

Implementation of the Physical Distancing Concept on Waiting Chair Design in Public Space

Titi Ayu Pawestri*, Asril Kurniadi, Guruh Pratama Zulkarnaen

Universitas Brawijaya
Malang, Indonesia

*titipawestri@ub.ac.id, asril.kurniadi@gmail.com, guruh.pratama871@gmail.com

Abstract—Restrictions on the use of public spaces, self-isolation and physical distancing due to Covid-19 have changed people's habits and behavior in public spaces. The new normal condition demands adjustments in the architectural and interior fields, one of them is the design of waiting chair in public space specifically. So that this research will become a solution to solve the problems in the new normal interior by waiting chair design. The research method uses experimental research methods with analysis. The experimental method is used when designing the chair through the QFD (Quality Function Deployment) method which will then be discussed by analyzing the data according to the theoretical basis. QFD method used to achieve design quality based on user demand. Steps in QFD method those are product planning, design product, process planning and process-control planning. **Product Planning:** the process of collecting data related to user profiles, field observations, user interviews and also appropriate literature studies. In the second step, **Product Design:** brainstorming to create product concepts based on analysis of existing data. In the third step, **Process Planning:** modeling produces 3D images, working drawings and 1:1 prototype model and the last step, **Process Control Planning:** product evaluation to prospective customers by distributing questionnaires to determine aesthetic and ergonomic aspects of design.

Keywords—*new normal, physical distancing, public space, waiting chair*

I. INTRODUCTION

The outbreak of the Corona Virus Disease pandemic or popularly called Covid-19 throughout 2020 became a phenomenon that shocked the world. As of November 23, 2020, there were 58,958,324 cases of Covid-19 worldwide. Of that number, 1,393,138 people died and 40,745,898 people recovered [1]. This epidemic has not only changed human life but also design trends, especially interior design. The interior design will undergo several changes, both in terms of material specifications, dimensional standards and visually. A room must be designed with due regard to health protocol standards. This phenomenon is like repeating the incident when the Spanish flu virus outbreak hit Europe, where initially the interior design style used a lot of closed interiors to switch to

designs with wide openings to provide adequate air circulation and natural lighting [2].

The application of adaptive interior design in the new normal era has begun to be campaigned from private residences to public spaces which are more complex and have heterogeneous users. Currently, public spaces are the most risky places for disease transmission in the midst of an outbreak like this. The main step to stop the virus growth process, so that the patient are no longer a source of infection [3], one of which is spread through touch surfaces on every inanimate object. Touch surfaces on chairs in public waiting rooms are a source of inanimate objects that have the potential to spread viruses and bacteria. Especially in this new normal period, people will continue to use public facilities not only for emergency purposes, but now people have started their activities with routines like before the pandemic era occurred [4].

Waiting room facilities are based on the concept of livability [5], meaning that users of waiting room chairs must be able to feel comfortable in relation to the overall environment and waiting activities. Waiting activity is a passive activity so it requires comfort both physically and psychologically in this case virus-free security which makes users feel more comfortable. The use of waiting room chairs in several public places has undergone significant changes. The existence of a social distancing protocol in an effort to suppress the spread of Covid 19, changing the use of waiting chairs that can initially be used close to one another, now far apart into an intermittent seat arrangement by placing a sticker on the seat area as a sign that it should not be occupied. Attaching a sticker or mark to the stand does not have a significant impact, in fact in the field there are many violations of this visual sign because it still allows the seat area to be used comfortably. This makes the social distancing protocol no longer valid in the waiting room area. On the other hand, visual aesthetics will be disturbed by the irregularity of sticking stickers or tape on the waiting chairs.

II. LITERATURE

Physical distancing will affect the design in the future. Reporting from the Vox page, people who are used to doing

work such as indoors by considering physical distancing will want a room that has a large space after this pandemic is over. Like individual rooms, the distance between furniture such as tables and chairs is wide. Kaickers said that there will be changes not only in the design of the room, but also in the furniture design, which will be affected by this pandemic. The distance between desks in activity zones such as offices which are usually 1.8 m apart has shrunk to 1.6 m to 1.4 m. Bill Keevil, professor of environmental health at the University of Southampton suggests using materials such as copper in furniture in the future, research says that the virus only sticks to copper for 4 hours. This will result in more personal or private office space for individuals, and more space between desks and chairs, like a lounge or waiting chairs in public area. Required seating area per square meter can be seen in Figure 1.

