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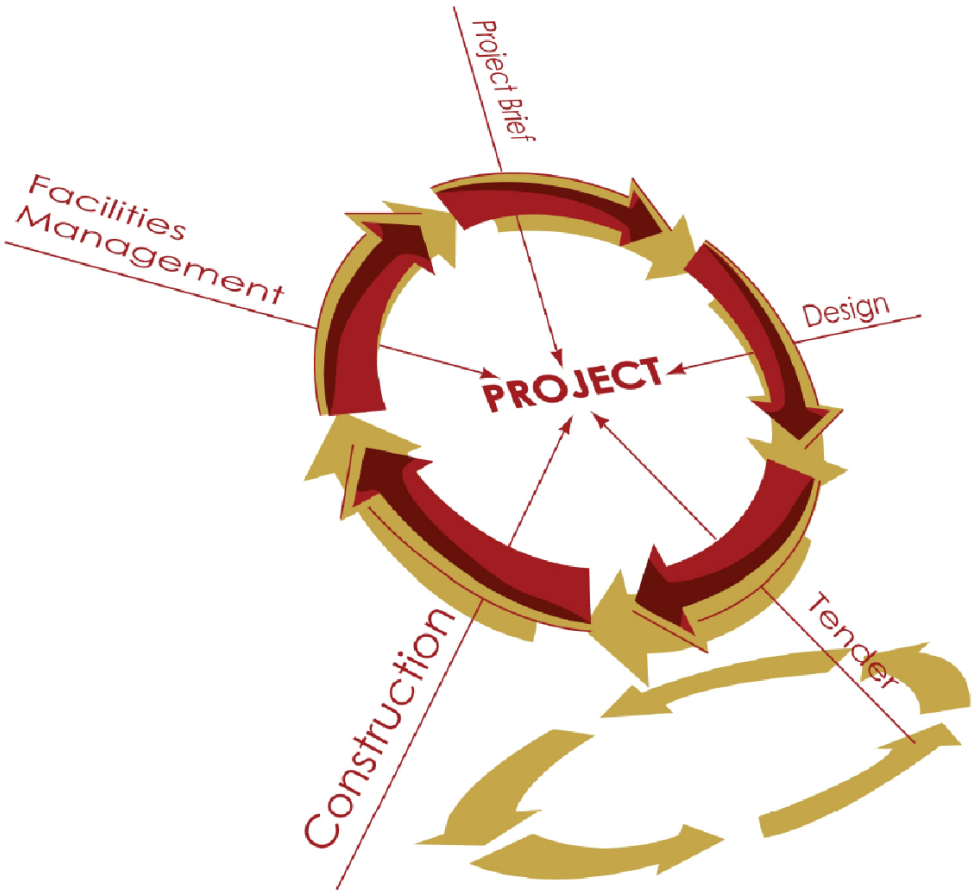
6TH HABITECHNO INTERNATIONAL CONFERENCE 2023



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Contents

Introduction

Shaping Sustainable, Inclusive and Resilient Habitats for The Future

The relentless pace of global urbanisation presents profound challenges and opportunities for the built environment sector. As cities and settlements expand, particularly in developing nations, the imperative to create human habitats that are not only functional but also sustainable, inclusive, safe, and resilient becomes increasingly critical. Addressing this complex objective requires a multi-faceted approach, integrating innovative design, appropriate technology, sound construction practices, sensitive urban planning, and a deep understanding of socio-economic dynamics. The construction industry stands at the forefront of this endeavour, tasked with translating evolving societal needs and environmental responsibilities into tangible, enduring structures and communities.

This Special Edition of the Malaysian Construction Research Journal (MCRJ) delves into this critical imperative, assembling a collection of research focused on advancing the knowledge and practice required to foster sustainable human settlements. While the genesis of these contributions lies in the vibrant discussions at **the 6th Habitechno International Conference 2023, themed 'Sustainable Human Settlement: Create Inclusive, Safe, and Resilient Habitat'**, this issue transcends the event itself to highlight enduring themes and innovative explorations pertinent to construction research and development, particularly within the Southeast Asian context and beyond.

The articles curated within this volume represent a diverse spectrum of inquiry, reflecting the interconnectedness of factors influencing our built environment. We begin with **explorations into the frontiers of design**, examining novel methodologies like interpolation as a design development tool, the practical barriers and perceptions surrounding "Design for Disassembly" in promoting circularity, and the rich, often unspoken, sensory insights derived from traditional or 'unselfconscious' design cultures. These studies push the boundaries of conventional practice, seeking more adaptable and culturally resonant design solutions.

Recognizing that sustainability also involves sensitive engagement with the past, a section addresses **building conservation and architectural history**. Research presented here investigates the sustainability implications of building conversions within neighbourhood contexts and sheds light on historical figures and practices that shaped early architectural development, providing valuable context for contemporary challenges.

Significant focus is placed on **advances in building technology and construction practices**. This includes critical investigations into public and community perceptions regarding sustainable materials like bamboo and wood, highlighting the socio-cultural dimensions of material adoption. Technical studies delve into optimizing building performance through analyses of airtightness using CFD simulation and literature reviews on innovative 'breathing wall' designs. Furthermore, the crucial role of contractual elements in determining construction project success from a stakeholder perspective is meticulously examined, underscoring the importance of robust project management frameworks.

The complexities of **urban housing dynamics**, especially for low-income and younger generations, form another core pillar of this edition. Research explores housing preferences within Transit-Oriented Developments (TOD), evaluates the quality of public rental housing through user feedback analysis, measures the spatial characteristics of formal housing developments, and maps the persistent challenges of housing affordability for low-income households. Evaluations of specific housing programs, like Indonesia's 'Rutilahu' initiative, and proposals for integrated homeownership schemes offer practical insights into policy effectiveness and potential solutions.

Finally, the edition broadens its scope to encompass **urban health, resilience, and broader sustainability concerns**. Studies propose frameworks for enhancing urban flood resilience through community adaptation, investigate the potential of community-based urban greening initiatives to bolster environmental resilience in low-income settlements, and analyse the economic impacts of sustainable green open spaces within urban fabrics.

Collectively, these papers underscore the multi-faceted nature of creating sustainable, inclusive, safe, and resilient human settlements. They offer valuable theoretical insights, empirical findings, and practical considerations for researchers, practitioners, policymakers, and educators engaged in shaping a more sustainable and equitable built future. MCRJ is pleased to present this Special Edition as a contribution to the ongoing dialogue and innovation in construction research vital for navigating the urban challenges of the 21st century.

Editorial Advisory Board

Secretariat Special Issue

Editorial

Welcome from the Editors

Welcome to this special issue of the Malaysian Construction Research Journal (MCRJ), featuring selected papers from the 6th Habitechno International Conference held in 2023. We would like to express our sincere gratitude to our contributing authors for sharing their valuable research, to the dedicated reviewers for their insightful feedback, to the conference organizers for facilitating the initial exchange of ideas, and to our readers for engaging with this collection.

This special issue in MCRJ contains twenty (20) exciting papers covering critical aspects related to the theme of **"Sustainable Human Settlement: Create Inclusive, Safe, and Resilient Habitat"**. It is hoped that the readers will greatly benefit from the scientific content and quality of papers published in this issue, which collectively address pressing challenges and innovative solutions in the built environment, particularly relevant to developing countries.

A brief introduction of each article is given hereunder:

SECTION 1: EXPLORING FRONTIERS IN DESIGN

Ni Luh Made Rai Dyah Prathiviningsih et al., investigate obstacles faced by architects in Indonesia regarding the implementation of "Design for Disassembly" principles and the practical reuse of building components.

Rakhmat Fitranto Aditra et al., propose and investigate interpolation as an alternative, potentially more fluid or generative, method for the complex process of architectural design development, moving beyond traditional linear approaches.

Riva Tomasowa et al., delve into 'unselfconscious' design cultures, analysing how design moves beyond verbal articulation by emphasizing the crucial role of sensory insights and tacit, embodied knowledge in shaping-built forms.

SECTION 2: BUILDING CONSERVATION AND ARCHITECTURAL HISTORY

Wiwik Dwi Pratiwi et al., examine the relationship between building conversion construction projects and overall neighbourhood sustainability, utilizing specific case studies from Bandung, Indonesia, to illustrate impacts and planning considerations.

Mahatmanto et al., analyse the role of Abikoesno Tjokrosoejoso in the historical formation of the architect profession during Indonesia's colonial era, highlighting his influence on professional identity and standards.

SECTION 3: ADVANCES IN BUILDING TECHNOLOGY AND CONSTRUCTION

Brilliant Kholifal Amin et al., assess community perception regarding the utilization of bamboo as a sustainable building material, identifying levels of acceptance and socio-cultural factors influencing its adoption.

Amalia Nurjannah et al., utilize CFD simulations to determine appropriate building airtightness levels, seeking an optimal balance between enhancing split-system air-conditioning efficiency and ensuring adequate fresh air intake for occupant health.

Dewi Larasati et al., conduct a comprehensive literature review analysing the correspondence between various design parameters of 'breathing walls' and their resultant impact on overall building performance, particularly thermal and moisture regulation.

Novya Ekawati et al., evaluate the significance of specific contractual elements on building construction project performance, gathering insights directly from various stakeholders to understand key factors influencing project success or failure.

Dibya Kusyala et al., explore evolving community perceptions and current trends regarding the use of wood in house construction within specific localities, examining factors influencing its selection and acceptance as a building material.

SECTION 4: URBAN HOUSING DYNAMICS

Ageng Wiranti et al., investigate the specific housing preferences of Millennials and Generation Z concerning Transit-Oriented Development (TOD) based housing options within the Jakarta Metropolitan Area (Jabodetabek).

Audiza Nadella et al., explore perceptions of housing quality within public rental housing schemes by systematically analysing online user reviews, focusing on the West Java Transit Apartment complex as a case study.

Ilma Nurfadlilawati et al., apply space syntax measurement techniques to analyse the spatial configuration, layout characteristics, and potential social implications of formal housing developments constructed by private developers in Bandung City.

Tri Yuwono et al., map the complex, multi-faceted issues surrounding perceived adequate housing affordability specifically for low-income households residing within the Bandung Metropolitan Area, identifying key challenges and spatial patterns.

Juarni Anita et al., evaluate the effectiveness and sustainability outcomes of the 'Rutilahu' (Unlivable House Rehabilitation) program in Sukawening Village, Bandung District, focusing on its success in creating genuinely livable homes.

Agustinus Adib Abadi et al., propose an integrated approach that combines rental housing options with structured savings schemes to promote sustainable and accessible homeownership pathways for low-income households in Bandung.

Wibisono Bagus Nimpuno et al., analyse user perceptions of vertical public rental housing (Rusunawa) in Jakarta, utilizing online reviews to gauge resident satisfaction and identify common issues.

SECTION 5: URBAN HEALTH, RESILIENCE AND SUSTAINABILITY

Wardatut Toyyibah et al., propose strategies for enhancing urban flood resilience by studying and leveraging community adaptation mechanisms observed among residents living along three major river basins in Java, Indonesia.

Muhammad Amin Shodiq et al., investigate how community-based urban greening initiatives, exemplified by the successful Kampung Hijau program in Surabaya, can significantly enhance the environmental resilience of low-income urban settlements.

Nur Arief Hapsoro et al., examine the tangible economic effects that the presence, accessibility, and quality of green open spaces have on the local communities residing within large urban centers.

Taken together, the diverse studies presented in this special issue offer valuable insights into the complex challenge of creating more sustainable, inclusive, safe, and resilient human settlements. From innovative design approaches and material technologies to critical analyses of housing policies and community resilience frameworks, these papers highlight the breadth of research essential for progress. We trust that these contributions will not only enrich the academic discourse within construction research but also provide practical knowledge and stimulus for professionals, policymakers, and communities working towards better built environments, particularly in the Southeast Asian region facing rapid urbanization. We hope this collection inspires continued investigation, collaboration, and innovation in this vital field.

