ISSN:1533-9211
SEYBOLD REPORT
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Aesthetic Elements of Post-Disaster Modular Houses: Study of Architectural and Non-Architectural Student Preferences

ISSN:1533-9211
SEYBOLD REPORT
www.seybold-report.com

ISSN: 1533 - 9211

Basuki[1*], Johanes Bonivasius Muda[2], Yohana Nursruwening[3], Natasia Anggi Laxmita[4]

[1,2,3,4] Architecture study program, Faculty of Engineering, Wijayakusuma University, Purwokerto, Indonesia

CORRESPONDING AUTHOR:

Basuki
bas1arst@gmail.com

KEYWORDS:

Modular house, Aesthetic elements, State Preference

Received: 16 November 2023
Accepted: 12 December 2023
Published: 21 December 2023

TO CITE THIS ARTICLE:

Basuki, Muda, J. B., Nursruwening, Y., & Laxmita, N. A. (2023). Aesthetic Elements of Post-Disaster Modular Houses: Study of Architectural and Non-Architectural Student Preferences. *Seybold Report Journal, 18(10),* 194-216. DOI:10.5110/77. 1088

Abstract

Indonesia is a region prone to earthquake disasters. Aesthetic development in post-disaster modular houses is needed not only to produce housing that is quickly produced, efficient, but also promotes psychological and sustainable well-being. The aesthetics of a home is not only related to a touch of art, but can also come from a touch of technological simplicity. Aesthetic perceptions can be different which can be influenced by information, knowledge and experience regarding aesthetics. Aesthetic perceptions can differ between individuals with a background in art, design and architecture compared to individuals with backgrounds outside of art, design and architecture. This research aims to: (1) develop a measurement model for the aesthetic elements of post-disaster modular houses, (2) compare measurement models based on the preferences of architectural and non-architectural students. The model for measuring the aesthetic elements of post-disaster modular houses was developed theoretically from previous research in consultation with practitioners and academics. Furthermore, the measurement model was evaluated on a limited basis on subjects with different knowledge and experience of art and, design and architecture. The research results found that the aesthetic elements of post- disaster modular houses consist of elements: assembled structure, connection joints, texture, symmetry, windows scale. The aesthetic elements of post-disaster modular homes do not differ between individuals with a background in art, design and architecture compared to individuals with backgrounds outside of art, design and architecture. The implication of this research is to provide a model for measuring the aesthetic elements of post-disaster modular houses.

1. INTRODUCTION

Indonesia is a region prone to earthquake disasters. Earthquake disasters often have a major impact on damage to residential infrastructure. Developing housing that is adaptive to earthquake disasters is necessary for sustainable residential development. The ancestors of the Indonesian people have actually inherited ways of coexistence and harmony with nature to adapt to earthquake disasters. Building structures with strong and flexible joints, natural materials and asymmetrical building shapes are adaptive ways of living against earthquake disasters.

The building structure is not only technical, but also involves simple and artistic (beautiful) processes. Structural details (such as column and beam connection details), as well as non-structural details such as building walls (made of wood or bamboo) are completed using carpentry techniques. Building walls made of wood or bamboo not only fulfill technical aspects but are patterned (modular) with carpentry techniques to fulfill beauty. Building walls and the connections of wall elements are also flexible, meaning they are easy to move, change or modify according to needs. The modular space for resting at any time can be easily converted into a room for storing harvests, a meeting or celebration room. The building wall details also have pores which not only fulfill technical aspects (breathing for the building to overcome humidity) but also aesthetics.

The house is a modular system consisting of elements that are autonomous and easily reconfigured. These cultural aspects are relevant for the development of inclusive and sustainable post-disaster housing in the digital era. In the digital era, technology is increasingly developing. Technological developments have enriched the ways in which houses and/or their elements are produced, printed and assembled. The use of information technology , production techniques (such as: cutting, printing, molding) enriches crafting techniques for houses that are not only strong and technically flexible to adapt to earthquakes, but can also be produced quickly, efficiently and artistically.

Post-disaster housing not only requires buildings that can be built quickly, through a simple process (efficient, cheap) but also provides psychological and social value. Post-disaster housing is not only related to how to build it correctly (logic), but also related to efforts to build psychological well-being (subjective well-being). Several studies (Coburn et al., 2017; Dai et al., 2022; Zhao et al., 2020) shows that aesthetic qualities can influence mood, cognitive function, behavior and even mental health.

In Indonesia, the Risha House (Instant, Simple and Healthy House) is a type of modular house which was originally designed to develop cheap houses that could be produced quickly, especially after a disaster occurred (Nelza et al., 2021; Planoearth, 2020). Risha is an instant house (can be built quickly), simple (in terms of cost and structure), healthy and safe against earthquakes. However, the Risha house being developed in Indonesia currently prioritizes function (cheap, efficient and quick to build) and has not

considered the aesthetic aspect. Based on preliminary studies, it can be found that the aesthetic aspect has not been considered in the current development of the Risha disaster relief modular house. Aesthetic considerations in post-disaster housing development are important if you want to develop houses that are not only livable and physically healthy, but also psychologically, subjectively and sustainably prosperous (Wang, 2016) .

