

Modular outdoor furniture product for new normal public space

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Abstract. The limitation of shared activities in public spaces during the New Normal period requires flexible, multi-functional furniture that can be applied in public spaces. Outdoor modular furniture that can be flexibly modified to avoid spreading the virus through surfaces is required to add value to the public outdoor facility. Outdoor modular furniture with cellular lightweight concrete (CLC) as its material has been developed to be used in public space sitting areas. The modular furniture produced from this study can function as a sitting, playing and working facility with various arrangements in its geometrical form. The furniture can be used by adult users and children with the dimensions that refer to both variants of the user. The design had been made into a 1:1 scale prototype to produce compositions that can be used by adults and children for various activity. The prototype had also been tested for two years in outdoor public facilities. The test results showed that it is necessary to improve the material weight, give more rounded corners, improve the finishing as well as the construction process.

1. Introduction

The ongoing Covid-19 pandemic since 2020 has made changes in people's behaviour when using public facilities as well as to other various aspects of human life around the world. Covid-19 transmits between humans easily, and spreads through clusters in public spaces [1]. Human interaction in public spaces needs to be limited to prevent the high spread of the virus. However, outdoor activities still need to be encouraged as part of the current focus in the society to maintain a healthy lifestyle. With the establishment of New Normal health protocols and physical distancing regulations, human interactions and social activities can still ensue in this New Normal period, but in a different way. This opportunity requires innovations that can adapt to new human habits to survive with the changing social and economic conditions of the world [2]. In response to this New Normal period, a new seating facility arrangement for public spaces is needed.

This study focuses on creating modular seating facilities in public areas that are flexible and can be easily modified to reduce the spread of virus transmission. The design had been developed for public seating facilities previously and can also be applied in the New Normal period. The material used to make this furniture need to meet certain requirements namely, availability, cheap, fast to produce, and easy for maintenance to be used as a public facility.

The modular design approach highlighted the flexible geometric shape, and hence can be changed easily to avoid spreading the virus over the surface of the object. The materials used can be easily

sterilized and used for a long time. The material used in this research is cellular lightweight concrete (CLC) as a base material which is produced by inserting air bubbles into the concrete mortar mixture [3]. CLC is used because it is relatively lightweight, can be cast easily, waterproof and has good weather resistance. Furniture designs made from concrete are generally heavy so that the design is made permanent and cannot be moved. By using CLC, modular furniture can be arranged and moved as needed.

2. Research method

In this study, a modular outdoor furniture product design and prototype that can be used for various outdoor social activities was made. The development of the design had been presented previously for the outdoor modular furniture for various public activity [4,5]. The design can be used by both adults and children as a sitting, playing and working facility. The existing design was made into a 1:1 scaled prototype using CLC material. The design prototype that has been made was tested in outdoor public facilities from December 2018 to December 2020. This experiment was conducted to determine the level of material readiness and product function. The test process results will produce new conclusions that can be developed as an advanced design in the New Normal period.

3. Findings and discussion

Ideate and define

The global transmission of the virus between humans has limited the role of humans as social beings. The pandemic had caused problems to the world economy as well as social relationships. Many researchers argue that humans experience the most significant transition period, especially to the system pattern and work environment. Humans no longer work together within the boundaries of space, but humans work together only within the limits of time. Some jobs and business competencies can survive this condition and move their jobs from office to home [6]. However, some places still need a place to gather and sit together to carry out their activities.

Safety precautions are needed when there is still no cure for the Covid-19 pandemic yet. The only effort that can be done is to control the spread of the virus through human movement. Viruses that can survive on the surface of objects also facilitate the transmission of viruses from between humans [7]. Some public areas reduce the capacity of sitting facilities. Another effort that has been made is by creating a certain distance between seating facilities. These efforts need to be accompanied by the maintenance and cleaning of seating facilities in public areas. The resistance of the human coronavirus on several types of material surfaces can reach 2 to 8 days. Tests have been carried out on several material surfaces such as glass, metal, wood, paper, plastic and ceramic surfaces [8,9].

In public facilities such as seating facilities, furniture surfaces can be a means of transmitting viruses between humans. The effectiveness of cleaning the surface of material objects is also a concern for health facilities and public facilities [10]. Therefore, it is necessary to strive for a design of public seating facilities that can be modified practically, to avoid spreading the virus through the surface of objects. The seating facility design needs to be modified on a daily basis, to prevent virus transmission from one user to another. Existing designs need to be complemented by a flexible modular system with surfaces that are easy to clean. Based on observations made on several outdoor public facilities, several design aspects were generated including form, function, material and dimensions that were adjusted to the needs of the New normal, namely:

- The form consists of two main modules, as shown in Figure 1. This shape is developed from Froebel geometric blocks in children toys and modern Froebel architecture [5]. The two modules can be arranged in various vertical and horizontal compositions so that the form configuration can be changed every day.
- The function of the required facility must be used as a sitting facility. The module compositions can be arranged vertically or horizontally. These compositions can create different configurations that can be used as for sitting, playing and learning facilities [4].