OBSTACLES IN THE IMPLEMENTATION OF "DESIGN FOR DISASSEMBLY" AND THE REUSE OF BUILDING COMPONENTS IN INDONESIA: ARCHITECT'S PERSPECTIVE

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Abstract
Buildings significantly contribute to elevated carbon emissions and generate substantial construction waste. Consequently, the World Green Building Council has declared its commitment to achieving net zero emissions for all buildings by the year 2050. In the context of construction development, adopting a circular economy scenario has the potential to mitigate both environmental impacts. The integration of Design for Disassembly (DfD) concepts within the framework of a circular economy offers a solution for enhancing the disassembly and reuse of building materials in the foreseeable future. Nevertheless, Design for Disassembly (DfD) concepts have not yet assumed the primary criteria status in building design within the construction industry. This study seeks to identify and analyse the constraints associated with the implementation of DfD. This research delved into the perspectives of architects, architectural designers, and students in architecture studies, focusing on the implementation of "design for disassembly" and the reuse of building components. The methodology employed explorative qualitative analysis grounded in theory. Data collection encompassed an online questionnaire, utilizing non-random sampling techniques, with 118 respondents meeting the inclusion criteria. The analysis applied open, axial, and selective coding methods. The findings of this study reveal five primary hindering factors faced by architects and architectural practitioners in Indonesia during the implementation of the Design for Disassembly (DfD) principles, along with implementable strategies.

Keywords: *Barriers; building design; circular economy; construction; and design for disassembly*

INTRODUCTION

Awareness of the environmental impacts stemming from building construction activities has garnered considerable attention in contemporary academic literature. According to research conducted by the International Energy Agency (IEA) in 2019, the building construction sector contributed 39% to the total global CO_2 emissions. Simultaneously, findings from a study by Yeheyis et al. (2013) indicate that approximately a quarter of the total global waste production arises from the construction sector.

Projections from Low Carbon Development Indonesia for 2021 reveal a potential increase of up to 82% in waste production from the building construction sector in Indonesia by 2030 (lcdi-Indonesia, 2021). Recognizing the substantial impact of this sector, the World Green Building Council (World GBC) underscores the importance of two primary goals: reducing at least 40% of the carbon content in the construction sector by 2030 and achieving zero carbon emissions in both operations and building materials by 2050 (World Green Building

Council, 2019). Therefore, placing emphasis on strategies for reducing CO_2 emissions is of utmost importance (Langevin et al., 2019; Larasati et al., 2023; Primasetra & Larasati, 2021).

The concept of the circular economy underscores the importance of maximizing the benefits and added value of raw materials, components, and products to minimize the generation of unused waste materials, particularly in the context of building construction materials or components (Garcés-Ayerbe et al., 2019; Urbinati et al., 2017). The strategic reuse and recycling of building materials constitute essential measures in the concerted effort to mitigate CO_2 emissions (Ma et al., 2019; Rahla et al., 2021; U.S. Department of Defense, 2002; U.S. Environment Protection Agency (EPA), 2008; Wheaton, 2017).

The DfD approach is tailored to enhance the efficiency of building construction by optimizing the use of new materials and improving waste management throughout the construction, renovation, and demolition processes (Guy & Ciarimboli, 2003; Rios et al., 2015; Roxas et al., 2023). The overarching principle of DfD aims to prolong the service life of buildings and establish a sustainable reservoir of materials for future development (Carvalho Machado et al., 2018; Durmisevic, 2006; Wheaton, 2017). According to the Ellen Macarthur Foundation (2019), the application of these principles holds the potential to reduce carbon emissions by up to 38% by the year 2050.

Despite numerous studies highlighting the significance of the Design for Disassembly (DfD) principle in mitigating carbon emissions, its implementation in building design still appears to be relatively infrequent (Akinade et al., 2020; Citraningrum et al., 2023; Wahyu Adi & Wibowo, 2020). The research conducted by Cruz Rios et al. (2021) further suggests that the adoption of this principle in building construction remains at a low frequency.

Several studies have explored obstacles to the adoption of Design for Disassembly (DfD) principles (Citraningrum et al., 2023; Cruz Rios et al., 2021; Park & Tucker, 2017; Tingley & Davison, 2011; Tleuken et al., 2022; Wahyu Adi & Wibowo, 2020). Commonly encountered barriers encompass limited financial resources and time, absence of a market for reusable materials, insufficient knowledge among stakeholders, apprehensions regarding aesthetic aspects and material quality, uncertainty about product longevity, inadequate financial support, and regulatory frameworks, as well as a deficiency in systems and technology for the collection and management of reusable materials.

Therefore, conducting the identification of local perspectives on the implementation of Design for Disassembly (DfD) principles is highly significant, as the acceptance and integration of these principles are intrinsically influenced by the diversity of cultural backgrounds (Citraningrum et al., 2023). Several studies related to the identification of DfD implementation have been carried out in Indonesia. For instance, Citraningrum et al. (2023) engaged architects, developers/contractors, and the general public in their research. The majority of respondents were in the middle-aged group (35-44 years old). Additionally, a study conducted by Wahyu Adi and Wibowo (2020) investigated the construction industry, particularly in building, road, and bridge construction, with the majority of respondents also falling within the middle-aged group (35-44 years old). However, the latter study did not specifically focus on building construction.

The objective of this research is to understand the challenges in implementing DfD principles and reusing materials in the context of building construction. The primary focus is on evaluating the perspectives of architectural designers, particularly those in the early stages of their careers, to comprehend the barriers and opportunities for implementing these concepts in the field of architecture in Indonesia.

RESEARCH METHOD

This research employs qualitative methods, utilizing a grounded theory approach. Grounded theory is a systematic research method wherein researchers develop a conceptual framework or theory through the inductive analysis of theoretical evidence (Charmaz, 2014). The choice of grounded theory is deliberate as it facilitates the acquisition of an in-depth understanding of the phenomenon of applying Design for Disassembly (DfD) principles in the context of design.

The necessary data is gathered through the utilization of an online questionnaire, comprising both closed and open-ended questions. Closed questions are designed to obtain personal data from respondents and evaluate the frequency of applying the Design for Disassembly (DfD) principle. For this evaluation, a Likert scale is employed, where a value of 1 signifies 'never applies,' and a value of 5 signifies 'always uses' the DfD principle. Additionally, as a supplement, an open-ended question has been included in the survey. In contrast, open-ended questions aim to elucidate the motivations behind respondents' choices and elucidate the reasons for either integrating or abstaining from implementing DfD principles. A detailed overview of the question format in the online questionnaire is available in Table 1.

Table 1. Example of Online Questionnaire

Question	Pattern of Response
Respondent Attributes	
Gender	Multiple choice
Age	Multiple choice
Residence	Open-ended
Profession	Multiple choice
Frequency of Applying DfD	
Have you ever considered the DfD principle when designing buildings?	1 2 3 4 5 (likert scale)
Reasons for Choosing the Frequency	
Explain why you chose the above answer?	Open-ended

In this study, respondents were selected using a non-random sampling method with purposive sampling technique through the questionnaire distribution. The selection of this method is based on the consideration to choose sample units that possess specific characteristics, namely, a profound understanding and experience in the field of architectural design. Inclusion criteria involved architecture students who have completed at least 6 design studios and practicing architects. Participant recruitment took place from February 14, 2023, to May 13, 2023. The questionnaire was distributed to 120 respondents, resulting in 118 valid responses. Detailed information regarding the characteristics of participant respondents can be observed in Figure 1.

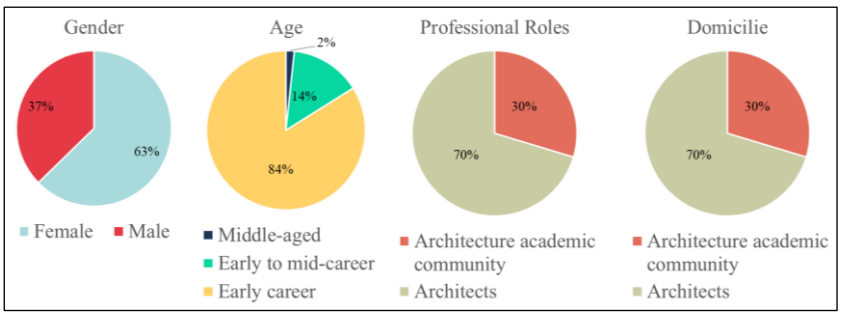

Figure 1. Participant Characteristics Details

The analysis data in this research encompassed three stages of content analysis coding: open coding, axial coding, and selective coding, following the method proposed by Corbin and Strauss in 1990). The distribution analysis process was also conducted to ascertain the frequency of categories in each collected statement. During the initial stage of open coding, key components were identified and individually labelled. In the subsequent axial coding stage, codes were grouped and synthesized into more general categories, exploring the relationships and correlations between the codes. The final stage, selective coding, involved identifying comprehensive relationships that bind entire categories with existing codes and data, while also formulating a hypothesis model based on the results obtained from the axial coding stage (Corbin and Strauss, 1990). Data processing was executed using the JMP Pro application, and the results of the collected data were presented via a dendrogram to enhance comprehension of the analysis outcomes.

RESULTS

Relationship Between the Frequency Level of Design for Disassembly (DfD) Implementation and The Age Group of Respondents

The results of the open and axial coding analyses indicate the identification of eight main categories related to the reasons or motivations of respondents in using the Design for Disassembly (DfD) principle, as presented in Table 2. To minimize bias in the coding process, category names were adopted from previous research with a focus on similar topics, as outlined in the studies by Cruz Rios et al. (2021) and Tleuken et al. (2022). Each category is accompanied by the frequency obtained through distribution analysis. The most frequently occurring factor is "Cultural Aspect" (frequency: 62), followed by "Technical Aspect" (frequency: 36) and "Economic Aspect" (frequency: 22). Categories with the lowest frequencies are "Regulation" (frequency: 1), followed by "Aesthetic Quality" (frequency: 8) and "Secondary Considerations" (frequency: 9). The category "Regulation" (frequency: 1) demonstrates minimal occurrence and is thus not included in further analysis.

The results depicting the relationship between the frequency level of Design for Disassembly (DfD) principal application and the respondent's age group are illustrated in Figure 2. This analysis aims to elucidate the general conditions of DfD implementation concerning the respondent's current age. The results of the analysis demonstrated high significance ($p=0.314$, Pearson = 0.0131).

Table 2. Grouping of Sub-Categories and Categories: Motivations for Implementing DfD Principles

Sub-Category	Category
Enhancement of Aesthetics (6)	
Increased Design Creativity (1)	Aesthetic Quality (8)
Design Originality (1)	
Not a Primary Focus in Design (9)	Secondary Considerations (9)
Cost Reduction (11)	
High Recycling Material Costs (1)	Economic Aspect (22)
Inadequate Return on Investment (1)	Economic Aspect (22)
Maintenance Costs (2)	
Limited Funding Sources (7)	
Efficiency Considerations (2)	
Considering DfD Principles (8)	
Project Criteria (11)	Cultural Aspect (62)
Ignoring DfD Principles (27)	
Architect's Perspective (2)	
Client Preferences (12)	
Awareness of sustainability (2)	
Attention to Environmental Issues (4)	Environmental Aspects (17)
Commitment to Environmental Sustainability (11)	
Lack of Examples of Constructed Buildings (1)	Knowledge Aspects (14)
Limited and Poorly Disseminated Information (13)	
Lack of Responsibility Due to Unclear Regulations (1)	Regulations (1)
Constructing sustainably (9)	
Easy Availability of Recyclable or Reusable Materials (2)	
Lengthy Process in Reusing/Recycling Materials (3)	
Limitations in Reusable/Recyclable Materials (5)	
Concerns about the Durability of Recycled Materials (2)	Technical Aspects (36)
Quality of Reusable/Recyclable Materials (7)	
Difficulty in Estimating Reusable/Recyclable Materials (3)	
Safety Considerations (2)	
The building is assumed to be durable (3)	

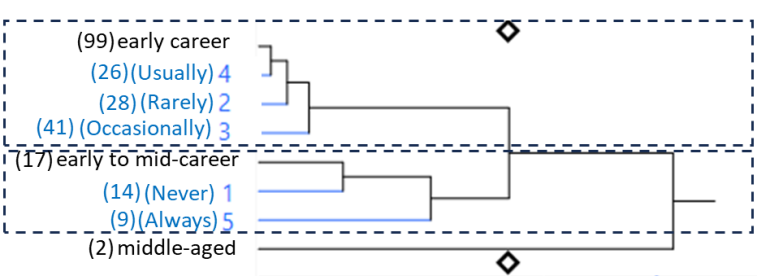

Figure 2. The Relationship Between the Level of DfD Application Frequency and The Age Groups of Respondents

Overall, respondents were categorized into two primary groups, with the middle age group excluded due to its non-dominant representation. The first group, termed the "Young Potential Group," comprises individuals aged 15-24 who are in the early stages of their careers. They exhibit variations in the application of the Design for Disassembly (DfD) principle, occasionally utilizing it and sometimes infrequently. The second group, referred to as the "Mature Professional Group," consists of early-career individuals aged 25-34 who are in mid-career. They exhibit a tendency to consistently use or, conversely, never use the DfD principle at all.

