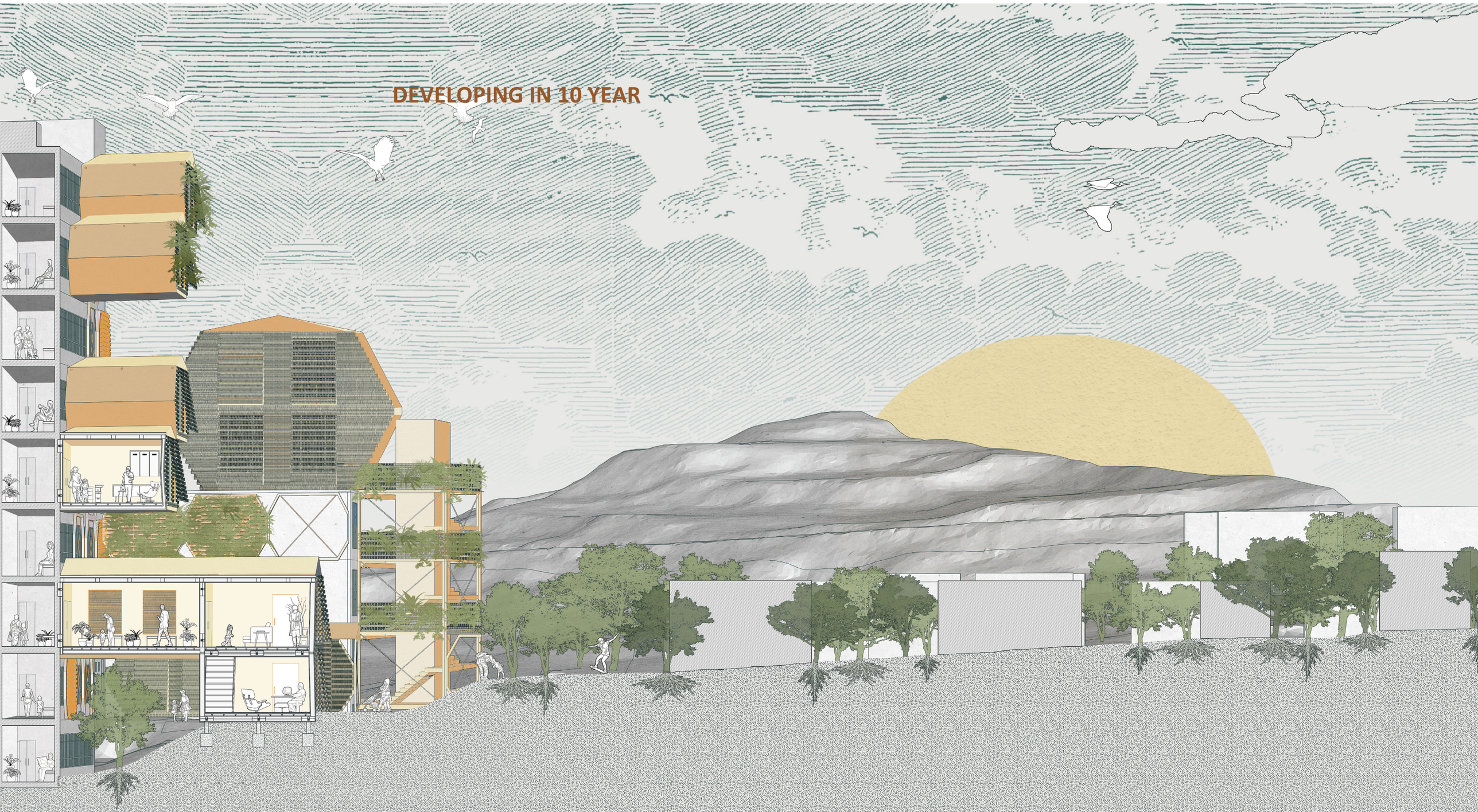


Figure 103: Section to show more sevice installed and functional of the model strategy

DEVELOPING IN 5 YEAR



DEVELOPING IN 10 YEAR



PART 6: CONCLUSION

This project research and investigation to developed the Amoeba Strategy that combines modularity, amoeba and biophilia to support the challenges that arise in the quickly changing environment nowadays. By incorporating the biophilia concept into the design, it can improve the healthcare environment and enhance the comfort and well-being of patients and healthcare professionals in order to create extra space for healthcare while at the same time catering to comfort space.

This strategy provide new ideas to the development of healthcare architecture. As the healthcare field continues to evolve, the flexibility and adaptability of this strategy will make it an important tool for future collaboration and coordination.

Findings and Reflection

In reflecting on this thesis, the key advantage of this strategy is the ability to quickly respond, disassemble, and reconfigure modules to meet changing healthcare needs. This flexibility is especially important in the current context of population growth, and unexpected situations such as the COVID-19 pandemic. The design flexibility of modular buildings allows hospitals to configure space to meet the needs of different departments and functions without the need for environmentally disruptive and time-consuming remodelling. This helps healthcare facilities stay operate efficiently.

However, in the design of this study, some concerns that need to be discussed further. Firstly, the 'plugged-in' cantilevered modular installations on existing buildings may trigger connection problems between different floors, as the floor heights of different buildings may not be consistent. This requires methods such as mass-customisation to accommodate these subtle differences.

Additionally, while the Amoeba Strategy improves GCSC's ability to respond quickly, the location of services may change as needs change. This can lead to difficulties for visitors to adapt to the GCSC environment, thus reducing patient and staff comfort. Therefore, additional site planning and orientation initiatives are needed to ensure that GCSC improvements are consistent with the aims of the modularization strategy.

In summary, thought researching and analysing amoeba strategies can indeed open up new opportunities for the design and construction of GCSC, increasing the speed of buildings and enhancing the ability of hospitals to respond to future healthcare needs. However, it will require multiple collaborations to achieve this aim, including public engagement and cross-disciplinary collaboration, balanced to create better healthcare environments. In the future, modular buildings can continue to play a key role in healthcare to ensure that visitors receive high quality care as well as the environment.

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