The modular structural system as an innovation for temporary public healthcare project of 4th-year architecture students at UIN Maulana Malik Ibrahim Malang

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***Abstract*- The module structure system implements development by utilizing fabricated materials or components made outside the project site or on-site. Consumable shipping containers are often used to make architectural space rated more quickly and efficiently. The advantages of containers are customized, strength, durability, modular, labor, movable, availability, expense, and eco-friendly. The rapid spread of Covid-19 in various regions demands fast, proper, and adequate public health facilities. Containers can be an innovative solution for providing temporary, flexible, efficient, functional, and sustainable public health room facilities. This study describes the uses and advantages of modular container systems for architectural spaces. The result is a schematic design from the design studio of the 4th year architecture student of UIN Maulana Malik Ibrahim Malang, who is trying to improve the function of the use of consumable containers to get more benefits as a temporary architectural space for sustainability and public awareness of health and handling Covid-19.**

Keywords—Architecture; Container; Design; Modular; Public healthcare; Structure; Sustainable;

I. INTRODUCTION

Currently, health facilities are a significant concern in response to the COVID-19 outbreak, especially in urban centers with high population density. The increase in the percentage of the spread of COVID-19 is caused by lack of public health facilities and is also much influenced by lack of public awareness of their health, mainly because of high cost and distant health test locations. Therefore, currently, effective and efficient health facilities are needed. The implementation of good health services must be available and launched, easy to achieve in financing that must be adapted to the economy, acceptable to all groups, easily accessible from a strategic location, and of good quality according to available standards and codes of ethics to satisfy satisfaction [1]. The readiness of health facilities and assessed services can influence people's perceptions to care more about their health. The current condition can also disturb the psychology of the community. Therefore, an assessment from the community is needed regarding the implementation of health services to remain confident in getting health services [2].

Public Healthcare is needed to provide health services that are easily accessible, inexpensive, and can serve public health problems that are urgent in emergencies. Community Healthcare must be designed to meet health regulatory standards, equipped with supporting facilities such as outdoor or indoor fitness, pharmacy, health education galleries, a proper rapid test system, and can be carried out using a drive-thru system. Service standards and health protocol systems must be clearly defined and properly implemented to avoid the spread of the COVID-19 outbreak.

Public health clinics are solutions for easily accessible healthcare services for both urban and rural residents. They can serve urgent health care issues in emergencies. With the epidemic outbreak, the need for medical facilities increases; these clinics will function as mini hospitals in such conditions, eliminating the number of infected victims who suffer from the unavailability of health facilities [3].

The design aspect is small but can be expanded according to the needs of the design concept. Can be equipped with various aspects that have more functions that support improving the quality of public health. Realized a creative design for a public health clinic which is a small clinic near the neighborhood that serves all primary healthcare services, especially for COVID-19 testing. Community Healthcare can be quickly built, functional, aesthetically pleasing, easy to build with container/precast/modular box designs.

II. LITERATURE REVIEW

Shipping container architecture could be defined as that type of architecture generally characterized by the re-use of steel shipping containers as a structural element and Architectural envelope that can host a specific function or a human activity [4]. Modular manufacturing is gaining traction worldwide. It can be called sustainable construction because it tries to utilize container cargo that is no longer used. The uniform modular formation in the form of square blocks and standardized sizes makes containers one of the quick solutions

to generate space because one module already has the completeness of space, namely floors, walls, roofs, and doors.

A shipping container is a steel frame-usually cuboid-with a suitable strength to support significant cargo transits and stowage. There are various types of containers, varying from refillable to universally standardized. For global trade, the term container is directly associated with a shopping container that can be loaded onto a significant number of transportation options without requiring unpacking of its contents [5].

The need for medical space during the pandemic, especially for a temporary and movable swab or rapid test activities, makes the modular system an effective alternative for the needs of handling COVID-19. The benefits of a modular construction system include; fast production and installation turnaround times, ease of transportation and installation in remote locations, standardized work and automation of increased safety, quality and consistency, cost efficiency, mitigation of high-risk weather, environmentally sustainable nature, and reduction of construction waste.