Aesthetic elements of Risha's disaster preparedness modular home can differ from other home contexts. This is because some aesthetic elements are general (objective factors-design solutions), while other elements are specific (subjective factors) to various types of aesthetic objects and user/observer tastes. Aesthetic elements vary depending on different contexts (such as building aesthetics: hospitals, offices, residences, children's schools) and different user characteristics.

This research was motivated to fill the gap in literature regarding the determining aesthetic elements of post-disaster modular houses. The aesthetic elements of Vitruvius's aesthetics have often been put forward theoretically (Coburn et al., 2017) and empirically (Arenibafo, 2017; Doe, 2020; Imrie, 2003; Mallgrave, 2010; Wang, 2016; Yosef et al., 2021), but still There is a gap in literature regarding aesthetic elements for post-disaster housing. Judging from its technical elements, modular houses have their own characteristics both in the connections of the main structure and related panels, as well as in the communications (joints) between elements. Symmetrical shapes are one of the characteristics of post-disaster modular houses that are able to respond well to earthquakes. The determining aesthetic elements of post-disaster modular homes is still a gap in the literature, and this is also the motivation for this research. The development of technical aesthetic elements combined with artistic aspects is necessary to develop a Risha disaster relief modular building that is livable and sustainable.

User perceptions may vary depending on education, experience, and artistic preferences. Perceptions of design and art observers can differ between different observers. This is due to potential perception biases that depend on education, experience, and preferences. Furthermore, the research evaluated the aesthetic elements of disaster relief houses based on the preferences of architecture, civil engineering and art students compared to architecture, civil engineering and art students). Furthermore, the research aims to evaluate the aesthetic elements of disaster relief houses based on student preferences. Student preferences were selected as a pilot study prior to a large-scale community survey. Student preferences also have more homogeneous segment characteristics when comparing age, education and educational background (architecture, art and design students vs. non-architecture, art and design students).

2. LITERATURE REVIEW

Etymologically, the word "aesthetic" comes from the English word aesthetic, which means feeling or perception (Lang, 2014) . Aesthetics is the perception of external stimuli that are felt (experience) through sensory sensors (perception) which influence the understanding (cognitive) process (Cropley & Cropley, 2008; Douchová, 2015) . The Vitruvius Triad describes that a building must be strong and durable, stable (firmity), meet functional needs (utility) and appeal to an aesthetic sense (Coburn et al., 2017). Aesthetics as one of the design goals (added value) must be considered in product development. Creating aesthetic value (value creation) requires understanding technical aspects, art and functionality, as well as other requirements for architects to fulfill all requirements simultaneously. The task of architects and designers is to develop aesthetic elements in accordance with various existing factors. The relationship between the "technical" and "aesthetic" values of a product is determined by the purpose or function of the product.

Elements of art are a set of techniques that describe how to present works of art. These elements are combined with the principles of art (movement, unity, variety, balance, emphasis, contrast, proportion, and pattern) during design and production. **Semantic elements** related to product communication. The purpose of a semantic element is to translate a composition or its parts into a language that the user (observer) can understand. **Technical elements** are often related to science and technology. Most mathematicians derive aesthetic pleasure (a sense of beauty) from their work, and from mathematics in general. Technology itself can have an aesthetic dimension ("technological beauty"), such as the process and experience of using the technology). The beauty of technology is that technology provides convenience.

Aesthetics are assessed objectively and subjectively (Kaljun et al., 2012) . Aesthetic value is formed by elements (design solutions), which characterize the perception of the product, while the subjective feelings of the user or observer. Aesthetics is assessed objectively as a "universal" or general measure of the aesthetic value of each product. Objective factors determine aesthetic elements and relationships between elements, which are blocks of elements or systems that can be configured to lead to harmony. A group of factors, including functional factors such as shapes that are adapted to the main function of the product to increase aesthetic value.

Research on aesthetic elements with a subjective approach is usually carried out through user observation studies. Psychosocial aesthetic theory adopted by the fields of psychology and sociology (Marković, 2012) explains that the feeling of beauty in relation to an object depends on experience, perception, imagination, feelings and social influences (symbols, signs, social identity) (Scruton, 2015). Aesthetics are assessed subjectively based on perception, interpretation and appreciation of beauty. People feel different emotions such as joy, awe, astonishment, and admiration for beautiful things. Subjective

factors are closely related to potential users, so they are relatively difficult to measure. Aesthetic values are shaped by personal and cultural norms in the user's environment. Much of a successful design depends on the designer's knowledge of the environment in which the product is introduced to a user segment. Psychological, sociological and philosophical studies can be used in this regard. Subjective factors include a psychosocial approach (Marković, 2012). Adopting from the fields of psychology, sociology and neuro-psychology, it explains that the sense of beauty towards objects depends on experience, perception, imagination, emotions and social influences (symbols, signs, social identity) (Scruton, 2015) .