Relationship Between the Frequency of Implementing Design for Disassembly (DfD) and The Motivation for Its Utilization

The axial coding analysis in Figure 3 presents an understanding of the groups applying the Design for Disassembly (DfD) principle in Indonesia and their correlation with the motivations for its implementation. The objective of this analysis is to explore the relationship between the motivation for utilizing DfD and the frequency of its application, resulting in the identification of four groups reflecting DfD practices in Indonesia. The analysis identified two groups encountering barriers, namely the environmentally unaware group and the environmentally indifferent group. One group exhibiting a positive response to DfD is the environmentally conscious group. Additionally, one group demonstrated both barriers and a positive response to DfD, namely the environmentally conscious group with a focus on cost aspects. The analysis results indicate high significance (p=0.0007, Pearson = 0.0054).

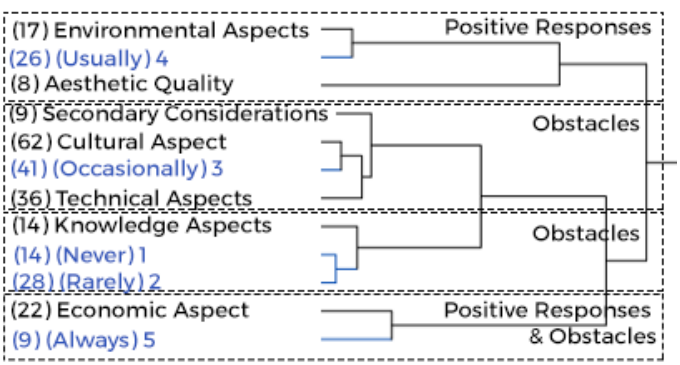

Figure 3. Results of Correspondence Between Frequency and Motivation of DfD Utilization

The determinants and hindrances for each group are explicated in detail below, accompanied by a visual representation of the data distribution from Table 2 using nested pie charts. The inner pie chart elucidates the categories, while the outer pie chart delineates the corresponding sub-categories. This presentation also involves direct and relevant quotations from respondents' questionnaire answers, with the exception of using ellipses (...) to denote the omission of some text for clarity. Yellow-coloured pie chart diagrams indicate positive responses, while red diagrams delineate impediments.

Notably, this distribution analysis does not elucidate how frequently respondents referenced these aspects within one group. Instead, the analysis encompasses frequencies across respondents as a whole without considering the frequency with which individuals employ the DfD principle.

Groups Exhibiting Positive Responses: Environmental Consciousness Group

The Environmental Consciousness Group is primarily composed of respondents who frequently implement the Design for Disassembly (DfD) principle. The predominant factors characterizing this group include a heightened concern for the environment and an emphasis on aesthetic quality. The results of the distribution analysis pertaining to environmental aspects and aesthetic considerations are depicted in Figure 4. Notably, this group exhibits a noteworthy absence of significant barriers, primarily attributed to their heightened awareness

of environmental sustainability and their adeptness in integrating aesthetics into the application of DfD principles. Their environmental concern is further bolstered by elements such as a robust awareness of sustainability, attentiveness to environmental issues, and a steadfast commitment to environmental sustainability. The subsequent section provides an illustrative example of questionnaire responses from this particular group.

"Due to my awareness of environmental preservation and sustainability, I conscientiously contemplate the use of sustainable materials, at the very least." (Respondent No. 112, Male, Recent Architecture Graduate).

Respondents underscore the aesthetic dimension, emphasizing that the implementation of Design for Disassembly (DfD) principles, particularly through building reuse, contributes to enhanced aesthetic value, heightened design creativity, and originality in designs, as exemplified in the subsequent example.

"Contemplating the future of the materials used allows for the incorporation of aesthetics into new buildings through the utilization of old materials (reuse and recycle)." (Respondent No. 44, Male, Recent Architecture Graduate).

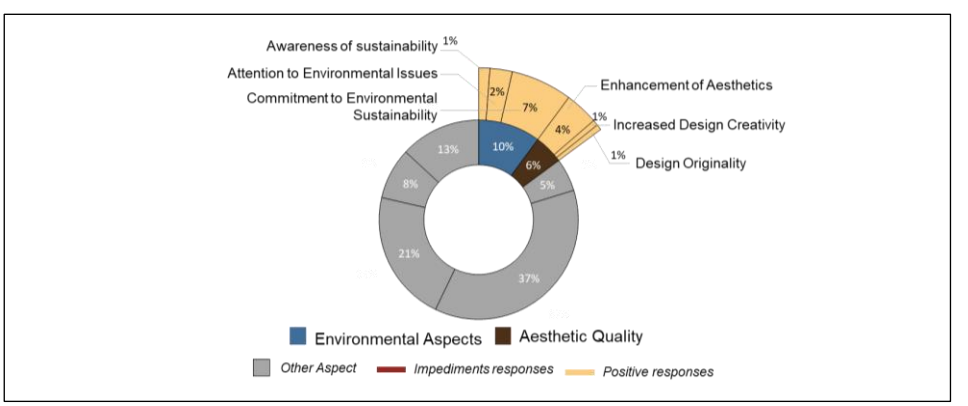

Figure 4. Analysis of The Frequency Distribution of Environmental Aspects and Aesthetic Quality

Barrier Group: Environmentally Indifferent Group

The Environmentally Indifferent Group is primarily comprised of respondents who occasionally implement the Design for Disassembly (DfD) principle and represents the most prevalent obstacle group. Factors identified within this group encompass secondary considerations, cultural aspects, and technical aspects. The analysis of these three factors is presented in Figure 5.

The impediment factor of secondary considerations arises due to this principle not being the primary focus in the design process. Respondents affirmed that, in the design process, the central emphasis tends to be on aspects such as aesthetics, functionality, comfort, cost, material strength, and material maintenance, rather than the direct application of Design for Disassembly (DfD) principles. The subsequent section provides an illustrative example of questionnaire responses from this particular group.

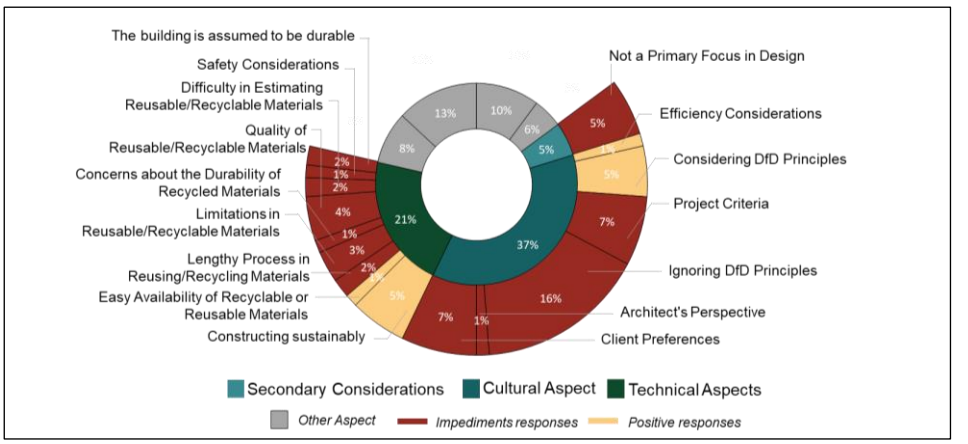

Figure 5. Analysis of the Frequency Distribution of Secondary Considerations, Cultural Aspects, and Technical Aspects

"(...) in the design process, there is still an excessive focus on other aspects such as comfort, cost, aesthetics, etc., and insufficient consideration is given to the stage when the building is no longer used for its original function as initially designed." (Participant No. 83, Male, Master's Degree Student in Architecture).

The second factor in this group pertains to the cultural aspect. Frequently raised concerns by respondents encompass the neglect of Design for Disassembly (DfD) principles, adherence to project criteria, and reliance on client preferences. The architect's perspective also constitutes a consideration within the cultural aspect, albeit with a limited distribution, indicating infrequent expression by respondents. Individuals disregarding the DfD principle mention that, during the design phase, they have not taken into account the future sustainability of the materials used.

"Because, during the design process, there are instances where we overlook considerations for the future sustainability of the materials used." (Participant No. 114, Female, Undergraduate Student).

Respondents expressed concerns related to obstacles arising from project criteria, highlighting the necessity to initially align with the character, type, and demands of the project before considering Design for Disassembly (DfD) principles.

"An architect can incorporate the ideals of a (...) concept that involves the utilization of materials that can be recycled or reused, with several considerations, including alignment with the taste and character of the design." (Participant No. 65, Male, Project Architect).

Respondents expressed concerns regarding client preferences, noting that, generally, clients favour the utilization of new materials. Architects perceive that the Design for Disassembly (DfD) principle may not align with the preferences of clients.

"Because, in the projects I have been involved in thus far, it is exceedingly uncommon for clients to express a preference for second-hand goods; rather, they consistently prefer all materials to be new." (Participant No. 4, Male, Architecture Student Master).

Despite encountering obstacles in the cultural aspect, some respondents expressed a positive response to this dimension. This positive response entails consideration of Design for Disassembly (DfD) principles and acknowledgment of their efficacy in DfD implementation practices. However, the number of respondents providing positive responses was fewer than those facing obstacles in the cultural aspect. This underscores the dominance of cultural aspects as hindrances in the implementation of DfD principles.

Another factor in the group that exhibits environmental indifference is the technical aspect. Respondents emphasized the primary impediments within the technical aspect, specifically expressing doubts regarding the quality and limitations of materials that can be reused or recycled.

"(...) Moreover, even after the period of use has concluded, the material is seldom reused due to a decrease in its quality." (Participant No. 19, Female, Young Architect).

"In my opinion, there are only a few materials currently suitable for reuse and recycling, such as wood or natural stone." (Participant No. 66, Male, Recent Architecture Graduate).

Additional barriers encompass prolonged reuse/recycling processes, concerns regarding the durability of recycled materials, challenges in estimating reusable/recyclable materials, safety considerations, and assumptions about the longevity of buildings – even though each building component possesses varying inherent resistance capacities. Similar to the cultural aspects, several respondents also conveyed positive responses to the technical aspects. However, these affirmative responses were less prevalent compared to those encountering obstacles, indicating that technical aspects predominantly pose obstacles in implementing Design for Disassembly (DfD) principles. Positive responses included experiences of sustainable building practices and the perception that some respondents found it facile to locate materials that could be recycled/reused. An illustration of the distribution of obstacles and positive responses related to technical aspects can be seen in Figure 5.

Barrier Group: Environmentally Unconscious Group

The Environmentally Unconscious Group is primarily comprised of respondents who seldom or never apply Design for Disassembly (DfD) principles. Their primary reason is attributed to the knowledge aspect. The distribution analysis of the knowledge aspect is presented in Figure 6.