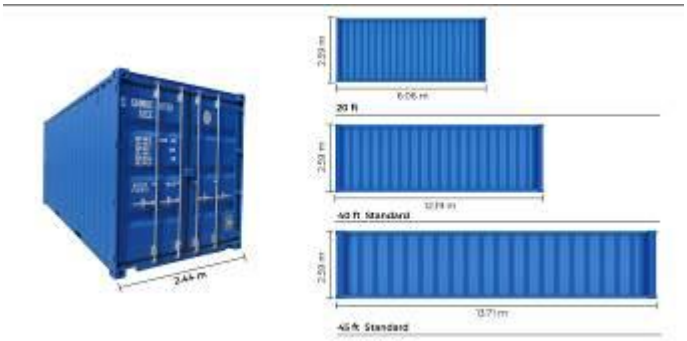

Fig. 1. Typical and size of shipping container [6]

Using shipping containers in creating various architectural spaces. Knowing that geometrically any space could be defined by different planes, horizontal and vertical, with a spatial relationship that organizes this space defines it and represents the human function that this space was created to be performed in, with the scale and dimensions, another value is added, thus leading to a better performance in this function or another function that could be added or performed. So looking at any steel shipping container, the primary and essential conditions of space exist; with some modifications, it can host various human activities of functions, thus creating not only functioning spaces but also exciting spaces for people to live, use and enjoy [4].

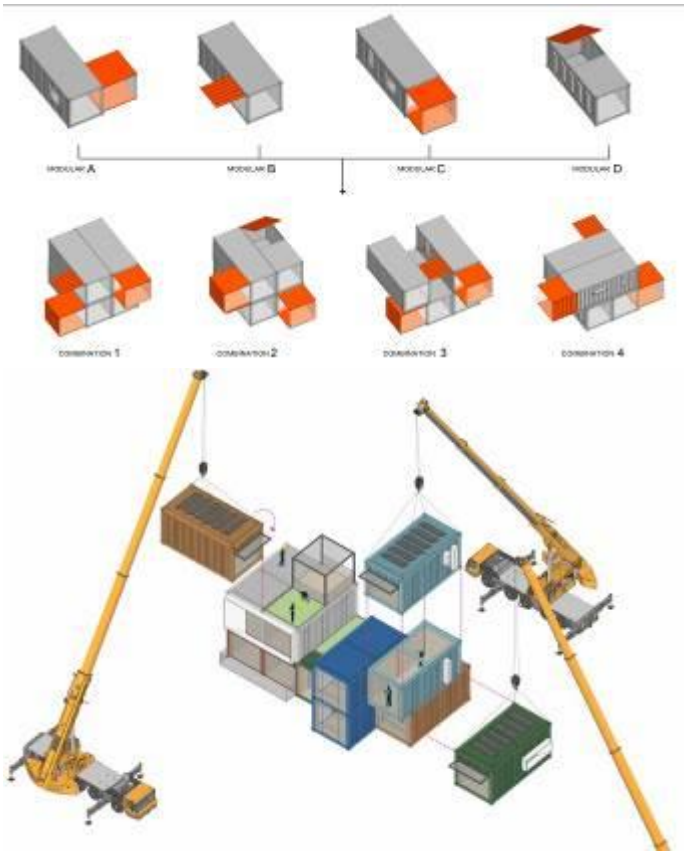

Fig. 2. One of the shipping container assembly system [7]