The results of empirical research on the aesthetic elements of traditional-classical architecture in the digital era generally show that Vitruvius' aesthetic elements consisting of technical elements (firmity), artistic elements (aesthetics) and functional elements (utility) are always consistent. The beauty of a building is manifested in its inherent strength (technical dimension), artistic and meaning (functional value).

Table 1. Mapping of Aesthetic Elements Based on Previous Research

Aesthetic	**Element**	**Supporting Empirical Studies**
Technical	Structure, Joint connection Materials, Ornament Details, Interactions, Facade Systems, smart materials, Assembled	(Al-Alwan & Mahmood, 2020; Cucuzzella et al., 2022; Doris & Kowaltowski, 1998; Elrayies, 2018; Gawell & Grabowiecki, 2021; Kulasuriya, 2005; Ratnamaya & Mudra, 2022; Spence, 2020; Stankovic et al. , 2019)
Art	Texture, Color, Scale, Symmetry, Contrast, Hierarchy, Unity, Movement Balance, Homogeneity, Rhythm, Articulation	(Al-Alwan & Mahmood, 2020; Cucuzzella et al., 2022) (Elrayies, 2018) (Spence, 2020) (Design & Approaches, 2021) (Ratnamaya & Mudra, 2022) (Design & Approaches, 2021) (Kim et al., 2021) (Design & Approaches, 2021) (Kulasuriya, 2005) (Kulasuriya, 2005) (Hübner & Fillinger, 2016) (Kulasuriya, 2005) (Hübner & Fillinger, 2016) (Cucuzzella et al., 2022; Jiang, 2019) (Elrayies, 2018) (Design & Approaches, 2021) (Annechini et al., 2020)

Semantics	warm-cold, simple-complex peace and tranquility Artificial-Natural Inelegant-elegant natural harmony	(Annechini et al., 2020; Beck et al., 2021; Liu et al., 2018)

Source: mapped by researchers from previous research

Recently, the technical elements, artistic elements and functional elements of architecture have developed along with the development of digital technology. The beauty of a building does not only refer to strength, splendor, decoration details, but also processes (assemblies), interactions (connections), communication between elements or systems or subsystems, decoration details (including information systems), sensors and knowledge systems (meaning) (Gawell & Grabowiecki, 2021). Decorative details of classical architecture, considered ineffective in the era of modern mass industry, are becoming important again in the information age. Decorative details are not only visually beautiful, but also provide comfort and beauty (a sense of awe) technologically, for example by adapting to weather, air, sound, heat (e.g. parametric architecture) (Gawell & Grabowiecki, 2021). The semantic beauty that is often found in traditional and classical architectural values again offers broad meanings, such as sustainable buildings, environmentally friendly buildings, energy efficient buildings, zero waste, affordable homes and other valuable expressions (Ghom & George, 2021). Digital era architecture emphasizes the relationship between aesthetics, function and technology (Gawell & Grabowiecki, 2021; Ghom & George, 2021) .

Empirical studies of aesthetic elements with an objective approach are usually carried out using qualitative approaches such as case studies. Several studies (Al-Alwan & Mahmood, 2020; Elrayies, 2018) shows that the modular layout is used in both classical and modern architecture, but the beauty of classical architecture lies in the details of its decoration, while the beauty of modern architecture in the era of mass industry lies in this. simplicity of decoration (efficiency), while the beauty of architecture in the digital era lies in articulation and assembly (Al-Alwan & Mahmood, 2020; Elrayies, 2018) .

The beauty of traditional, classic, contemporary and digital buildings emphasizes the relationship between construction, materials and expression. The deep meaning of architecture remains consistent from traditional, classical, contemporary to digital (revealing the truth of the building and its surroundings), but the technical aspects change along with the new possibilities of digital tools. Traditional, classic, modern and digital buildings represent different ways of expressing art and technology. Classical architecture is more real and real because of its emphasis on materials and construction details. Digital architecture is more

abstract and process-oriented, because it emphasizes assembly techniques, building components, where the architect controls the program and controls all technical and aesthetic aspects. Classical architecture also emphasizes the relationship between construction, materials and cultural expression, while digital architecture emphasizes the interaction of technical and aesthetic aspects. The strategies used are: generation, production, movement, information and simulation. Even though the elements are tools, articulation (clarity of language) and composition (Al-Alwan & Mahmood, 2020) .