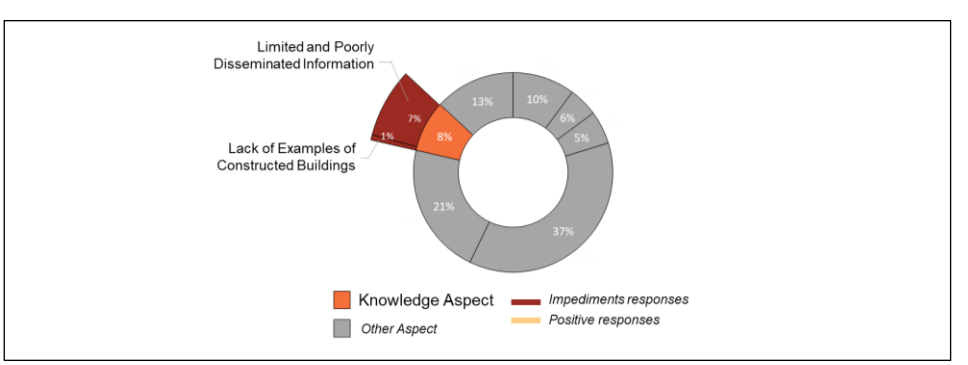

Figure 6. Analysis of the Frequency Distribution of Knowledge Aspects

The main challenge in this obstacle is limited and unevenly distributed information. Respondents expressed the need for detailed procedures that could provide guidance in implementing this principle. Another concern involves the scarcity of examples of buildings that have successfully implemented this principle. The subsequent section provides an illustrative example of questionnaire responses from this particular group.

"I am interested in reusing and recycling materials, but due to my limited knowledge about these materials, I have not implemented the use of reused and recycled materials in some of the designs I have worked on." (Participant No. 15, Female, Young Architect).

Barrier Group and Positive Response Group: Environmental Consciousness Group with Emphasis on Economic Aspects

The group that prioritizes environmental concerns while focusing on the economic aspect is predominantly composed of respondents who consistently apply the Design for Disassembly (DfD) principle. Economic factors were identified as influential within this group. There are two conflicting aspects with equal distribution in this factor, comprising issues with positive responses and obstacles. Despite encountering obstacles, respondents in this group tend to persist in applying DfD principles. It is suspected that other positive aspects may be more dominant, thereby mitigating the economic obstacles from being the primary reason for some respondents not to apply this principle. The distribution analysis of the economic aspect can be observed in Figure 7.

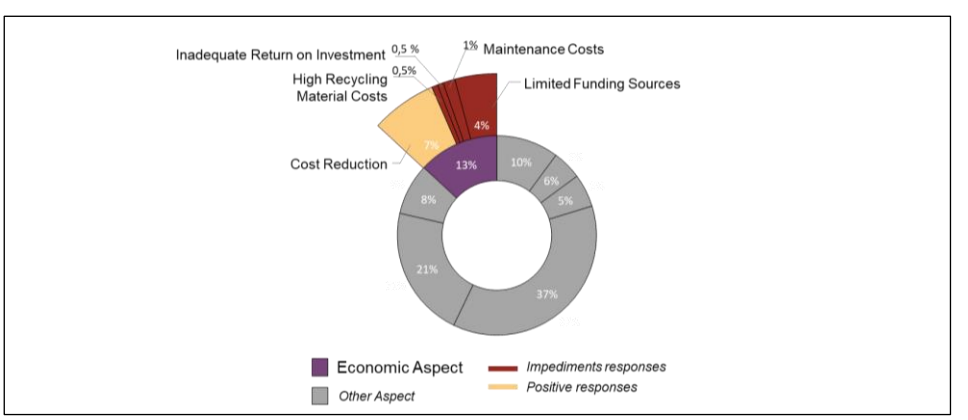

Figure 7. Analysis of the Frequency Distribution of Economic Aspects

The positive response articulated by respondents was that the Design for Disassembly (DfD) principle can lead to a reduction in budget costs. They emphasized that by utilizing and reusing building components, they could achieve cost savings, perceiving the reuse or recycling of materials as a relatively more economical approach. The subsequent sentences exemplify responses from respondents concerning economic aspects.

"By considering the future, the materials used can be (...) and one day, if they are dismantled, they can be used in other new buildings with the aim of reducing costs." (Participant No. 44, Male, New Architecture Graduate).

Meanwhile, obstacles to this factor include high costs of recycled materials, disproportionate investment returns, maintenance costs, and limited funding sources. The issue of limited financial resources was identified as a more dominant concern compared to other obstacles, as illustrated in the following example response.

"It depends on the client's budget constraints. Sometimes the availability of reuse/recycle materials is limited, which means the costs and efforts spent to obtain them are not commensurate with the value obtained or the client's budget." (Participant No. 28, Male, Young Architect).

DISCUSSION

This study reveals the relationship between the frequency level of DfD implementation and the respondent group and investigates the frequency level of DfD implementation and the reasons for it. This approach aims to provide an in-depth understanding of the current conditions surrounding DfD implementation and identify specific barriers to implementing DfD principles. The findings of these barriers are expected to provide a basis for formulating strategies that can improve the understanding and implementation of DfD principles by architects in Indonesia. Recommendations for improvement are based on a review of previous literature.

The results of the correspondence analysis between the level of frequency of DfD application and the age group of respondents resulted in two categories, namely the young potential group and the mature professional group. In the context of the potential future use of DfD in Indonesia, this finding indicates a great opportunity to guide and encourage young architects, who dominate the young potential group, in applying this design principle. This is due to the fact that this group has not yet gained a strong foundation of design preferences. In contrast, the mature professional group tends to have formed established opinions and is less open to specific design principles. This finding is in line with the view of the United Nations Commission on Population and Development (2012), which states that the younger generation, including in Indonesia, has the potential to become agents of change in the future.

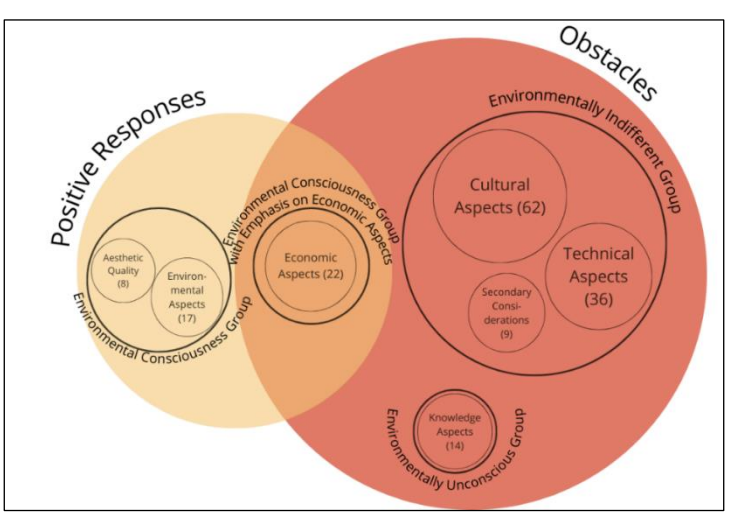

Figure 8. Four-Group Model Resulting from Correspondence Analysis: Level of DfD Implementation and Motivations

The outcomes of the correspondence analysis on the level of Design for Disassembly (DfD) application and its motivations identified four distinct groups, as depicted in Figure 8. In this framework, the size of each circle corresponds to the frequency of each factor, with larger circles indicating a more dominant factor. The first group exhibits a positive response to DfD, identified as the environmental care group. The second group manifests both positive responses and barriers, specifically the environmental concern group with a focus on the cost-price aspect. In contrast, the remaining two groups exhibit barriers, namely the unconcerned and environmentally unaware groups.

The cultural aspect emerged as the most frequently cited barrier factor by respondents, which differs from previous research suggesting that technical aspects were the most dominant factor in applying the Design for Disassembly (DfD) principle (Cruz Rios et al., 2021). This factor is associated with the group that does not prioritize environmental concerns. The predominant issues within this factor include adherence to project criteria, architects neglecting DfD principles, and reliance on client preferences. These findings align with existing literature (Cruz Rios et al., 2021; Park & Tucker, 2017; Sassi, 2004). Park and Tucker's (2017) research also highlights architects' perceptions that clients pose a significant obstacle to improving construction waste management. Client-driven variations in project requirements may contribute to increased material waste during construction, and a lack of client interest or support for reusing construction materials. Despite architects exhibiting a tendency to be passive in waste reduction, they express enthusiasm for the reuse of construction materials.

In addressing the challenges identified in the cultural aspects, strategic recommendations drawn from prior research involve active government involvement in leading change initiatives (Park and Tucker, 2017), integrating Design for Disassembly (DfD) principles into design contract requirements, and establishing salvageable component targets (Cruz Rios et al., 2021). Additionally, there's an emphasis on increasing awareness among stakeholders in the construction industry (Cruz Rios et al., 2021).

The second frequently mentioned obstacle factor is the technical aspect, identified within groups that do not prioritize environmental concerns. The primary issue characterizing this factor is doubts about the quality and limitations of materials that can be reused or recycled. This finding aligns with insights from previous studies (Citraningrum et al., 2023; Cruz Rios et al., 2021; Densley Tingley et al., 2017; Park & Tucker, 2017; Sassi, 2004). For example, the research by Cruz Rios et al. (2021) implicitly discusses concerns about quality, particularly damage during the deconstruction process. Densley Tingley (2017) study, focusing on the reuse of steel materials, highlights uncertainties related to the source and availability of used steel materials, as well as the lack of a supplier resource base for such materials.

Recommendations for strategies to address technical aspects from previous research encompass several key steps. Firstly, it is suggested to implement clear criteria for assessing the feasibility of reuse. This involves evaluating the material retrieval process during deconstruction, as well as assessing material quality and storage techniques (Citraningrum et al., 2023). Another proposed strategy is to provide comprehensive details about a product or material, allowing the information to be passed on to subsequent generations. This

information can be documented in a record known as a 'material passport' or 'resource passport,' containing data on the attributes and characteristics of the product, its origin, production date, and manufacturer. This approach facilitates potential future reuse or recycling once the product's primary life cycle is complete. Furthermore, for specific components, such documents support maintenance throughout their lifetime (Citraningrum et al., 2023; Cruz Rios et al., 2021; Gorgolewski, 2017).

The subsequent obstacle is associated with the knowledge aspect and is observed in groups that lack environmental awareness. The primary issue in this factor is the limited and poorly distributed information. Several previous studies have also highlighted this aspect as a hindrance to implementing DfD principles (Citraningrum et al., 2023; Cruz Rios et al., 2021; Densley Tingley et al., 2017). For instance, in Citraningrum et al. (2023), research, the issue of limited information was indicated by a lack of understanding of whether a material could be reused or not.

Recommended strategies for overcoming barriers to knowledge, based on previous research, include increasing public awareness of DfD principles through public campaigns, integrating DfD principles into university curricula in various sectors, and organizing DfD principles training as a licensing requirement for architects, engineers, and contractors (Cruz Rios et al., 2021). Another suggested strategy is education and training, which can play a pivotal role in addressing institutional challenges across the sector. Effective training can encourage a division of labor between specialists and contractors while enhancing awareness and interest among potential clients, clients, and developers (Park & Tucker, 2017). The second least frequently mentioned obstacle by respondents was secondary considerations, identified in the group that did not prioritize environmental concerns. The underlying issue behind this obstacle is that respondents believe Design for Disassembly (DfD) principles are not the primary focus in the design process. Similar findings were also observed in previous research by Wahyu Adi and Wibowo (2020), who found that designers often consider environmentally labeled materials as alternatives. However, the reasons expressed in this research differ from those in Wahyu Adi and Wibowo (2020) study. In this research, respondents used this principle as an alternative because they believed that decision-making of this nature requires a considerable amount of time in the design process (Wahyu Adi and Wibowo, 2020).

No specific strategy has been identified in previous research to overcome barriers related to secondary considerations. However, strategies applied to the knowledge aspect can serve as a reference. This aims to provide architects with a deeper understanding of the importance of the DfD principle, enabling them to integrate it as the main principle in designing buildings.

The issue that was less commonly mentioned by respondents in the context of this research was economic barriers. The economic aspect is in the environmental care group with a focus on the price-cost aspect. These findings show differences with previous research where economic aspects were generally identified as the main obstacle in implementing Design for Disassembly (DfD) principles (Cruz Rios et al., 2021; Densley Tingley et al., 2017; Park & Tucker, 2017; Tleuken et al., 2022). Although economic obstacles were detected in this study, several respondents considered the economic aspect as a positive response that could be obtained through the application of DfD principles. This finding is in line with the results of previous research also conducted in Indonesia (Citraningrum et al., 2023a). In this

context, although some respondents see the economic aspect as an obstacle, the majority of them still consider the DfD principle because there are other factors that are more dominant in showing a positive response to the DfD principle. As a result, respondents tend to focus more on the positive aspects than on the economic obstacles that may arise.