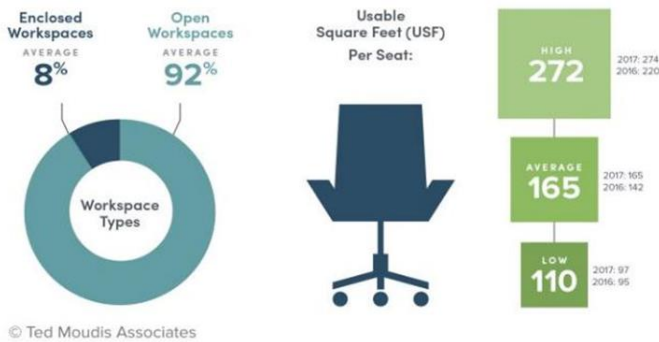


Fig. 1. Required seating area per square meter [6].

A. *Sosiofugal Space (Sociofugal)*

Sociofugal space is an arrangement that is able to reduce social interaction, we often encounter this spatial arrangement in the waiting room. For example, in an airport waiting room or at a train station, visitors sit back to back. Although the seating arrangement is made facing each other, it does not always mean that there will be conversation between visitors [7]. Communication Distance Edward Hall, argues that personal space is a communication distance, where the distance between individuals is also the communication distance. Hall dividing the distance between them are [8]:

- Intimate distance: near phase (0.00-0.15) and far phase (0.15-0.50 m) at this distance in communication simply by whispering.
- Personal distance: near phase (0.50 – 0.75 m) and far phase (0.75-1.20 m), this distance is for conversation between two friends or two people who already know each other.
- Social distance: near phase (1.20 – 2.20 m) and far phase (2.10 – 3.00), this distance is the normal limit for individuals with similar activities or the same social group.

B. *Ergonomics of Chair*

Ergonomics is a science that studies the relationship between humans and other elements in a system and work that applies theory, principles, data and methods to design an optimal system, from the perspective of humans and their performance. Ergonomics contributes to the design and evaluation of tasks, work, products, work environment and systems, so that they can be used in harmony according to human needs, abilities and limitations [9].

Many factors cause accidents in the use of furniture. It could be a human factor who is not careful when sitting down, or an error occurs in the product. In the science of ergonomics, making a chair many aspects that need to be considered. There are materials, anthropometry, colors, dimensions, and functions on the chair.

User anthropometric data is applied in the product design process by considering the physical ergonomics aspect. Physical ergonomics will be directly related to the dimensions of the user's body. Anthropometric data will basically be different based on several data groups based on age, gender, ethnicity, occupation and body position. So that in designing the public area waiting chair product, it will be adjusted to the body dimensions of the person who will operate it.

TABLE I. REFERENCE OF ANTROPOMETRI AND PERCENTILE [10]

No	Dimension	Reference	Percentil
1	Shoulder width	Chair back width	95
2	Hip Width	Seat width	95
3	Backrest height	Backrest height	50
4	Lower thigh height (popliteal)	Chair height	50
5	Lower thigh length (popliteal)	Chair length	10
6	Elbow height when sitting	Armrest height	50
7	Shoulder to head	Headrest height	50

Percentile is a value which states that a certain percentage of a group of people whose dimensions are equal to or lower than that value [11], so the percentile value is used to determine the dimensions of the chair to be designed. The width of the chair using the 95th percentile aims that humans with large dimensions are still comfortable sitting in the chair, while the seat height uses the 50th percentile (Table 1) which aims to represent the same population, meaning that the group of 50% of small dimensions and 50% of large dimensions can still use it comfortably. When designing a waiting chair without a backrest, what needs to be considered is the width of the hips for the width of the seat, the length of the popliteal for the length of the seat and the height of the popliteal for the height of the seat.