Risha's aesthetic elements for disaster response can be explored based on the technical and artistic characteristics inherent in Risha's House. Technical elements: disassembly structure and connecting joints. Elements of Art: texture, symmetry and scale. First, related to **disassembled construction**. The building structure is designed based on its technical and artistic dimensions. In contrast to classical architecture (Al-Alwan & Mahmood, 2020; Cucuzzella et al., 2022) , the beauty of modern architecture lies in the assembly process, autonomous modules and interactions between modules (Al-Alwan & Mahmood, 2020; Elrayies, 2018). However, whether the beauty of demolished buildings is one of the aesthetic elements of post-disaster modular homes is still a gap in the literature and is the motivation for this research. Second, modular houses have their own special features in terms of **joint connections**. related joint connections not only the main structure, but also related panels and connections (Al-Alwan & Mahmood, 2020) (Elrayies, 2018). However, whether the beauty of joints, with or without details, is one of the aesthetic elements of post-disaster modular homes remains a gap in the literature and is the motivation for this research.

The third is related to **symmetry-asymmetry**. Post-disaster modular houses have their own characteristics in terms of symmetrical structures. The symmetrical shape is associated with earthquake response construction. In addition, symmetry refers to layout/pattern (Al-Alwan & Mahmood, 2020; Cucuzzella et al., 2022). Psychometry is associated with formal forms such as public buildings, while asymmetrical forms are associated with a dynamic atmosphere. However, whether the beauty of symmetry is one of the aesthetic elements of post-disaster modular homes is still a gap in the literature and is the motivation for this research. A flat open scale that connects the interior with the exterior. Buildings with high ceilings and open spaces are elements of classic architectural beauty. The spatial scale and field aperture scale influence changes in EEG parameters (Vartanian et al., 2015). Other research (Kim et al., 2021) also found that the scale of the room as measured by ceiling height and window aspect ratio influenced the user's (hospital patient) relaxation response, as measured by the alpha-beta ratio (RAB) parameter.

Fourth, related to **texture,** Semper (1803-1879) proposed presenting materials (crafts) to create an expression of the beauty of buildings. Digital technology makes it possible to print, cut, combine, blend

construction elements, expressing the beauty of buildings (Cucuzzella et al., 2022; Jiang, 2019; Elrayies, 2018). The beauty of the texture may vary depending on different building contexts and users. However, whether the beauty of texture is one of the aesthetic elements of post-disaster modular homes is still a gap in the literature and is the motivation for this research.

Sixth, namely **Windows Scale**. The scale of the opening area that connects the inside space to the outside space. Structures with high ceilings and open spaces are elements of classical architectural beauty (Al-Alwan & Mahmood, 2020; Cucuzzella et al., 2022). The spatial scale and field aperture scale influence changes in EEG parameters (Al-Alwan & Mahmood, 2020; Cucuzzella et al., 2022). Another study (Kim et al., 2021) also found that the scale of the room as measured by the ceiling height and window area ratio influenced the user's (hospital patient) relaxation response as measured by the Alpha to Beta (RAB) wave ratio parameter.

3. MATERIALS AND METHODS

The research was conducted using a survey approach . The research object is the aesthetic elements of post-disaster residential modular houses. The aesthetic elements tested are aesthetics: assembly structure, connection joints, symmetry structure, texture, and windows scale/openings. Variables are measured using student state preferences. Aesthetic preferences were evaluated from design and art student subjects (architecture, art and design students), as well as compared with students outside of architecture, art and design. The population of this study were students at several state and private universities in Indonesia. The research sample was 156 students taken using a simple random sampling technique, namely students who were found and were willing to become research respondents.

The research instrument is a list of questions given online via googleform regarding aesthetic preferences (likes and dislikes) towards certain aesthetic elements. This research instrument was developed from previous research (Annamary et al., 2016; Davis et al., 2021; Hübner & Fillinger, 2016; Luo et al., 2023; Tawil et al., 2022) and adapted to disaster relief housing architectural products Risha. Respondents were asked to rate the beauty of the aesthetic elements of the modular house on a scale of 1-5 (1= really don't like it, 2= don't like it, 3= like it a bit, 4= like it, 5= like it a lot) against a comparison of video clips of modular houses. The video clip is an actual house redrawn in 3d animation. Use of 3D animated images to make variables easy to modify and to control other variables. Respondents were asked to choose what they preferred in the video clip between modular houses: (1) with a static structure and an assembled structure (disassembled), (2) panel connection details with details-without details, (3) symmetrical-asymmetrical structures, (4)) without texture - crafting texture, (5) monochromatic color - full color, (6)

wide field opening scale - limited.

a. **Disassembled Walls** Regarding modular house components (easy to assemble and disassemble), respondents were asked to assess two types of rooms, namely: (1) rooms with static walls, and (2) rooms with walls that are easy to disassemble.
b. **Joint Connection**. Next, respondents were asked to assess the two types of rooms by comparing the joints between joints without details and joints with detailed crafting.
c. **Symmetry-Asymmetry**. Next, respondents were asked to assess the two types of rooms by comparing modular spaces with symmetrical basic shapes, which were compared with modular spaces with asymmetrical shapes but still developed from symmetrical basic shapes.
d. **Texture-Detail Crafting**. Achieving beauty is not done with simple materials and processes through crafting techniques. Next, respondents were asked to assess two types of rooms with plain materials and spaces that involve crafting processes and details to create beauty.
e. **Scale**. Apart from instant and simple homes, Risha's other element is a healthy home. A healthy home is achieved by connecting the interior space with the exterior space for views, adequate air circulation and light. Next, respondents were asked to assess two types of windows scale by comparing: (1) modular rooms with wide openings which have an open aesthetic impression, (2) modular rooms with limited openings which provide privacy.