Obstacles in the economic aspect are caused by the main issue of limited funding sources. Recommended strategies that can be adopted, based on previous research, include providing incentives such as subsidies, tax credits, and low-interest loans to companies that commit to DfD practices (Citraningrum et al., 2023a; Cruz Rios et al., 2021; Densley Tingley et al., 2017). In addition, conducting workshops and increasing the number of case studies detailing life cycle costs can help designers and building owners understand the economic benefits of applying DfD principles (Cruz Rios et al., 2021; Densley Tingley et al., 2017).

CONCLUSION

This research extensively investigates the impediments to the implementation of Design for Disassembly (DfD) principles, particularly from the perspective of young professional architects in Indonesia. The study categorizes five barrier factors into groups that do not prioritize environmental concerns, groups lacking environmental awareness, and groups caring about the environment with a focus on the price-cost aspect. Interestingly, one group exhibits a positive response to DfD implementation, namely the environmentally concerned group, with the primary underlying factors being environmental and aesthetic aspects.

The barrier factors most frequently cited by respondents in this study were cultural aspects and technical aspects, followed by secondary considerations and knowledge aspects. In contrast, economic aspects garnered a lower level of attention. A comparison with previous studies from various countries reveals some differences. For instance, in many earlier studies, technical aspects were the primary obstacle, whereas in this study, cultural aspects were more frequently mentioned by respondents.

While previous research emphasized economic aspects as the primary obstacle, this study unveils that some respondents perceive it as an obstacle, while others view it as a positive response. Additionally, this research notes that, even though some respondents consider the economic aspect to be a hindrance, the majority still adhere to the DfD principle because other factors, especially environmental concern and aesthetic aspects, are more dominant and influential.

The statistical data presented in this research possesses a notable limitation that warrants consideration – the generalization of identified barriers is constrained due to the respondent group not encompassing the entire population of architects and designers who adhere to DfD principles. Specifically, 84% of respondents were recent graduates with one to two years of professional experience. However, this aspect can be regarded as a strength of the research. Given that the majority of respondents are young professionals, the study offers profound insights into perceived barriers and their potential influence on emerging architects, who play a pivotal role in shaping industry practices.

For future research endeavours, it is advisable to expand the respondent pool, incorporating a more extensive and diverse range of professional backgrounds and experiences. This approach is anticipated to provide a more holistic understanding of the impediments associated with implementing the DfD principle. Considering the significance of clients' perspectives in decision-making related to the adoption of DfD principles, future research could delve deeper into client preferences and their impact on the motivations or barriers that architects may encounter in implementing DfD principles.

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INTERPOLATION AS AN ALTERNATIVE METHOD FOR DESIGN DEVELOPMENT

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Abstract
Design development includes various multidiscipline analysis that could affect building design, such as structural analysis, and construction detailing. As algorithmic design approaches emerge, the possibilities to incorporate those steps into design processes as early as possible are explored. Many of these analyses teem with non-analytical problems. There are already available tools for high level non-analytical problems. For example, evolutionary algorithm tools for design optimization and dynamic relaxation for form-finding. However, these tools usually require separating the design workflow and need to be controlled manually. In contrast to that, interpolation method is a basic method that should be able to be executed smoothly. This study discusses the use of interpolation methods for three cases of design development: (1) Pneufin, (2) modular reciprocal tunnel, and (3) deployable bamboo structure. The evaluation of those studies suggests that interpolation is an effective method to smoothen the design workflow which then enables the increase of design complexity. The problem just needs to be simplified enough to avoid the use of complex data (such as solids) as datasets. Users rarely need to be involved in the interpolation steps. However, if the problem contains qualitative problem, users need to have access to preview and control the interpolation steps.

Keywords: *Analytical method; interpolation; parametric design; and design optimization*

INTRODUCTION

Design development includes various multidiscipline analysis that could affect building design, such as structural analysis, and construction detailing. This analysis could be unique depending on the buildings or structures. Previously, many of those steps were segregated and separated from design processes. As algorithmic design approaches emerge, the possibilities to incorporate those steps into design processes as early as possible are explored.

Many of these analyses teem with non-analytical problems. Analytical problems are defined as mathematical problems that could be solved through equation alone. This analytical solution involves modelling the problem into an equation with only one unknown variable.

In contrast to that, the numerical solution involves testing various suggestions for the solution and seeing which of those solutions are the closer to the known target. There are already available tools for high level non-analytical problems. For example, evolutionary algorithm tools for design optimization and dynamic relaxation for form-finding. Numerical solution is the backbone of those tools. In mathematic discussion, interpolation is one of the methods to solve non-analytical problems (Steffensen, 2006). Interpolation is a basic method that already been used in behind many optimization tools, or even 3D modelling.

While optimization and dynamic relaxation tools are a powerful tool for their intended purpose, those tools are usually non-linear tools that require separating the design workflow. Many of those optimization tools have to be controlled manually. Simulation tools are also either not seamlessly connected to 3D modelling software or require complex input for early design process. Meanwhile, some of the non-analytical problems during design are quite simple which will make the use of the existing tools become a hassle. If one stage of design could be simplified, the higher the possibility to increase the design analysis.

Since interpolation is a basic numerical method, it should be easy to create a smooth algorithm to execute interpolation specific for certain purposes. However, unlike evolutionary tools which involves mechanism to only test the most relevant dataset from its available data pools, simple interpolation method tests all given datasets. These might lead to higher computational time.

This article discusses the use of interpolation methods in various cases of design development case studies which tries to use the advantages of smooth and simple interpolation method while minimizing its computational time Some of those case studies are: (1) Pneufin, (2) modular reciprocal tunnel, and (3) deployable structure.

INTERPOLATION FOR 2D CIRCULAR TOPOLOGY

An interpolation method still needs additional user input to solve the problem which is the data set to be interpolated. The data set usually needs to be close to the prediction of the result to decrease the error (Steffensen, 2006). This requires, at the very least, two information regarding the datasets: the density/precision/number, and the range.

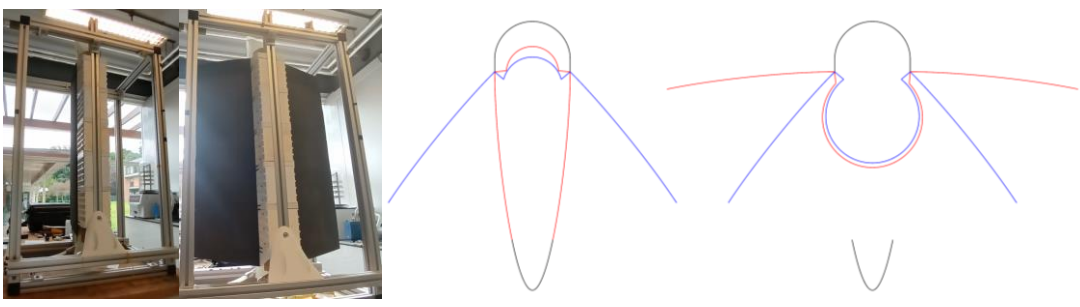
An arc has beneficial topology to simplify the generation of the data set: its radius is always between 0 to 360 degrees. Thus, if a problem has arc radius as its one of its two unknown parameters, the datasets range should be known. The remaining question will be how to simplify the algorithm so the number of datasets for the interpolation could be executed fast and smoothly.

The examples of interpolation studies below were all based on arc shape. All the interpolation in this article was written in the Grasshopper script. Some case study interpolation methods were further compared with the existing tools to see the advantages and disadvantages of the interpolation method.

Pneufin

Pneufin is a soft pneumatic adaptive external shading (Aditra et al., 2023). It has two modes: folded mode to let the sunlight in and unfolded mode to block incoming sunlight. As an external shading, its static structural performance affects its effectiveness to building energy saving. Thus, a computational tool, in form of Grasshopper script, was developed to seamlessly analyse Pneufin static structural performance with building design and building energy analysis. Interpolation was used in research of Pneufin for two functions: (1) Kinematic of the pneumatic tube section, and (2) deformation of the pneumatic tube.

The former was mentioned in Aditra et al. (2023) to find the form of the pneumatic tube under different wing angle. It saved time to do the simulation with different wing angles (Figure 1). The section of Pneufin was designed based on fully opened shape (Red lines in Figure 1). But the strength in its intermediate wing (Blue lines in Figure 1) angle also needs to be calculated.



Pneufin Pneufin section

Figure 1. Pneufin: Prototype and Schematic

An equation that defines correlation between active membrane angle $\theta_{1,2}$ and target arc span t_2 was made (Equation 1 and Figure 2 right). Interpolation was used with data set of membrane angles θ_2 for y-axis and right-hand side of Equation 1. The interpolation curves were then remeasured with left-hand side of Equation 1 to calculate final output of the targeted membrane angle θ_2 (Figure 2 middle). Another equation (Equation 2) was then used to determine the membrane arc height based on the targeted membrane angle (Aditra et al., 2023). With this method, the membrane section could be generated according to wing angle without user intervention. This interpolation method was written in custom Grasshopper component written in GPhyton (Figure 2 left).

$$\frac{\boldsymbol{\theta_1 \times r_1}}{\boldsymbol{t_2}} = \frac{\boldsymbol{\theta_2}}{\boldsymbol{\sin \theta_2}} \qquad \text{Equation 1}$$

$$\boldsymbol{h_2} = \frac{\boldsymbol{t_2}}{\boldsymbol{\sin \theta_2}} + \frac{\boldsymbol{t_2}}{\boldsymbol{\tan(\pi - \theta_2)}} \qquad \text{Equation 2}$$

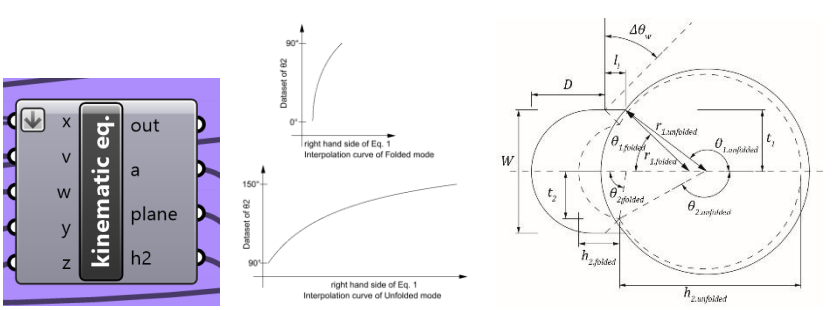


Figure 2. Kinematic Script (Left), Kinematic Interpolation Curves (Middle), Wing Angle to Chamber Section (Right)

The second interpolation method was used to simulate the deformation of the pneumatic tube. Previously in Aditra et al. (2023), FEM method in RFEM Dlubal was used to model the deformation of the material. With this method, each 3D Rhino model for each wing angle needs to be converted to RFEM Dlubal meshes.

To simplify the deformation analysis, an additional script was added (Figure 3 left). An equation was made based correlation between membrane arc length deformation l_{m} to elastic modulus E and hoop stress σ_h (Equation 3). The Equation 4 was broken down into Equation 4 which requires additional input of inflated arc angle θ_3, arc span t, pneumatic pressure ρ_m, and membrane thickness t_m.