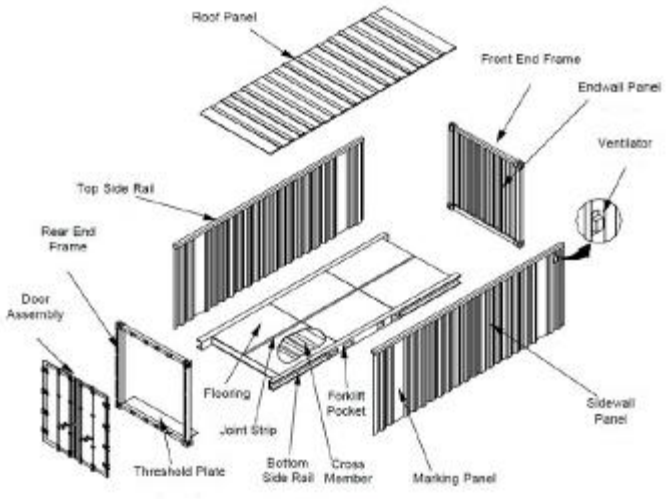

Fig. 3. Shipping container assembly structural system [8]

The use of modular systems in the form of containers for architectural rooms has been widely used. For the health sector, one of which is Spacecube, in collaboration with Monash Health and Aurecon who built a high-end semi-permanent Medical Resus facility in Melbourne, Australia. Spacecube's unique modular system can be easily reconfigured

and reused in a variety of ways. This medical resus facility was built using 25 separate modules covering 360 m2 arranged on two floors with six bedrooms, a nurse station, medicine, and a utility room.

Fig. 4. Monash Health RESUS Facility / Spacecube [9]

A modular structural system for the treatment of COVID-19 was also used at the Honshenshan Hospital in Wuhan, China's Caidian District. Citing the China Global Television Network (CGTN), Huoshenshan Hospital, built with a construction area of 33,900 square meters, will have a capacity of 1,000 beds. The hospital, which has started groundbreaking on January 24, 2020, is targeted to be completed on February 3, 2020, or in about ten days.

Fig. 5. Honshenshan Hospital Distrik Caidian Wuhan Cina [10]

Fig. 6. The Citizen Care Pod is a new initiative for COVID-19 smart screening and testing, WZMH Architects [11]

Carlo Ratti Converts Shipping Containers in Milan, Italy, also uses a modular system as a response to the immediate needs of the COVID-19 handling room. The Cura project consists of a modular maintenance room made of cargo containers with 6 meters. One unit of container module has been equipped with a standard room system with Airborne Infection Isolation Rooms (AIIRs).

Fig.7. Carlo Ratti Converts Shipping Containers into Intensive-Care Pods for the COVID-19 Pandemic in Milan Italia [12]

III. MODULAR SYSTEM IN ISLAMIC ARCHITECTURE

In this project, Islamic integration emphasizes the modular system itself, namely flexible, efficient, functional, and sustainable. Flexibility here is temporary, which can be dismantled and moved as needed. This will provide appropriate and targeted value by making it easier for users and the local environment to adapt. This property also minimizes environmental damage. The modular design of public health care is not only "green" but also combines the sustainability of human health and the environment. In this modular construction, there is no need for a full foundation and only requires a few piles or supports at the corners and temporary properties, which can be moved to minimize tread damage when finished. This can minimize environmental damage, according to QS Ar-Rum: 41-42.

The efficiency of using this modular system is the efficiency of use and function to optimize the wasted time, effort, and cost. Prefab modular manufacturing instead of on-site optimizes mass production efficiency. The distribution and construction process on the site becomes faster and easier. The nature of this efficiency is in line with Islamic values of efficiency and expediency.

Modular systems using shipping containers concentrate on reusing consumable containers by reconstructing them into an architectural space. The availability of containers at cargo ports that are no longer used can be a practical option informing space, and paying attention to the structured arrangement pattern will form a more extensive and more complex modular collection of containers. The arrangement can be changed according to the function according to future needs. Used materials, dismantling, and customizing are essential things to support the nature of sustainability in architecture.

The flexible principle is easy to build, dismantle, move, install. According to Ibn Asyur, one of the characteristics of houses mentioned in the Qur'an is that they are flexible to be built, dismantled, moved, and installed in the same place or different places. in QS. an-Nahel: 80 uses environmentally friendly materials such as animal hair and various materials that are easily recycled [13].