C. *Cognitive Comfort*

Cognitive comfort or psychological comfort formed when the psychological condition of the user feels comfortable and does not experience problems. For example, although the dimensions of the chair are not very comfortable according to the shape of the human body, but there is a priority scale in

psychological comfort that feels good and pleasant, so there will be no problem in the design. Aesthetics plays an important role in the emotional satisfaction of users and residents in terms of architecture and interior architectural design [12]. Psychological comfort will be related to compromise and design flexibility, so visual satisfaction regarding beauty will become user comfort as well.

D. Semiotic Theory

Pierce said that signs are related to objects that resemble them, their existence has a causal relationship or conventional bond with these signs [13]. Pierce divides into 3 terms namely icon, index and symbol, each of which has its own semiotic analysis:

- Syntactic Semiotics, discusses signs (as icons) in design works or the similarities between these signs.
- Semantic Semiotics, discusses the relationship between signs (as symbols) and their interpretations concerning the meaning and significance of the design form.
- Pragmatic Semiotics, discusses the influence of signs (as an index) with design users related to the function or impact of the sign

Semantics is a section that discusses the meaning and meaning behind a sign of architectural elements [14], as well as the physical form of architecture, furniture design as a result of human thought which has meaning also has a concept that will be the purpose and intent of the design. Designers will be inspired by the surrounding formations to be used as guidelines in designing.

III. METHODOLOGY

The method used in this research is experimental and analytical research methods. The experimental stage is carried out when testing the design results to the user and then the user's response will be analyzed according to the theory used. At the data collection stage, the QFD (Quality Function Deployment) method will be used. QFD was developed by Yoji Akao in Japan in 1966. According to Akao, QFD is a method for developing quality designs aimed at satisfying consumers and then translating consumer demands into design targets and key points of quality assurance for use throughout all stages of production. QFD is a way to guarantee the quality of the design while the product is still in the design stage is a very important side. The QFD method has four (4) phases, namely the product planning phase, product design, process planning and process-control planning. The stages are as follows:

- Product Planning: collecting data the process related to user profiles, field observations, user interviews and also appropriate literature studies will produce a foundation in the product design process.
- Product Design: brainstorming to create a product concept based on the analysis of existing data at the

product planning stage will produce a detailed design concept description in the form of basic sketches and initial drawings. Using semiotic theory to create an interesting design concept.

- Process Planning: modeling produces 3D images and technical drawings
- Process Control Planning: product evaluation to prospective customers by distributing questionnaires to determine aesthetic and ergonomic aspects of design.

The development of this chair product is carried out to find the best solution for design development with human characters and desires that always vary according to current conditions which are still pandemic and must keep a distance. There are phases in product development, namely planning, concept development, system design, detail design, testing, and repair.

IV. RESULTS

From the results of primary and secondary data collection from respondents, researchers will find out the needs of potential users, then create a visual design concept using the design thinking method. The expected achievement is the form of a waiting chair design that can maintain a massive distance with an aesthetic and unique appearance. Furthermore, it will be analyzed with observations from researchers in accordance with the specified parameters.

A. Product Planning

The product planning stage is taken from primary data and secondary data. Collecting secondary data, researchers conducted observations, documentation, and interviews with users of waiting chairs in public areas. Problems that occur in the community will be a benchmark and guide in designing the required waiting chair product design. The observation results show that during the pandemic, waiting chairs in public spaces, especially in public areas, have undergone changes in their use. Cross marks, either in the form of stickers or duct tape, make the design look less aesthetic. On the other hand, this method is not effective in changing people's behavior to maintain physical distance from one another. Often this neglect occurs by occupying one seat for two people, or occupying a seat that has been marked with a cross. From the results of the literature study, it was found that the level of human ergonomics is divided into physical ergonomics and cognitive ergonomics. Physical ergonomics, is human comfort measured by conformity to the dimensions of the human body, while cognitive ergonomics is measured from human perceptions or feelings looking at certain conditions. If examined from this theory, the phenomenon that occurs in society is that there is still physical comfort (marked by the condition of the seat which is only marked with a visual cross) when occupying this intermittent seat. For cognitive comfort, psychologically waiting chair users are not too worried about physical distance

being close during an emergency or being close to their own family.