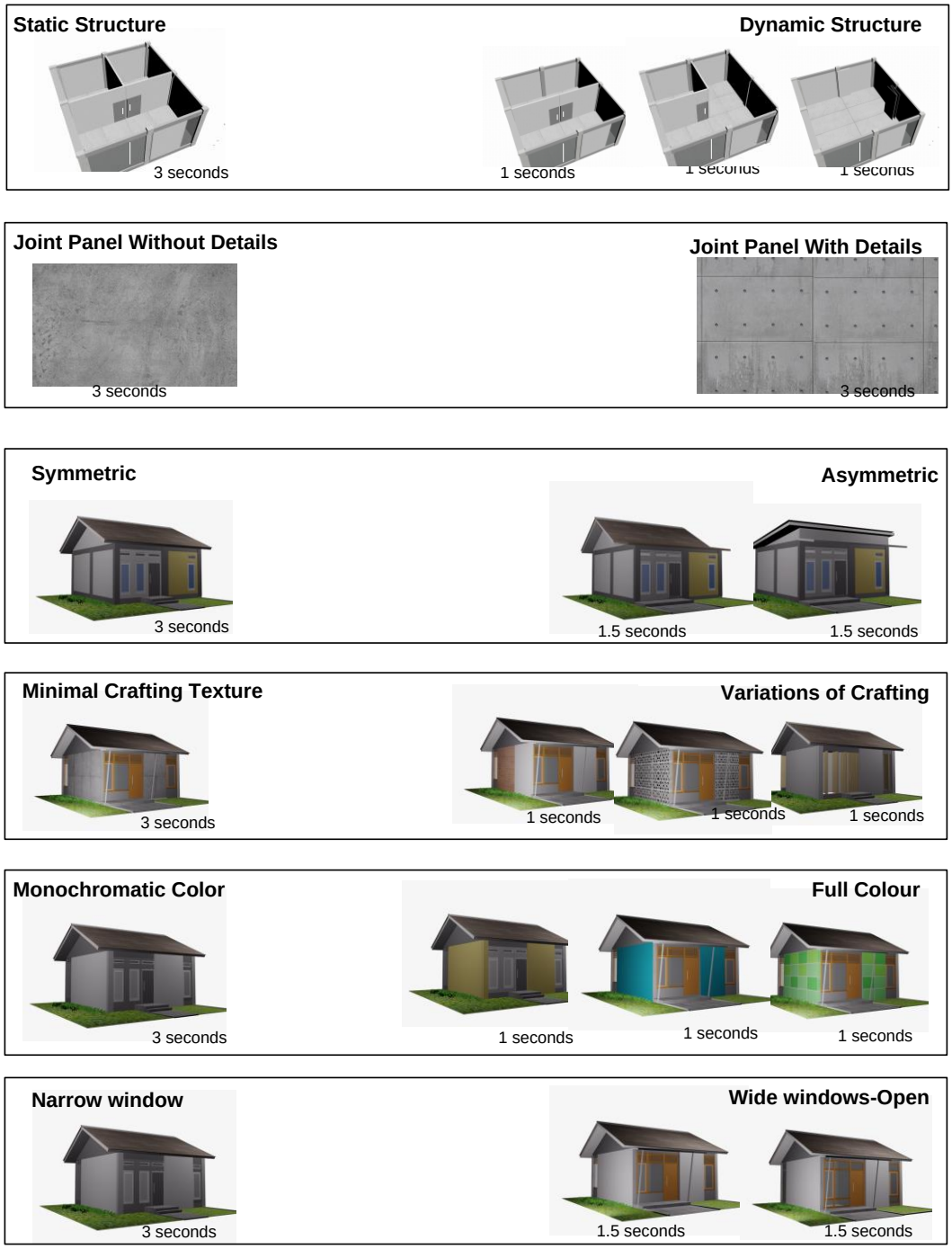

Figure 2. Video clip for survey instrument

The data analysis method used in this research consists of measurement model analysis and hypothesis testing analysis. Analysis of the measurement model uses confirmatory factors analysis (CFA).

Testing with discriminant validity and reliability. CFA analysis uses discriminant validity which can be seen from the cross loading value . An indicator is said to have good validity in reflective latency if it has a loading factor value greater than 0.70. The reliability of indicators in measuring constructs can be seen from the average variance extracted (AVE), Cronbach's Alpha and Composite Reliability values. The construct used is said to be valid if the average variance extracted (AVE) value is > 0.5, the composite reliability value is > 0.7, and the Cronbach's Alpha value is > 0.7 (Hair et al., 2017).