The interpolation method has data set of right-hand side of Equation 4 in x axis and inflated arc angle θ_3 in y axis. Similar with the previous interpolation method, the resulting θ_3 were then used to determine the inflated arc height using Equation 2 but with substituting subscript 2 with 3.

$$l_{\mathrm{m.inflated}} = l_{\mathrm{m.initial}}\left(1 + \frac{\sigma_h}{E}\right) \qquad \text{Equation 3}$$

$$l_{\mathrm{m.initial}}/_{t} = \frac{2\theta_3}{\sin\theta_3} - \frac{l_{m.initial} \cdot \rho_m}{\mathrm{E}.t_m.\sin\theta_3} \qquad \text{Equation 4}$$

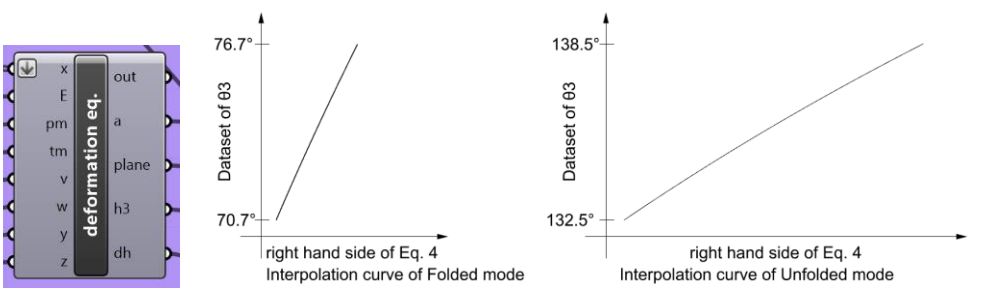


Figure 3. Deformation Script (Left), Deformation Interpolation Curve (Middle and Right)

The two interpolation procedures above were added to an overall 2D Numerical method for structural analysis of Pneufin (Figure 4). As shown in Figure 2, the interpolation procedure and graph for each mode are different. During the creation of the script in Figure 4, the range of datasets for each mode were limited to certain arc angles instead of from 0 to 360 degrees. This is to increase the precision of the graph. Nevertheless, once the range was determined, the user did not get involved in the interpolation anymore, even if the geometry of Pneufin is updated.

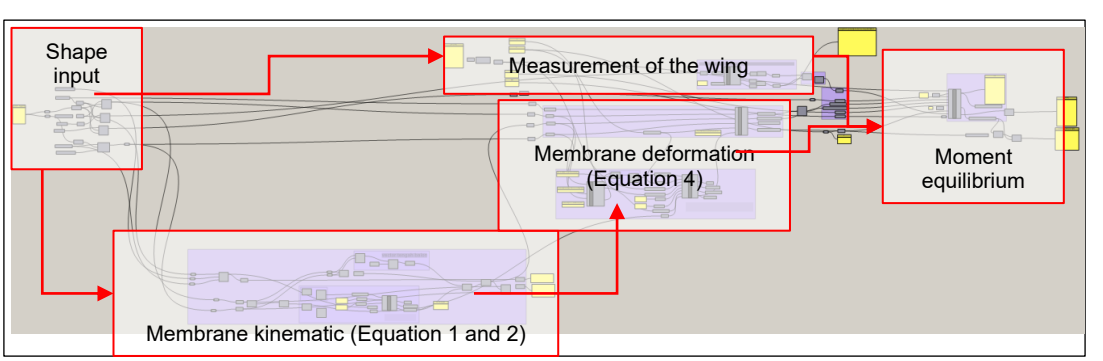


Figure 4. 2D Numerical Method for Structural Analysis of Pneufin

This 2D Numerical method is compiled into streamline script for each mode (Figure 4). This Grasshopper script was updated several times during the study of Pneufin, including reversed process with switched input and output. The previous script also used evolutionary tools, Galapagos, to solve the membrane deformation equation. The update of using interpolation for membrane deformation problem has proven to simplify the calculation of structural analysis, especially with multiple pneumatic pressure.

Modular Reciprocal Tunnel

Modular reciprocal tunnel was a modular version of Da-vinci bridge (Anastas et al., 2016). Da-vinci reciprocal bridge is easy to build. It does not need any scaffolding, which is good for fast build structures, or post disaster structures. Modular reciprocal tunnel was developed by Andry Widyowijatnoko using bamboo, in several post disaster relief and workshops. It was mainly used as shelter or installation rather than bridge.

Modular reciprocal tunnel was developed based on rectangular module of bamboo, even though geometrically could be any pipe shaped members. It requires 2 type of frames that reciprocally support each other. The panels could be prepared on the ground, then assembled to form the tunnel without the need of scaffolding. Since the module needs to be assemble prior to erection of structure, it still needs some type of joint in the panels. It could be in form of dowel or lashing.

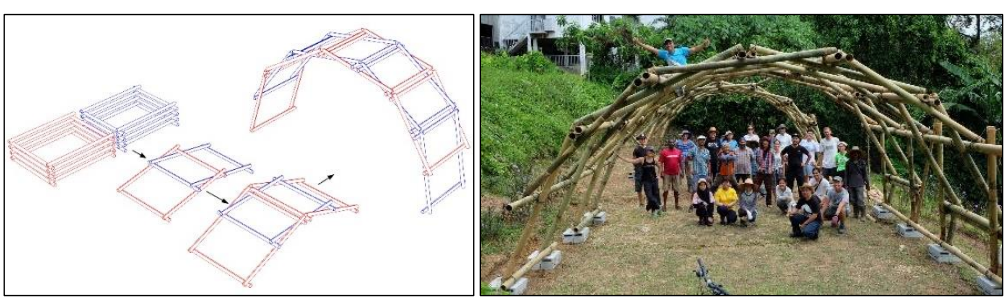


Figure 5. Modular Reciprocal Tunnel: Schematic and Built Pavilion

There are many methods to generate the shape of modular reciprocal tunnel. The easier one would be from its detail parameters: such as pipe and panel sizes. But to design from its span and height precisely would require non-linear method. If the pipe diameter is fixed, optimization tools could be used to iterate the right size of panels and number of segments to get the precise span and height. However, optimization tools would require user intervention. Alternatively, interpolation method could be used.

The schematic arc of modular reciprocal tunnel could be divided into segments with length of L_a and L_y (Figure 6). If the schematic arc dimension and number of segments were given, change in a/y ratio would change the diameter of the rods (D). This correlation is a non-analytical problem. Thus, to answer this problem, samples of a/y ratio are tested geometrically to get the h of the samples. The geometry of the samples is not a complete solid or even the complete lines of the tunnel. Instead, the geometry of the dataset were just the first three points which form the a/y ratio and determine the h or twice of the diameter (Figure 6). With these simple datasets, the interpolation did not need high computational power and time.

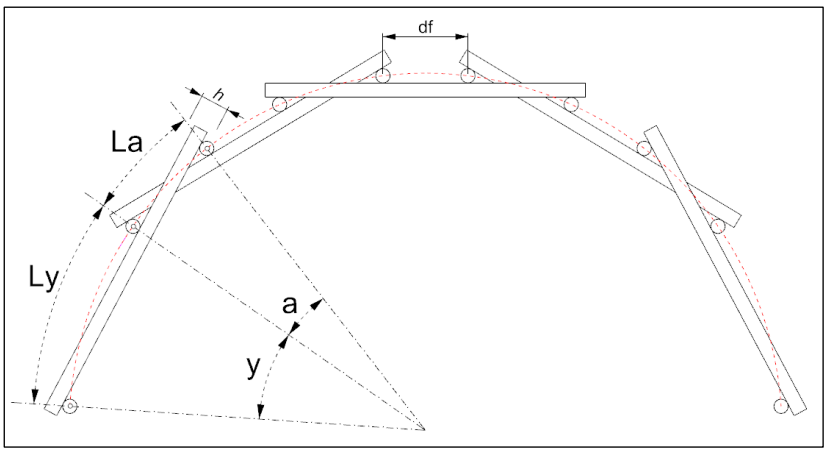


Figure 6. Schematic of Modular Reciprocal Tunnel (Left)

Interpolation curve is then plotted with a/y ratios as the x axis and *h* as the y axis (Figure 7a). The a/y ratio input samples ranged from near 0 to *n*. The *n* parameter is the a/y ratio when the diameter is large enough to make the panels touch each other (Figure 7c) which could be defined by Equation 5. Meanwhile a/y of 0 is when the diameter is 0 (Figure 7b).

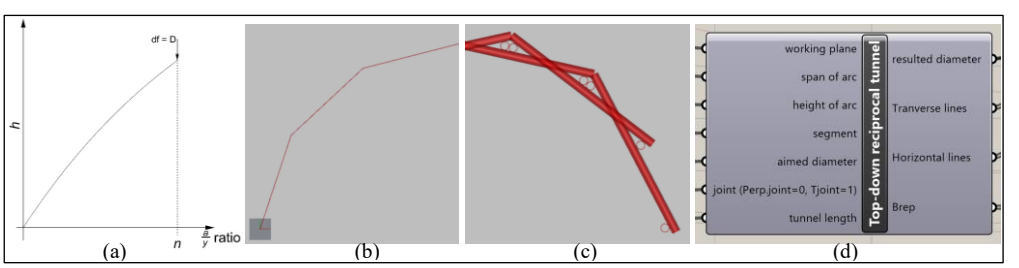


Figure 7. (a) Modular Reciprocal Tunnel Interpolation Curve; Modular Reciprocal Tunnel When h= 0 (b), and h=n (c); (d) Grasshopper Component of Modular Reciprocal Tunnel

Then, with the input of desired rod diameter, the interpolation curve could be traced back to find the desired a/y ratio. With an equation that determines correlations between a/y ratios with L_a and L_y (Equation 6), the L_a and L_y could be found, and the modular reciprocal tunnel can be generated. With this method, the span and height of the tunnel could be precisely controlled.

$$n = \frac{\theta - \left(2s \cdot \sin^{-1}\left(\frac{0.5D}{R}\right)\right)}{\left(2 \cdot \sin^{-1}\left(\frac{0.5D}{R}\right)\right) + \theta} \qquad \text{Equation 5}$$

$$L_a = L/\left(\left(s \cdot \frac{y}{a}\right) + 1\right) \text{ or } L_y = L/\left(s + \frac{a}{y}\right) \qquad \text{Equation 6}$$

Deployable Scissor Arc Structure

This study was part of Maurina's dissertation about deployable bamboo scissor-like arch structure. Interpolation method was used in this research to determine two questions: (a) the maximum span and corresponding depth, and (b) the maximum habitable area and its corresponding span and depth (Maurina and Blouin, 2021; Maurina, 2023).

The first question is about how far the deployable scissor structure could be extended. When the structure is folded (Figure 8 left), the span and height are small, while scissor angle (α_1) or depth are high. As the structure opens, the span and height increase while the depth decreases (Figure 8 middle). If the depth keeps increasing, at certain points, the height still increases but the span decreases again (Figure 8 right). In conclusion, there is a maximum span a deployable scissor arc structure could be deployed.

The algorithm to generate the deployable scissor arc structure with certain span, height-span ratio and depth-span ratio is straightforward, i.e. no interpolation method is needed. However, finding the maximum span of a deployable scissor arc structure could be stretched is not straightforward.

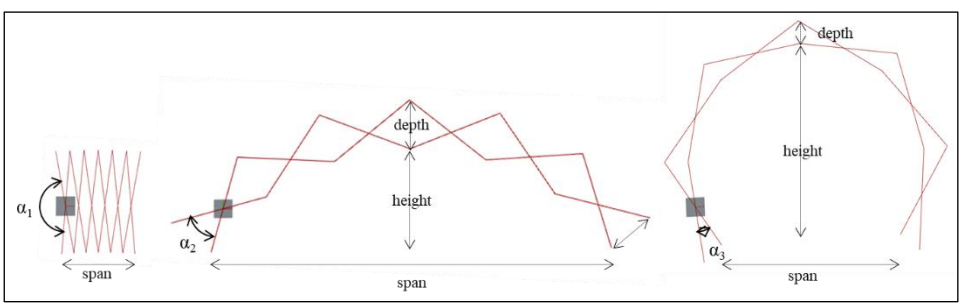


Figure 8. Schematic of Deployable Scissors Structure: Folded (Left), Starts to Open (Middle), and Almost Fully Opened (Right)

To define the maximum span, Grasshopper's optimization plugins like Galapagos and Octopus can be used. However, these plugins cannot be run automatically for different sets of cases, which involve varying design parameters for deployable structures such as length and number of bars. Therefore, a simple interpolation can be integrated into the algorithm to generate multiple sets of cases and predict the maximum span for each case without requiring user intervention. The dataset used for testing ranges from the maximum angle of the scissor-like structures (α=180°) to the minimum angle (α=0°). Several datasets within this range are tested to create an interpolated curve. The extreme point on the curve represents the maximum span (x-axis) and its corresponding depth (y-axis).