Data collection from respondents was carried out where the results were obtained from 30 respondents with an age range of 24-50 years in the form of digital questionnaires distributed through social media with the following results:

TABLE II. QUESTIONARE RESULTS

Criteria	Percentage	Conclusion
Sitting in a public room waiting chair for less than 30 minutes	(79.2%)	Useres do not need a chair that is too comfortable in a short period of time. SO that the design of a chair without a backrest is very appropriate so that users do not linger in the common room. It also does not require an armrest because it minimizes the user's touch surface.
The part that often comes intro contact with the skin is the armrest	(72.6%)	
The part that must be comfortable is the buttocks and thighs	(62.7%)	In a short period of time, the most important part to be given comfort are the buttocks and thighs
Metal material suitable for public waiting chairs	(72.6%)	The use of metal material is a material that is easy to clean and does not store bacteria and viruses for too long compared to other materials
Uncomfortable if someone sits close	(95.7%)	When the pandemic has changed the behavior of users of public lounge chairs who want chairs that are massively far apart as a marker of their territory, namely the existence of privacy space that are increasingly widespread compared to before the pandemic. So the design of the chair must minimize the occurrence of physical distancing violations
Need the waiting chair spaced out	(95.7%)	
Want a seat that can't be moved close together	(95.7%)	

Source: Documentation of Author, 2021

The conclusion from the digitally distributed questionnaires (Table 2) is that most of the respondents want public lounge chairs:

- Safe to maintain social distancing protocols,
- Easy-to-clean materials,
- Minimal touch surface,
- Comfortable to sit on and,
- Have a visual aesthetic

From this conclusion, it turns out that respondents really want physical and cognitive comfort. Physical comfort for the physical safety of their bodies while sitting in the waiting room chairs, cognitive/psychological comfort for feeling safe and enjoying being away from exposure to the virus while in public places in the pandemic era.

B. Product Design

1) *Basic concept:* Macro concept is a general or broad description of the concept that will be applied to the design design. Micro-concepts are derived elements of macro-concepts where the broad description and general meaning are more detailed and summarized according to needs so that they focus and become the dominant element in designing.

From the problems above, it can be described with various keywords for the selection of concepts related to physical distancing waiting chairs as follows:

- **Modern:** The modern style is a contemporary trend style, has a characteristic shape that does not use much decoration to decorate, looks neat and clean. The use of metal materials combined with the seat cover material, namely synthetic fabric fibers are applied as a characteristic of this design. This lightweight form makes the touch surface even more minimal.
- **Unique Form and aesthetics:** Attractive and unique shape by accommodating user needs for social distancing protocols. The form will use the semiotics of the sign prohibiting sitting close together.
- **Hygienic:** The material chosen is a material that is hygienic and easy to clean. Metal surfaces are materials that are easy to clean.
- **Comfortable:** Gives a clean impression that makes users feel at home and comfortable sitting in the waiting chair. The ergonomics aspect will be used as a parameter of the user's physical comfort. Social distancing in public spaces will also provide psychological comfort to users. According to Laurens' theory, the personal distance for the far phase criteria is 0.75 - 1.20 meters [8]. So that each seat has a distance of approximately 0.375 meters on the right and left sides.

2) *Design result:* The visual form of this stool type chair is taken from the analogous elements of an object's resistance to its surroundings. The shape on the right and left 'wings' of the seats is adopted from that this section cannot be occupied because it is a distance area. This pointy shape will be uncomfortable if they want to occupy this area like the hedgehog animal self-protection analogy (Figure 2).



Source: Documentation of Author, 2021

Fig. 2. Design idea

The analogy of the form of protecting itself from the threat of surrounding dangers such as a hedgehog developing thorns on its body, this method is adopted and analogous to a chair that is able to protect its user from threats around. So that the formation of the wing of the chair takes the analogy of the sharp spines of a hedgehog.