Hypothesis testing uses the Chi-square test (X^2). Chi-square analysis was chosen because the data is a binary variable. The Chi-square test is to compare the frequency of occurrence (observation) with the frequency of expectations. Prevalence Odds Ratio (OR) is a measure of association commonly used in cross-sectional research designs that shows the proportion between preference groups. If the observed frequency value and the expected frequency value are the same, then it is said that there is no significant difference in proportion between groups or in other words whether there is/isn't a relationship between two categorical variables. On the other hand, if the observed frequency value and the expected frequency value are different, then it is said that there is a significant difference in proportion between groups or in other words whether there is/isn't a relationship between the two categorical variables. Hypothesis testing by looking at the p value for each hypothesis. A probability value (ρ) < 0.01 indicates a very significant difference, $\rho < 0.05$ indicates a significant difference, while $\rho < 0.10$ indicates a quite significant difference.

4. RESEARCH RESULTS

The Measurement Model uses Confirmatory Factors Analysis to evaluate how each indicator (aesthetic element) can be used to evaluate the aesthetic characteristic of a modular house. Test the validity of the parameters using the convergent validity and descriminant validity parameters. The convergent validity value is the correlation coefficient (loading factor) value between the latent variable and its indicators. Expected value > 0.7. Descriminant Validity is a comparison value of the correlation between constructs (cross loading) factors which is useful for finding out whether the construct has adequate discriminant, namely by comparing the n square root of average variance extracted (AVE) value of each construct with the correlation between other constructs in the model, if it is square The root of average variance extracted (AVE) construct is greater than the correlation with all other constructs, so it is said to have good discriminant validity. It is recommended that the measurement value should be greater than 0.50.

Table 2. Cross Loading Discriminant Validity Test Value

	Outer loadings
disassembly <- Aesthetic Elements	0.539
joint <- Aesthetic Elements	0.569
symmetry <- Aesthetic Elements	0.576
texture <- Aesthetic Elements	0.575
color <- Aesthetic Element	0.576
scale <- Aesthetic Elements	0.566

Source: processed primary data (2023)

Reliability testing is related to the issue of trust in the instrument. An instrument can have a high level of confidence if the results of testing the instrument show consistent results. Thus , the problem of instrument reliability is related to the problem of accuracy of results. Reliability looks at the consistency of the instrument answers where the composite reliability and Cronbach alpha results show satisfactory values, namely the value of each variable is above the minimum value of 0.70.

Discriminant validity can be seen from the cross loading value. An indicator is said to have good validity in reflective latency if it has a loading factor value greater than 0.50. In Table 2, the results of the discriminant validity test using the Smart PLS 4.0 program are presented. Based on estimation results using the help of the Smart PLS 4.0 program application. The following output is obtained .

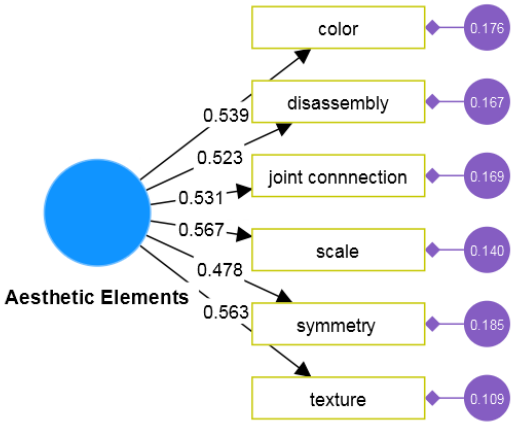

FIGURE 3. FACTOR LOADING VALUE DIAGRAM

Source: processed primary data (2023)

Based on T able 2 and Figure 3, it can be seen that all indicators (aesthetic elements) have a high correlation with the construct (modular house aesthetics). So it can be concluded that the research model has good discriminant validity in cross loading discriminant validity. Aesthetic elements can be used as differentiators (parameters) of modular house aesthetics.

The reliability of indicators in measuring constructs (variables) can be seen from the average variance extracted (AVE), Cronbach's Alpha and Composite Reliability values. The construct used is said to be valid if the average variance extracted (AVE) value is > 0.5, the composite reliability value is > 0.7, and the Cronbach's Alpha value is > 0.7 (Hair et al., 2017). Results of testing average variance extracted (AVE), Cronbach's alpha, and composite reliability with SmartPLS 4 . 0 is presented in Table 3.

Table 3. Average Variance Extracted (AVE), Cronbach's Alpha, and Composite Reliability values

	Cronbach's alpha (standardized)	Cronbach's alpha (unstandardized)	Composite reliability (rho_c)	Average variance extracted (AVE)
Aesthetic Elements	0.740	0.738	0.739	0.522

Source: processed primary data (2023)

Based on Table 3, the convergent validity results can be seen based on the average variance extracted value. These results show that all latent variables have an AVE value greater than 0.5, so that all constructs are declared valid. Based on Table 3, it can also be seen that all latent constructs have Cronbach's alpha and composite reliability values of more than 0.7. This indicates that all latent constructs have good reliability.