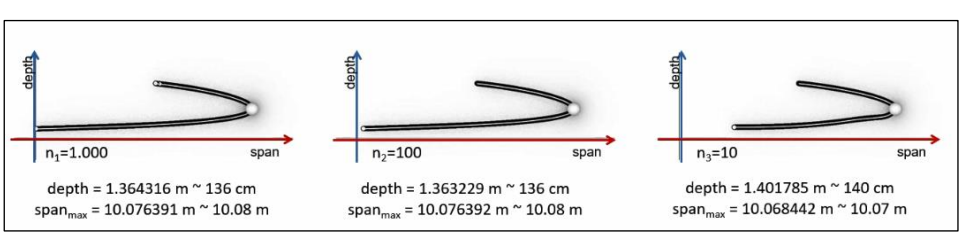


Figure 9. Depth-Span Interpolation Curve of Deployable Scissor Structure with: (a) n = 1000, (b) n = 100, and (c) n = 10

Three interpolation exercises were conducted with different number of datasets (*n)*: 10, 100, and 1000 (Figure 9) to determine the minimum number of datasets needed for precise measurement of the maximum span. From these exercises, it was found that there is a noticeable four-cm difference in depth between the datasets, but the generated maximum span does not show significant variation. For instance, a one-centimetre difference in a ten-meter span building is not considered significant.

The second question pertains to the maximum habitable area and its corresponding span and depth. The span alone cannot directly determine the habitable space beneath the structure. Some areas near the edges may be unusable due to height limitations. In this study, the habitable area is defined as the Habitable Floor Ratio (HFR), which requires a minimum height of 2.1 meters from ground to the structure, relative to the span. The highest habitable area is 1 HFR (Equation 7).

$$HFR = \frac{habitable\ area}{\text{span}}\text{, if } HFR < Span\text{, or}$$

$$HFR = 1\text{, if } HFR \geq Span \qquad \text{Equation 7}$$

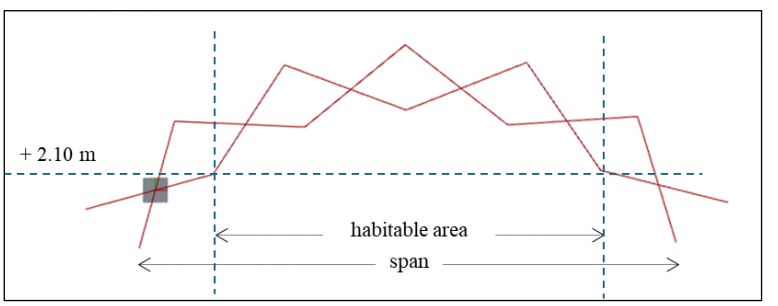


Figure 10. Habitable Area of Deployable Scissor Structure

Similar to calculating the maximum span, calculating HFR is also not analytical. In this study, the HFR value of the same geometry datasets from the previous analysis were measured and added to the interpolation as the third dimension (z-axis), creating a 3D interpolation curve. Using the maximum point of z-axis, the maximum HFR is defined.

The curvature of the HFR interpolation curve shows that there is a point where the GFR value becomes unpredictable (Figure 11 front and left view). As expected, this is due to the fact that HFR values are based on the qualitative measurement of space height. Therefore, in this case, a higher number of datasets is more accurate and preferred in terms of precision.

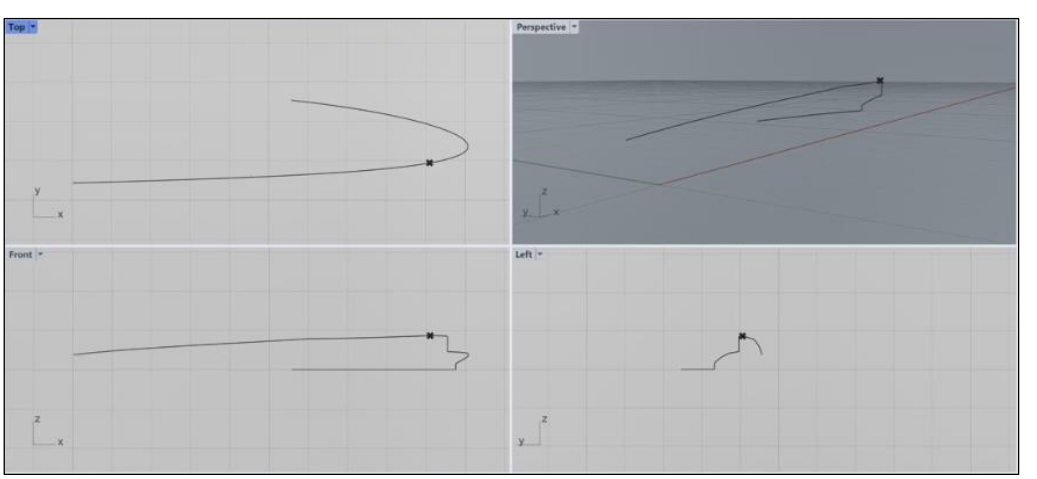


Figure 11. Habitable Floor Ratio (HFR) of Deployable Scissor Structure Interpolation Curve

As mentioned before, both analyses could also be solved using optimization tools. However, these analyses are only a part of a comprehensive study that examines other aspects: structural performance, flexibility, and constructability. Furthermore, 4 types of deployable bamboo scissor-like arch structures were also investigated. In total, over 20.000 cases were studied. Thus, this interpolation method significantly reduced the time and complexity of the overall study.

CONCLUSION

The evaluation of those studies suggests that interpolation is an effective method to smoothen the design workflow compared to evolutionary tools in some case involving arc or circular shape. With simplification of certain workflow, it enables the increase of design complexity. Without the need for user intervention, multiple tests could be done with ease. It could be easily integrated into an iteration process.

The studies suggested that, with an efficient algorithm, non-analytical problems of an arc or circular geometry could be solved through interpolation with the user rarely involved the creation of datasets. In addition to that, if the problem could be simplified simple enough, the computational time could be neglected even if the tested samples are greater than in optimization or evolutionary tools.

In case of qualitative problems, users still need to pay attention to precision and smoothness of the interpolation curves. Users might not need to be involved anymore if parameters of the initial interpolation curve are not changed. However, if the parameters are changed, the changes in interpolation curve might be unpredicted. Thus, users should have access to the preview of the interpolation curve and have the means to change the precision of interpolation curve in case of qualitative problems.

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DESIGN MOVES BEYOND WORDS: SENSORY INSIGHTS FROM UNSELFCONSCIOUS DESIGN CULTURE

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Abstract
Investigating design behaviour uncovers intricate mechanisms that overcome language barriers, improving data collecting and analysis. The limitations of think-aloud in extracting data from an unselfconscious culture hinder the unified theory construction. This study examines the complex link between design activities and sensory perceptions in media-absent design. Studying content and cognitive processes requires filtering behavioural data—cognition, motivation, emotion. A quantitative study of micro-processual performativity video analysis of design processes utilising event-logging shows problem-solving patterns. This illuminates sensory engagement in making and design-object interaction. Sensitivity denotes design quality, whereas sensibility reveals the designer's object recognition. These two abilities offer insights into the concealed design process within the unselfconscious design culture, a culture that wields significant influence beyond the constraints of design media.

Keywords: *Design Activity; Design Behaviour; Design Cognition; Sensitivity; Sensibility*

INTRODUCTION

Cognitive study in the realm of design encompasses an interdisciplinary domain that investigates the cognitive processes and representations that form the foundation of design actions, stretching across several fields. However, as Hay, Cash and McKilligan (2020) have observed, this particular sector encounters significant problems that require significant modifications to solve the lack of advancement in subjects and research procedures. The primary objective of this research is to investigate the specific cognitive processes and conceptual frameworks that play a role in the formation of purposeful actions within the complex interplay of social and cultural contexts. Within the domain of traditional architectural design, artisans utilise a straightforward method to make objects, often denoted as the unselfconscious design culture (Alexander, 1973). Our research examines the impact of design cognition in an unselfconscious design culture on the interaction between designers and their designs. We place particular emphasis on the importance of sensory perception as a means of exchanging information. This inquiry aims to unravel the impact of this relationship on the resilience and cultural attributes of such design processes. Furthermore, our intention is to place emphasis on microscopic study domains, specifically pertaining to the paths of interaction between designers and design artefacts.

The primary goal of cognitive design research is to examine the content and progression of design thinking within the context of the formal design process. This research generally emphasises self-conscious design culture and has a foundation in formal design education. However, the unselfconscious design culture that lacks design externalisations and is defined by a symbiotic relationship between the designer and the design object has not been extensively examined in the realm of design scholarship. This particular culture strongly emphasises experiential knowledge, eschewing formal design techniques like sketching and modelling. The lack of external design media presents a challenge to the prevailing notion

that design is strongly dependent on these tools. Furthermore, the existing research predominantly draws from professionals and students in self-conscious design cultures, leaving a notable gap in understanding design cognition within the unselfconscious context. For instance, researchers have collected data from various professionals and students in the field of architecture (Goldschmidt, 1991; Suwa, Gero & Purcell, 2000), product design, engineering design, computer software design (Cross, 1999), and mechanical engineering (Gero & Milovanovic, 2020).

This research aims to address the existing knowledge gap in cognitive design research by examining the unselfconscious design culture. This culture is characterised by design practises on a one-to-one scale, depending exclusively on experience knowledge rather than externalised design procedures. Bateson (1972) referred to this phenomenon as "deutero-learning," which denotes the process of independent and progressive learning, or the acquisition of skills related to learning itself, also known as "learning to learn" (Ingold, 2013). By examining this cultural phenomenon, our objective is to get valuable insights from an alternative perspective that can significantly contribute to the development of theoretical frameworks in the field of design cognition. Moreover, the primary objective of this study is to address the issue of language barriers by employing novel techniques for data collecting, such as video analysis (Wagner-Willi, 2012) and photographic analysis (Bateson & Mead, 1985). The primary goal of our study is to construct a theoretical framework that provides a comprehensive understanding of the cognitive aspects involved in the design process. Additionally, we aim to investigate the significance of sensory perception as a means of transmitting information. Ultimately, our research seeks to examine the relationship between design behaviour and the objects it relates to within the distinct cultural context under consideration. The study is based heavily on van Someren's (van Someren, Barnard, & Sandberg, 1994) model of human cognitive systems, which offers a strong theoretical foundation for our inquiry.

In our pursuit to understand the cognitive aspects of designing, we embark on an inquiry that leads us to the geographical region of Pengotan in the Bangli District of Bali. The Bali Aga artisans, who are members of an indigenous population residing in the mountains, possess a distinct cultural framework that enables them to maintain their isolation from the process of modernisation. The unselfconscious design culture exhibited by the individuals in question surpasses conventional norms, as it emphasises the acquisition of experiential knowledge and establishes a profound bond between the artisan and their creation.

COGNITIVE DESIGN RESEARCH

The Architecture of Designer's Mind

The field of design cognition has extensively investigated the systematic exploration of individuals' engagement in the process of designing using diverse models. These models aim to offer a systematic understanding of the cognitive processes associated with design thinking, providing noteworthy discoveries into the nature and progression of cognitive thought. This literature review critically analyses six prominent models in the field of design cognition, providing insights into their respective contributions, limits, and potential consequences.

The Asimow Model (Asimow, 1962), which was introduced in 1962 and predominantly utilised in the field of engineering design, aimed to depict the cognitive process involved in design thinking. This study conceptualises the process through which design practises undergo metamorphosis, resulting in the creation of a "particular design" that represents the ultimate manifestation of a design endeavour. At the core of its processing, a crucial aspect was the function of evaluation, which involved taking into account many factors in order to attain design objectives. Nevertheless, this particular approach largely focused on examining the sequential progression of design thinking, specifically during the evaluative phase. The decision-making outcomes in this paradigm have a binary nature, wherein findings are classified as either favourable or unfavourable, useful or not, loved or disliked. As a result, the model being presented continues to offer a somewhat broad representation of the design process.