The principle of time, energy, material, and cost-efficiency is one of the absolute requirements for a development to be carried out by the objectives of the revelation of Islamic law. Because the use of time, energy, materials, and appropriate and efficient costs are included in the principle of preserving property (hifẓu al-māli) [14], from another point of view, a development that is not based on the principle of efficiency, then at least in the Islamic Architectural Jurisprudence balance will be included in the category of makruh development. Improper construction is any construction, elevating a building or decorating a building that is carried out without a need. There is no other reason for the element of waste, waste of wealth, land, and building materials without use.

On the other hand QS. al-Isro ': 27 firmly that the unscrupulous elements are friends of the creatures God hates the most, the devil. Even into the group of people who are kufr by the grace of Allah SWT.

Modular System structure design

Design a typical module that is easy to construct in a factory and not expensive to transport and assemble at the building site. In order to achieve the goal, we must carefully consider all the different technological aspects in the concept phase [15]. This means that to save space and money and obtain a helpful unit, we have to start with a very open-minded approach, considering and anticipating all the problems concerning structure, architecture, and energy building [16].

First of all, starting with the architectural idea, we have to choose the most appropriate material to communicate a certain feeling, obtain some mechanical and technological properties and reduce weight [17]. It also has to save money and space and obtain good performance from the insulation point of view. After that, all the principle elements are designed looking at the assembly phase and the flexibility of our modules. In particular, the most innovative solution will be the easiest to assemble anywhere. Next, in the design phase, we have to consider many different combinations, starting from our modules and arriving at an actual complete, scalable building that is simple to disassemble and replace [18]. To obtain this purpose, great attention should be paid to the design details, such as all the joints between the different elements of a single module and the junctions between different units.

Designing basic modules, elements, and temporary buildings which are economical, comfortable, and even glamorous is only possible if a systematic, industrial and multidisciplinary approach is used during the creation process [19].

IV. ANALYSIS OF DESIGN DEVELOPMENT

The first example of prefabrications was in 1624 when the British used a wooden panelized building for the fishing fleet in Cape Ann [20]. This system was used by the British colonies that needed to build in a new world with uncertainty and no high skilled workers, and they brought directly prefabricated building parts from the mainland. 1964 saw the Archigram group creating the concepts for walking cities and plug-in cities [21]. With their conceptual and utopian ideas, they started to understand the importance of the mother structures that configured the architectural organism and locating the prefabricated and temporary modules. In these years of research, they interpreted the frequent changes of society and the people's movements.

In 1968 Richard rogered proposed his Zip-up enclosures as a series of standardized components in which users can purchase and expand this living structure [22]. This concept is based on layered arrangements, like books on a shelf, with a rigid and regular external appearance but a different internal space composition. Distinct elements could be bought and used to increase the size of the house units. In this way, it was able even to create cluster systems combining insulated housing elements.

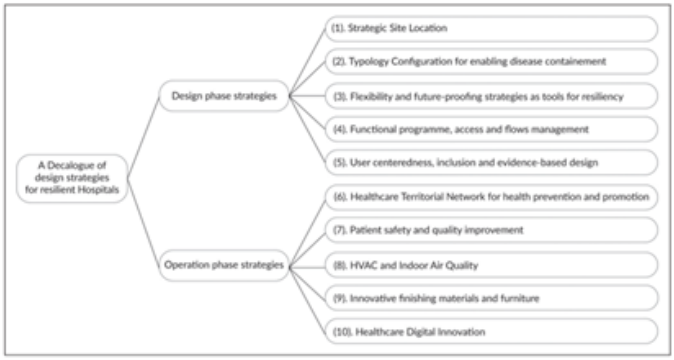

Fig.8. Flowchart of the decalogue of design strategies for resilient hospitals

In 2003 LOT-EK architects completed the prototype for a modular dwelling unit based on the shipping container converted industrially into dwellings [23]. They use extendable and retractable systems to increase and decrease the module usability of the interior spaces. They interpreted the recycling time of the first 2000 and used the same aesthetic of the actual container. This approach pushed the ideas of the reuse of materials in new and popular ideas at the beginning of this century.