Table 4 shows that the aesthetic elements of a post-disaster modular house consist of: disassembled structure, detailed joints, craft texture, symmetrical structure, color and scale. The assembled structure is one of the important elements of post-disaster modular house aesthetics. The odds ratio value of 62.8 % shows that 62.8% of respondents chose a disassembled structure compared to a static building structure (not easily changed). The chi square value (X^2) is 10,256 with a significance probability value (ρ)= 0.001, meaning that there is a significant difference in the error rate (α) below 1% between respondents who answered that they chose a dismantled assembled structure compared to a static building structure.

Table 4. Aesthetic Elements

		Frequency	odds ratio	Chi-Square	df	p
Disassembly structure	No disassembly	58	37.2	10,256	1	0.001
	Overhaul	98	62.8			
	Total	156	100.0			
Joint Connection	Joint with Details	90	57.7	3,692	1	0.055
	Joint without details	66	42.3			
	Total	156	100.0			
Symmetry	Asymmetry	29	18.6	61,564	1	0,000
	Symmetry	127	81.4			
	Total	156	100.0			
Texture	with crafting	109	69.9	24,641	1	0,000
	without crafting	47	30.1			
	Total	156	100.0			

Color	full color	33	21.2	51,923	1	0,000
	monochromatic color	123	78.8			
	Total	156	100.0			
Windows Scale	Wide	93	59.6	5,769	1	0.016
	Limited	63	40.4			
	Total	156	100.0			

Source: processed primary data (2023)

Joints connection are one of the important aesthetic elements of post-disaster modular homes. The odds ratio value of 57.7% shows that 57.7% of respondents chose joints with details compared to joints without details. The chi square value (X^2) is 3.692 with a significance probability value (ρ) = 0.055, meaning that there is a significant difference at the level of error rate (α) below 10% between respondents who answered that they chose joints with details compared to joints without details .

Texture crafting is also an important aesthetic feature of post-disaster modular homes . The odds ratio value of 69.9 % indicates that 69.9 % of respondents chose a crafting texture compared to no crafting texture. The chi square value (X^2) is 24,641 with a significance probability value (ρ) = 0.000, meaning that there is a significant difference at the error rate (α) level below 1% between respondents who answered choosing a crafting texture compared to no crafting texture .

Symmetry is also an important element of the aesthetics of post-disaster modular homes . The odds ratio value of 81.4 % shows that 81.4 % of respondents chose symmetry over asymmetry. The chi square value (X^2) is 61.564 with a significance probability value (ρ)= 0.000, meaning that there is a significant difference at the level of error rate (α) below 1% between respondents who answered that they chose symmetrical buildings over asymmetrical buildings.

Color is also an important element of the aesthetics of post-disaster modular homes. The odds ratio value of 78.8% shows that 78.8% of respondents chose symmetry over asymmetry. The chi square value (X^2) is 51.923 with a significance probability value (ρ)= 0.000, meaning that there is a significant difference at the level of error rate (α) below 5% between respondents who answered that monochromatic colors rather than full colors.

Windows scale rather than plane is also an important element of the aesthetics of post-disaster modular homes. The odds ratio value of 59.6 % shows that 59.6 % of respondents chose symmetry over asymmetry. The chi square value (X^2) is 5,769 with a significance probability value (ρ) = 0.016, meaning

that there is a significant difference at the level of error rate (α) below 5% between respondents who answered that wide rather than limited window scale.

Table 5. Aesthetic Elements between Architecture and Non-Architecture Students

		Students		Total	Chi-Square	df	p
		Non Architectural	Architecture				
E1	Static structure	34	24	58	,636	1	,425
	Overhaul	51	47	98			
	Total	85	71	156			
E2	Joint with details	44	46	90	2,688	1	.101
	Joint without Details	41	25	66			
	Total	85	71	156			
E3	Asymmetry	18	11	29	,826	1	,364
	Symmetry	67	60	127			
	Total	85	71	156			
E4	without crating	57	52	109	,702	1	,402
	with crating	28	19	47			
	Total	85	71	156			
E5	full color	24	9	33	1,615	1	.108
	monochromatic color	61	62	123			
	Total	85	71	156			
E6	not Broad	48	45	93	,767	1	,381
	Limited openings	37	26	63			
	Total	85	71	156			

Source: processed primary data (2023)

The evaluation results using the chi square difference test showed that there were no differences in aesthetic perception based on the characteristics of the research subjects (educational background). Respondents' perceptions of the six aesthetic elements did not differ between students with art, design and

architecture backgrounds compared to individuals with backgrounds outside art, design and architecture tested using the chi square test. All significance probability values (ρ) > 0.10 indicate there are no statistically significant differences.