- The material used is Cellular Lightweight Concrete (CLC) with a cast system. This material uses foam to produce air cavities resulting in lightweight, high workability, saving materials, low water absorption, and good temperature resistance. CLC concrete is lighter in weight than ordinary concrete so that it can be easily rotated and repositioned. This advantage will answer the need for flexibility in product module configuration in the New Normal.
- The resulting design dimensions must be able to accommodate both adult and child users. Figure 2 shows that variable arrangement of modules that can be assembled and in turn support variable activities. The modules can be arranged so that children, adolescents and adults can use them. The side with 40 cm in length and height can be used as sitting facilities for adults and teenagers. Meanwhile, the side with 20 cm in length and height in the module section can be used as a sitting facility for children.

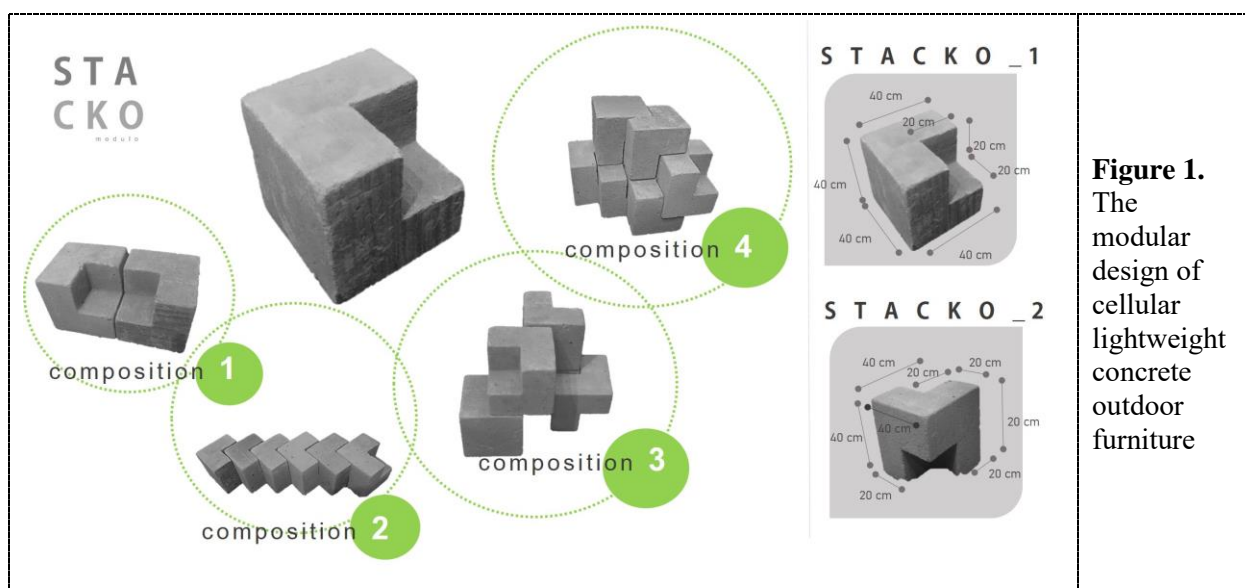


Figure 1.
The modular design of cellular lightweight concrete outdoor furniture

In the New Normal period like today, furniture compositions can be changed every day (Figure 2). The spread of the virus through surfaces can be avoided by regularly changing the side of the used furniture. Each side of the module can be rotated and function as a sitting, playing and working facility. The concrete surface is made non-porous so it can be easily sterilized. In the New Normal period, the configuration of the number of modules can be kept to a minimum, to avoid large groups of users. Configurations can be made of several small modules that are far apart and spreaded out. This facility can be placed in outdoor public areas such as city parks, public waiting areas, and several other public seating facilities.

Prototype and test

From the existing design, a 1: 1 scaled prototype was made. The CLC used is casted using an iron plate mold. CLC has an air cavity, weighing 60-70% lighter than conventional concrete in general. From the existing prototypes, tests were carried out to determine the suitability of the form, function and resistance of the material to the changing weather. The test was conducted from December 2018 to December 2020 in a public waiting area in Surabaya. From the results of the tests carried out, several conclusion points need to be considered for the final development of the design, including weight, form, material and finishing for weather resistance.

From the results of the prototype, it is known that each module weighs 30-35 kg. To change the module configuration, it takes 2-3 people to lift one module. For adjustment to the New Normal era, module configuration changes need to be done every day. So it is necessary to evaluate the material and lightweight concrete construction used. The existing lightweight concrete needs to be modified

with other materials to produce a lighter weight and stronger product. From the prototypes that have been made, the function of furniture placed in public facilities is tested (Figure 2).



Figure 2. Application of the modular furniture for single occupant activity.

In addition, the corners at each end of the module are still too sharp and may endanger users, especially children. In the initial design, the corner has been made rounder but needs to consider the oblique corners, so it is safe for children. In the development process, sharp corners on the concrete need to be processed again. After the concrete molding process, polishing needs to be done to make each concrete corner and side safer for children. As seen in Figure 3, many prototypes were damaged at the corners regarding the material and weather resistance. Many voids in the CLC material caused a high water infiltration rate. The water infiltration could also cause the concrete to be more brittle and easily damaged. The corner of the product has much brittleness, so it needs to be given a reinforcing structure on the concrete material. The module needs to have internal reinforcing made of wire mesh placed in the internal cavity so that the module is not easily broken off.