Based on decalogue of design strategies for resilient hospitals, there is consideration of analysis Healthcare Community [24]:

1. Communal participation, the involvement of people in a community in projects to solve their problems
2. Precaution of infectious diseases (airborne and droplet), hand hygiene before and after all patient contact. The use of personal protective equipment, which may include gloves, impermeable gowns, plastic aprons, masks, face shields, and eye protection.
3. Divide staff area and patient area, These models suggest implementing a patient-centered medical home4 and require a transformation of the fundamental principles, structures, and processes of family medicine.
4. Clean zone and contaminated zone, unclean items are either put straight on racks and loaded into the washer-disinfectors or manually cleaned after visual inspection. Manual cleaning methods include soaking or spray-gun rinse and ultrasonic cleaning before being loaded into the washer-disinfector.
5. Screening area, Expand the use of the screening area to other close contact processes with patients to protect the safety of healthcare staff.
6. Cleaned waiting rooms require a high level of hygiene as they accommodate both those who are most likely to transmit harmful pathogens and those who are most susceptible to them.
7. Good visibility of path and waiting room for the patient, The concept of the patient experience related to patient satisfaction is a complex dynamic. It is a dynamic that is becoming increasingly more important as patients are faced with multiple choices for their hearing and balance care.
8. Durability material and minimum infection, Environmental infection-control strategies, and engineering controls can effectively prevent these infections.
9. Restroom for the staff.
10. Good standard of the consultation room and laboratorium.
11. Good ventilation and insulation area for reducing infection probability.

V. THE TECHNIQUE OF MODULAR SYSTEM INNOVATION FOR PUBLIC HEALTHCARE

The system consists of two majors elements: a core and a dwelling module. The first acts as a case for the latter, independent and not invasive for the dwellings. The core that stands for both the structural system and the vertical connection is a set of concrete elements, such as bearing walls and slabs, creating a unique standard for where it is located [25]. The construction process is based on prefabrication to reduce cost and time. The mother building structure is built on-site while the modules are produced and assembled in a factory to further allow faster installation on-site [26]. The whole system aims to reduce time and cost through a new way

of conceiving housing. This concept allows a high degree of freedom and flexibility, generating a structure able to change in time according to the client's needs and wishes.

"Wellness involves the pursuit of activities that lead to holistic health, happiness, and well-being," said ADB Chief Economist Yasuyuki Sawada. The pandemic has had a significant negative impact on physical and mental health, and governments should incorporate wellness-promoting policies into their recovery plans to promote economic growth that will benefit both individuals and society [27].

Governments should also encourage healthy eating by improving consumer information and awareness of nutrition and diet. For instance, some regional governments are already imposing higher taxes on sugary drinks and tobacco products, combined with regulations on nutritional information disclosure for food and beverage products and public awareness campaigns [28]. This is important because annual direct medical costs due to obesity are estimated at 0.8% of the region's gross domestic product (GDP). Pursuing universal health coverage can amplify the benefits of wellness for all Asians. The modular system technology that can be done is through the following steps:

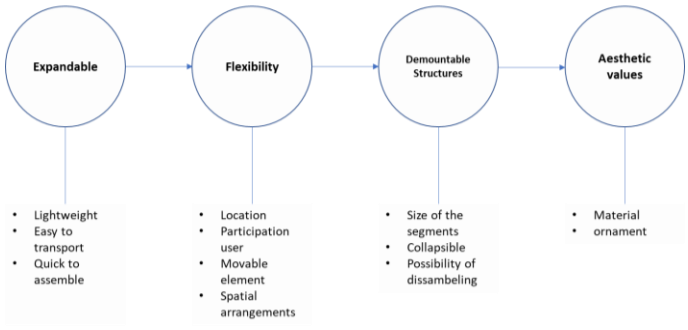

Fig.8. Modular system design method

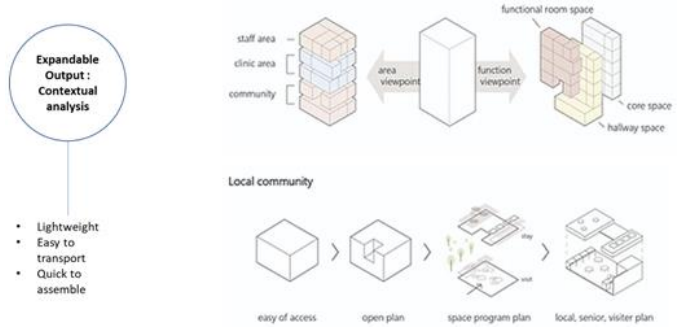

Fig.9. Step 1 of expandable system produce contextual analysis

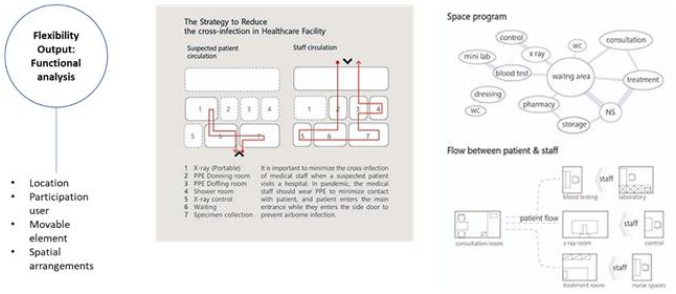

Fig.10. Step 2 of flexibility system produce functional analysis

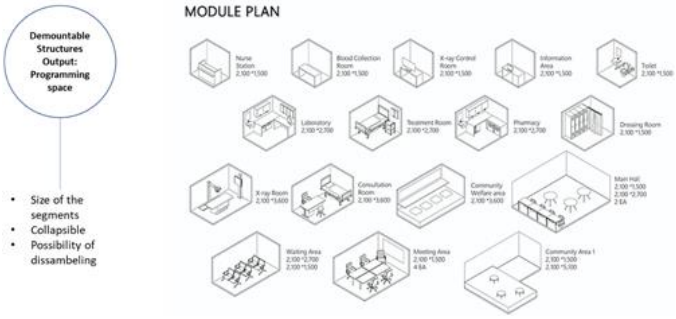

Fig.11. Step 3 of demontable structures produce programming space

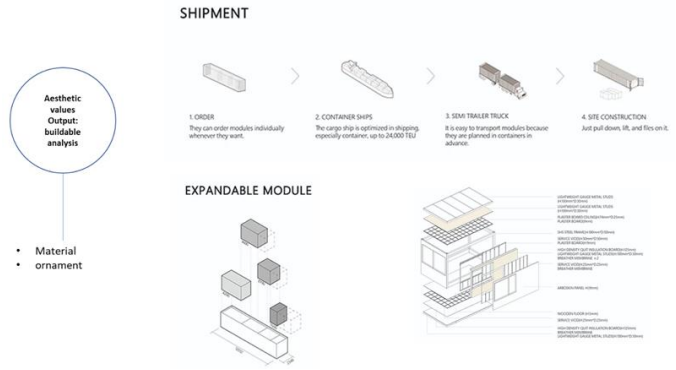

Fig.12. Step 4 of Aesthetic values produce buildable analysis

VI. DESIGN SUBMISSIONS FOR TEMPORARY PUBLIC HEALTHCARE PROJECT OF 4TH-YEAR ARCHITECTURE STUDENTS

This project proposes a "Public Health Improvement Room Design" that can answer issues regarding room services for handling Covid-19 and concern for personal health and the environment. Design a space for a modular medical clinic with basic facilities for first aid treatment and minor medical problems. The design is intended to accommodate basic health facilities in a modular form and optimize open space. It includes Consultation space, Nursing/Dressing space, Consultation space, Waiting Space, Storage, Pharmacy, Mini Laboratory, Central Sterile Services, Waste Management, and lavatory. Also equipped with supporting areas for Screening tests, Rapid test areas, Drive-thru for rapid tests, Fitness,

Educatif Gallery, Prayer Room, Prayer Room, Parking lot, Ambulance, and Services (utility management).