According to the theory of semiotics proposed by Pierce, humans can only think and communicate by means of signs. The tapered shape on the right and left wings of the chair in a semiotic syntactic manner was analyzed for similarities with the shape of the porcupine spines. Semantic semiotic discussion, meaning or interpretation of the user will feel dangerous if he occupies the pointed area, so that it will have an impact on the behavior of users who will stay away from this pointed area (pragmatic semiotic concept). This concept was finally achieved as the implementation of social distancing in public spaces.

C. Process Planning

The physical distancing chair design will be simulated with computer software, namely SketchUp and AutoCAD software. AutoCAD software is software for drawing working drawings digitally. Sketchup software is used to create 3D image models and rendering applying materials and colors (Figure 3).

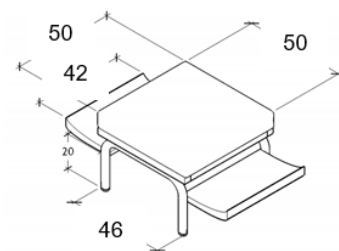


Source: Documentation of Author, 2021

Fig. 3. Indoor visualization.

The designed chairs will be simulated with different configurations and layouts according to the area and shape of the room. It was concluded that when chairs were arranged in close proximity to other chairs, it turned out that it had a massive impact on maintaining the distance between chair users. Between users it is not possible to physically touch.

The dimensions of the width and length of the seat are 50 centimeters (Figure 4). These dimensions are the dimension that represents the 50th percentile. While the seat height of no more than 45 centimeters represents the 10th percentile because its function is for the comfort.



Source: Documentation of Author, 2021

Fig. 4. Dimension of chair

D. Process Control Planning

After the process of distributing questionnaires, it can be seen and can be evaluated that the aesthetic and ergonomic aspects of comfort are highly desired by respondents with more than 50% of respondents agreeing about it. This will be a reference for further evaluation later to see the real product application, namely public waiting room chairs that can provide comfort and security during this pandemic with respondents feeling safe and comfortable because these chairs can maintain physical distance between other users.

Process control and evaluation of chair products requires the use of new techniques in securing the built environment by running alternatives, exploring and inspiring new ways to build more sustainable and safe. The following relates to the evaluation of material adaptation and design models in the construction sector to create a safe environment:

1) *Modular construction*: Modular construction strategies were popular and effective before the Covid-19 outbreak and were used to deal with the pandemic and to make things cheaper and faster to build. It is important to meet the diverse needs of healthcare services with prefabricated standard components. These components can help the object adapt to the need for wide flexibility of space for treatment and quarantine.

2) *Lightweight and adaptable structure*: When dealing with a pandemic, more lightweight and adaptable structures are needed because of their speed and portability. Currently, many experts are developing ways to suppress the COVID-19 virus.

3) *Hygienic material*: Specific strategies are needed to consider and think about the access of every place in the built environment that is touched by the community and the possibility of the place being a source of transmission. Modern design that rejects ornaments for the sake of cleanliness, modern designers and does not leave a visual aesthetic that tends to use hygienic and easy-to-clean materials. The new normal order will implement more cleaning strategies based on the new technology.

V. CONCLUSION

The implementation of waiting chair designs in public areas with the concept of physical distancing is able to have a positive effect and contribute to innovation in the new normal. Design conveys more than one message so that it can attract the attention of many people. Chairs are designed in terms of shape and design with considerations of ergonomics, function, style, durability of finishing, structural stability, as well as determining the use of materials and placement in space.

Base on the experimental results and the results of design analysis, waiting chairs with minimal touch surfaces are more effective in minimizing the spread of viruses through the seat material media, because the more touch surfaces, the greater the potential for transmission of viruses and bacteria in public spaces. This applies to the design of the chair without the use of armrests and backrests. The shape of the pointed wings on the right and left of the seat is a unique concept as well as a sign of prohibition to occupy this section. In terms of ergonomics, respondents feel safe and comfortable with the waiting chair design model that has been made. The foam seat covered with synthetic leather is not only comfortable for the buttocks and thighs, this type of material is also easy to clean.

Respondents no longer feel that they are sitting close together, intentionally or unintentionally, because the form of the chair design 'forces' the order to become massive and shapes the behavior of users to always maintain physical distance in public spaces.

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