Figure 3. Outdoor exposure of the prototype after two years.

The finishing also needs to be added with a waterproof layer, so that the product lasts longer. The coating on the concrete surface will make it easier to clean, especially during the New Normal period (Figure 4).

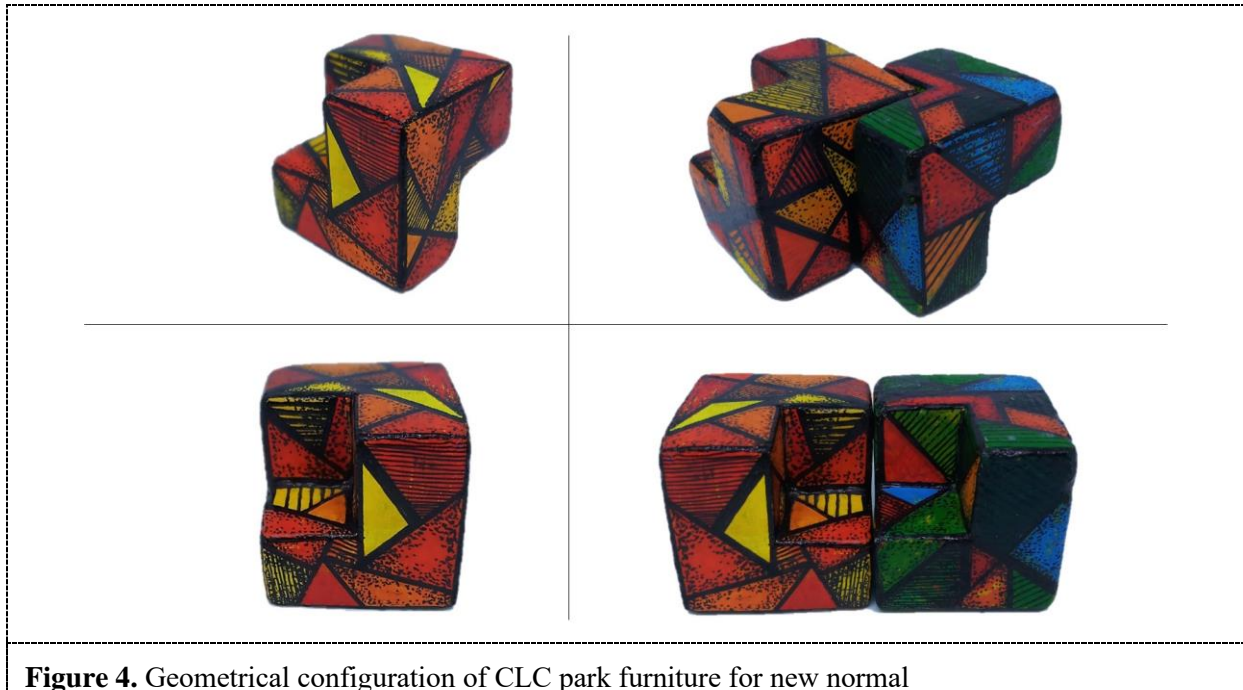


Figure 4. Geometrical configuration of CLC park furniture for new normal

4. Conclusion and recommendations

From the tests carried out in the field, several suggestions regarding designs need to be improved for product applications in the New Normal period. The product module must be made lighter and stronger. This improvement is made to facilitate changes in product configuration during the New Normal period. The intensity of changing the seating facility module can inhibit virus transmission. Changing the sitting facility model can solve problems related to the ability of the virus to survive on surfaces.

Some recommendations regarding products that have been made as public facility innovations in the New Normal era are as follows:

- The form of the module is flexible enough to allow changes in the configuration of furniture arrangements to adapt to joint activities in the New Normal.
- The corner of the module needs to be rounded so that the module is safe for users, especially children.
- The weight of the lightweight concrete material used is still too heavy to be moved by one person. The material needs to be modified with other materials, such as the inclusion of expanded polystyrene in the middle of the module to reduce product weight.
- The surface of the module absorbs water during the rainy season. The absorption is due to the use of CLC which is hollow, so it can easily absorb water. Hence, the module needs to be given a waterproof outer layer so that the surface is easier to clean. The water infiltration could cause the product to be more brittle and some parts to be eroded. Besides, the product's outer surface needs to be modified utilizing a groove to avoid stagnant water on the product surface.

- The product needs to be improved with the addition of a wire mesh as the internal skeletal reinforcement to increase the overall strength of the product material. The casting process needs to be modified by the inclusion of a wire mesh
- Another alternative that can be developed is the development of a modular form, using a ferrocement as the thin outer layer and polyurethane or polystyrene fillings.

The recommendations can help to create a public facility that is suitable for adaptation to new habits in the New Normal period. As social beings, humans can continue to carry out their activities in public areas by still paying attention to the applicable health protocol.

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