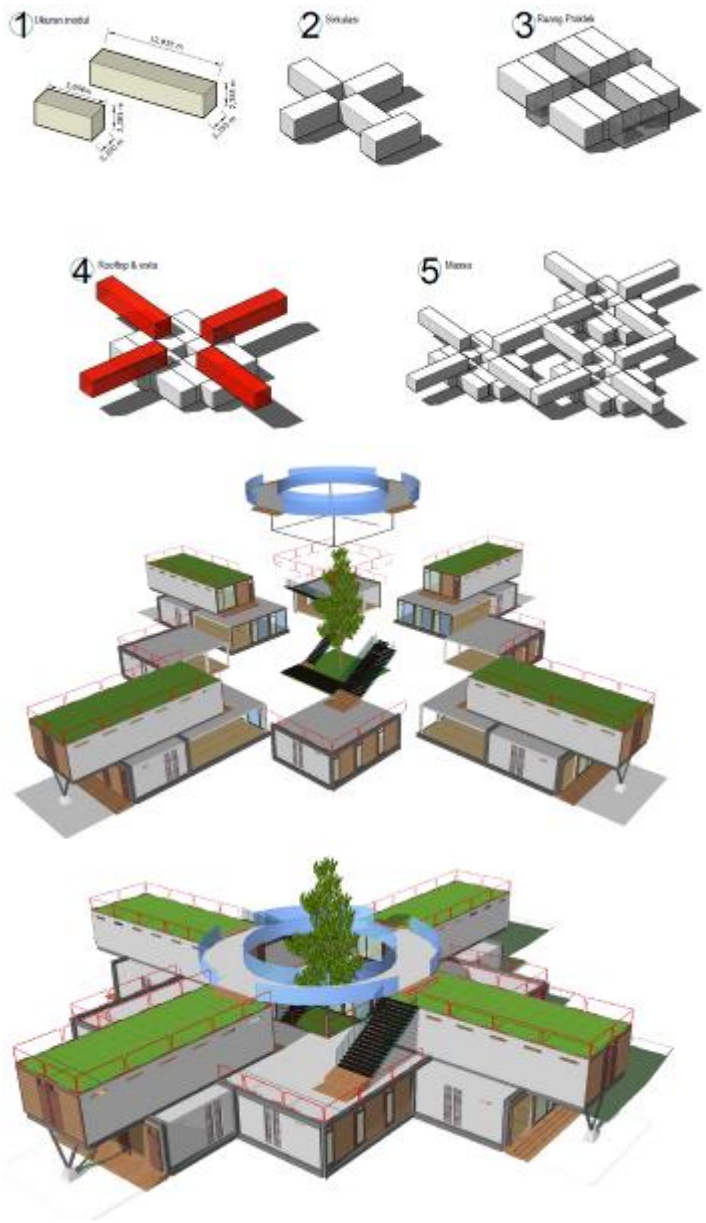

Fig.13. Modular system design development

Fig.14. Final rendering shipping container as temporary public healcare

VII. CONCLUSION

The rapid spread of Covid-19 in various regions demands proper and adequate public health facilities. Shipping containers have modular characteristics that are flexible, efficient, functional, and sustainable, which are considered to answer these needs. The arrangement of the container modules can be adjusted to the needs of space and still pay attention to the existence of the environment. The modular innovation of consumable containers as public health facilities is also in line with Islamic values, which are recommended to protect the environment, facilitate humans, reduce construction industry waste and take advantage of the existing potential hablumminannas-hablumminal alam-hablumminallah.

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