5. DISCUSSION

The aesthetic element in this case is not only visual beauty, but also technical beauty. The technical aesthetic elements are dismantled assembly structures, detailed joint connections and symmetrical structures. Respondents preferred modular houses with disassembled structures (62.8%, ρ < 0.01), detailed joints (57.7%, ρ < 0.10), symmetrical shapes (81.4%, ρ < 0.01). These three elements are proven to significantly differentiate aesthetic perception responses. The assembly structure, detailed joint connections and symmetrical structure are elements that characterize the aesthetics of disaster relief modular houses.

The dismantled assembly structure means modular houses can be produced quickly, efficiently and quality can be controlled because it is done in the factory and on site. Assembled structures also allow modular homes to be moved and modified (added and subtracted). On the other hand, the assembly structure also allows the function of the space to be easily changed according to needs. The family room can be easily transformed into a work space, relaxing or resting space, by moving the wall panels. The assembled structure also allows modification of the appearance of the room atmosphere.

Symmetrical shapes are not only related to technical aspects (the building's ability to respond to earthquakes), but also influence the composition of the building's visual appearance. The structure and construction of the building (disassembly, detailed joints, symmetrical structure) not only plays a role in the strength of the building but more than that it can also express the beauty contained within it. The technical aspects created produce architectural works that are strong, sturdy, (earthquake resistant) and aesthetic. These three elements are not only rational-functional (i.e. creating strength, efficiency, fast production) but can create a sense of a technological touch.

Texture, color and non-plane scale are also aesthetic elements of post-disaster modular homes. Respondents preferred modular houses with craft textures (69.9%, ρ < 0.01), monochromatic colors (78.8%, ρ < 0.05) and non-wide windows scale (59.6%, ρ < 0.01). Structural panels, walls, floors, ceilings with detailed crafting are preferred over those without details. This supports previous research where ornamental details create an expression of the beauty of classical buildings (Al-Alwan & Mahmood, 2020; Cucuzzella et al., 2022; Elrayies, 2018) . Texture also plays a role in creating an atmosphere (sense) of place (Spence, 2020). Surface articulation also creates a sense of place (Cucuzzella et al., 2022; Elrayies, 2018; Jiang, 2019). Technological developments also make it easier for materials to be printed (Al-Alwan & Mahmood,

2020; Elrayies, 2018).

Apart from texture, respondents also prefer modular houses with monochromatic colors rather than full colors. This could be because disaster victims need calm/peace, whereas monochromatic/soft colors evoke theta waves associated with calm (Kim et al., 2021) compared to colorful rooms. Colorful rooms distract from focus compared to no color (Stern-Ellran et al., 2016). Color is proven to create an atmosphere with various effects on aesthetic preferences (Design & Approaches, 2021). Color has also been proven to have an influence on the EEG parameters Delta, Theta, Alpha, Beta and Gamma waves (Cabrera et al., 2021) .

Apart from texture and color, respondents also preferred modular houses with large openings rather than limited ones. This could be because disaster victims need calm/peace, while the wide scale of the openings creates a connection with the outside space. These findings support previous studies (Kim et al., 2021) on inpatient hospital treatment subjects. Studies through EEG experiments found that a wide opening scale increased the user's relaxation response. Another study (Vartanian et al., 2015) also found that open spaces were rated as more beautiful compared to closed spaces and active areas in the temporal lobe were related to perceived visuals.

6. CONCLUSION

The results of this research found that the aesthetic elements of post-disaster modular houses consist of: disassembled structures, detailed joints, craft textures, symmetry, and non-wide scale. The results of this research have the implication that to develop the beauty of post-disaster modular houses, you can develop attractive elements in: disassembled structures, detailed joints, craft textures, symmetrical structures, and non-wide scale.

This research has several limitations. First, this research uses a survey approach, with research variables measured by the subjects' perceptions. The perception approach provides research weaknesses related to perception bias, namely that it can be subjective, even though there are control variables that test differences in the background knowledge and experience of research subjects. Future research could use experimental approaches such as those based on neuroscience.

Second, the research subjects are students. Student subjects were selected to control the variables of knowledge and experience. However, students may have different characteristics from post-disaster modular home users in general. Future research could use experimental approaches such as neuroscience-based by taking subjects who use modular homes.

COMPETING INTERESTS

The authors have no competing interests to declare.

Author's Affiliation

Basuki[1*], Johanes Bonivasius Muda[2], Yohana Nursruwening[3], Natasia Anggi Laxmita[4]

[1,2,3,4] Architecture study program, Faculty of Engineering, Wijayakusuma University, Purwokerto, Indonesia

HOW TO CITE THIS ARTICLE:

Basuki, Muda, J. B., Nursruwening, Y., & Laxmita, N. A. (2023). Aesthetic Elements of Post-Disaster Modular Houses: Study of Architectural and Non-Architectural Student Preferences. *Seybold Report Journal, 18(10),* 194-216. DOI:10.5110/77. 1088

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