In the year 1968, Eastman, Zhang, and Wang (1968) put forth a paradigm of design thinking that explored the aspects of content, transformations, and the content's location within the design process. Eastman expanded the initial observations by introducing the notion of "general constraints" as guiding principles for every individual piece of information. As a result, the analytical framework of the study revealed the presence of manipulative forms and constraints that originated from the assigned tasks, which may be seen as logical operations. These cognitive processes encompassed confirmation, the amplification of information, and finally the development of inductive associations, all occurring within the cognitive framework of the designer. The conclusion of this procedure manifested as a design decision that served as an external solution to a design challenge. Eastman established the concept of memory as a repository for design features or qualities that may be used for manipulating purposes. Although the concept of multi-layered content analysis was acknowledged, the fundamental nature of design judgements continued to be binary, since they primarily focused on differentiating between pleasure and dissatisfaction in the relationship between design features. This study has made a valuable contribution to the field by deepening our understanding of the content and flow of design cognition within memory structures.

The van Someren et al. model, which is based on the verbal reporting, delineated the integration of external information into the cognitive processes of designers by means of sensory gates (Figure 1). Data gathering from the external environment was facilitated by means of questioning and sensory input, with the primary verbal strategy employed being think-aloud. According to Van Someren et al., there exists a transient store known as a sensory buffer, which serves the purpose of organising incoming raw information from active sensory pathways. The conceptualization of five modes of transformation within the information processing framework includes perception, retrieval, construction, storage, and finally verbalization. These transformations establish connections between memory nodes, including working memory and long-term memory. In the end, these concepts were condensed and formalised into a design protocol that was communicated by the designer, either orally or through design activities. Although the model recognised the intricate nature of the information layers at play, the empirical substantiation of the concept of long-term memory continued to pose a significant challenge. Significantly, the process of decision-making exhibited a departure from the traditional binary framework observed in prior models. The decisions that emerge as a result of the interaction between working memory, long-term memory, and sensory buffer inputs may be influenced by the quality of categorical systems.

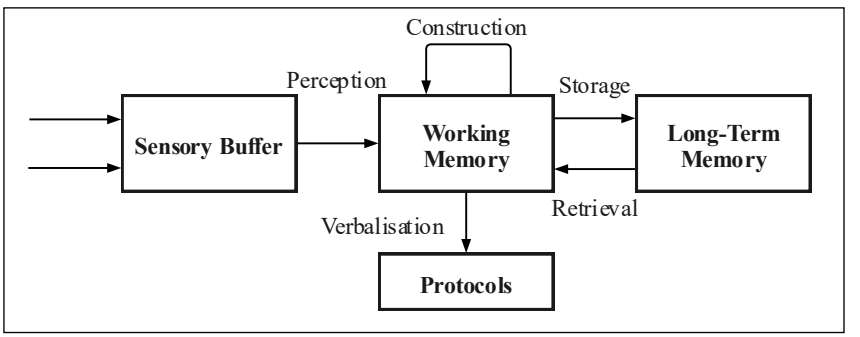

Figure 1. van Someren's Memory Model

The researchers Suwa, Purcell, and Gero (1998) made a significant contribution to the field by classifying cognitive design content using data collected from both professional architects and students involved in design assignments. The study revealed four distinct categories of cognitive content, namely perceptual, functional, conceptual, and physical. It is imperative to acknowledge that the process of information transformation commences with the initial stage of sensory recognition, subsequently progressing to perceptual understanding and ultimately culminating in semantic comprehension. The conclusive data obtained from the procedure encompassed a combination of visible and non-visual components, conveyed through verbal communication, physical gestures, or illustrative representations, which served as manifestations of the designer's external outcomes. The present model elucidated notable differences in the behaviours exhibited by professional architects and students, with a particular focus on categorising cognitive material according to its qualities and recurrence during the design process.

The FBS ontology of design model (Gero, 1990; Gero & Kannengiesser, 2014) which was first introduced by John Gero in 1990, presents a conceptual framework that reconceptualizes the notion of "design" as a metagoal. This framework emphasises the process of converting requirements, often referred to as functions, into design descriptions. In addition to the requirement of "Function," this model incorporates the inclusion of the node "behaviour," which is further subdivided into expected and actual behaviours. These behaviours are derived from the design attributes. The structured relationships were constructed by these attributive elements, which were represented by the node labelled "Structure." The early FBS model identified many content transformations, such as formulation, synthesis, analysis, reformulation, and comparisons. The ultimate outcome produced by the designer was understood and represented as a comprehensive description of the design, encompassing the various components of the artefact and their interconnectedness. The primary objective of the design was to convert the set of functions (F, where F is a set) into a design description D in order to enable the resulting artefact to effectively perform these tasks. Similar to previous model suggestions, the intricacy of the model was apparent, however, the organisation of the information maintained a straightforward and unidimensional development. During the various developmental stages of the "Model of Design as a Process," certain nodes presented difficulty in comprehending their contents, as the categorisations appeared somewhat vague.

The situated-FBS model (Gero & Kannengiesser, 2000, 2004), derived from the FBS ontology of design model, focuses on the spatial and temporal aspects related to the placement of content within nodes. The three worlds that were segmented were the external world, the

interpreted world, and the expected world. The term "expected world" refers to a conceptual framework that encompasses both physical and conceptual acts, which are articulated through a design description. The concept of the "interpreted world" functioned as a domain in which the intersection of expectations and present circumstances occurred and were subject to interpretation. Finally, the "expected world" encompassed all design reasoning criteria that were internalised within memory and were present within the many layers of this world. The division of realms facilitated a clearer understanding of the transfer of cognitive loads across different nodes. However, the growing intricacy of this model presents significant challenges in comprehending cognitive processes and information organisation. This is particularly noteworthy since the process maintains its simplicity, despite the coexistence of functional, behavioural, and structural components. Moreover, the concept exhibits equivalence in the categorisation of cognitive information pertaining to the condition, hence contributing to the escalation of complexity. The three design cognition states cannot directly interact to generate a new understanding due to their varying levels of significance. This is the point at which the model remains a single layer.

After an in-depth analysis of six design cognition models, several key insights emerge as foundational pillars for future development:

- Incorporation of Memory Nodes: It becomes evident that there is a recurring element in these models, which is the integration of memory as nodes that serve as repositories for cognitive content.
- Identification of Cognitive Content: These models clearly demonstrate that cognitive information is not only recognised but also systematically organized within these memory nodes.
- Transformations in Design Cognition: The models reveal that design cognition content undergoes various forms of transformations, accompanied by the establishment of criteria for specifying the circumstances and locations where these alterations occur.
- Education-Centric Focus: Most of the examined models have predominantly drawn upon research conducted within formal educational settings, where design is primarily expressed through media, with sketches being the prevailing medium of choice.
- Limitations of Protocol Analysis: While protocol analysis methods offer important revelations into the designer's thought process, they have inherent limitations and can feel synthetic in their preparation and testing environments. The study and empirical extraction of the idea of "long-term memory" pose a notable problem, particularly when employing methods such as protocol analysis that depend on think-aloud procedures for the collecting of verbal data.
- Verbal Data Dominance: Verbal data still holds prominence as the dominant dataset in concept formation, stemming from both data collection methods and processing techniques, leaving room for further exploration and development."
- Untapped Real-World Design Practice: The practical application of design, involving the direct interaction between the designer and the design product in real-world scenarios, has remained relatively unexplored within the realm of design cognition.
- Complexity vs. Single-Layer Flow: Existing design cognition models, although appearing complex, essentially involve single-layer flows of content processes. This raises critical questions about the true complexity of design thinking in practice.

Overall, these insights offer valuable groundwork for advancing the understanding of design cognition. They prompt researchers and practitioners to explore avenues beyond the formal educational settings and delve into the intricacies of design thinking as it unfolds in real-world design practice.

This research further emphasises the potential to investigate phenomena that can be directly observed or understood through empathy, within the limitations of data collection focused on behaviour, actions, sensations, and design artefacts. The limitations imposed by language need a search for an optimal approach to elicit design thinking without the use of verbal communication. Alternative data sources beyond verbalization can be revealed through the utilisation of methodologies such as photographic analysis and micro-processual performativity within multidimensional analysis of video data, offering pertinent discoveries.

Design Cultures

Christopher Alexander sought to emphasize the distinction between design cultures by intentionally magnifying the contrast between them. His aim was not to provide an exhaustive or precise depiction of any particular culture but to underscore the significance of comprehending the disparities between cultures characterised by high design consciousness and those lacking such awareness. The realm of design within academia thrives, evolving primarily within architecture education, as an effective means to scale down design projects. In contrast, direct architectural design, as practiced by traditional craftsmen, embodies what is referred to as an unselfconscious design culture.

Unselfconscious design cultures have their origins in the work of artisans who, in contrast to formal education, lack structured and externalised knowledge, as elucidated by Fischer (2004). Consequently, within cognitive design research, the predominant presence of self-conscious design culture has informed and shaped our understanding of designers. This is evident in studies involving architects, product designers, engineering designers, computer software designers, and mechanical engineers, encompassing both professionals and students.

The phenomenon of designing within the backdrop of an unselfconscious culture demonstrates a unique ability for designers to create, nurtured through different means within formal education. They engage in architectural design at an actual scale, drawing upon experiences stored in their memories, all without sketching or modelling. This cultural phenomenon has remained largely unexplored within cognitive design research, which could offer an alternative perspective and potentially address identified stagnation.

Pure design cognition abilities, devoid of formal education, present an avenue for theory development. In this research, particular attention is drawn to the concept of "unselfconsciousness," a rarely discussed yet well-established characteristic. As Alexander himself explains, this approach relies on rudimentary problem-solving methods based on past thinking and solutions as responses to failures. Problem-solving is underpinned by enduring traditions upheld within the community. The validation of successful design problem-solving lies in its acceptance within the community, which continually practices the same decisions. These patterns collectively shape the unselfconscious design culture within the community (Balaram, 2011). However, these agreements remain implicit, unwritten, and unstructured, giving rise to a lack of detailed prescriptions regarding problem-solving methods. This leads

to spontaneous and immediate problem-solving, which, in turn, results in common challenges encountered during the design and creation processes. Such intensity fosters a strong connection between the designer and their design object.

This intense interaction between the designer and their design object occurs at the intersection of the designer's sensory perception and the signals emanating from the design. Sensory perception plays a pivotal role in shaping the designer's understanding of the design space, as it involves the reception and interpretation of visual, tactile, auditory, and even olfactory cues from the object of creation. Understanding how these sensory inputs are processed and integrated into the design cognition process provides critical observations into the nuanced relationship between the designer and their creation. As we delve into the realm of sensory perception in design, we uncover the intricate dance between the perceiving mind and the tangible world of design, shedding light on how sensory experiences inform the creative process.

The study opportunity presented bears significant importance within the context of the unselfconscious design culture observed in Bali Aga, specifically in Pengotan Village. The design practises within this society are characterised by a strong adherence to tradition and communal knowledge, with a notable absence of drawings and formal planning. As a result, this discrepancy offers a significant chance to explore the design phenomena taking place in this context. By actively attending to the sensory stimuli and responses, one can extract vital insights into the intricacies of designing and making within this specific cultural milieu.

Sensory Perception in Design

The human sensory system has been the subject of in-depth research for centuries, and our understanding of human sensory perception has evolved significantly over time. The tradition of thinking about human senses began with Aristotle's model, which outlined five sensory modalities: vision, hearing, smell, taste, and touch (Aristotle, 2016). While this model has long served as the foundation of our understanding of sensory perception, contemporary thinkers have questioned the limitations of Aristotle's model in embracing the true complexity of human sensory experiences. For instance, Pallasmaa (2015) conducted a critical analysis of Aristotle's model, highlighting its shortcomings in describing the role of human sensory perception in architecture. They proposed a more comprehensive view of the human sensorium, acknowledging that human presence in the world is far more intricate and nuanced than we might assume.

Furthermore, modern perspectives on the human sensory system have also developed. For example, Hochberg introduced the concept of six perceptual channels that guide how we experience the world around us (Broadbent, 1973). Cohen (2007) presented the idea of 54 natural senses and their sensitivities, expanding our view of how humans interact with their environment. Additionally, the concept of sensory perception has inspired fields such as sensory aesthetics (Small & Prescott, 2005) and sensory design for user experience (Bowers, 2007), which explore how the integration of senses and physical stimuli can influence human perception.

A deeper understanding of the human sensory system from various perspectives opens up opportunities to delve further into the role of sensory perception in design cognition. As we continue this research, we will explore how sensory information is processed by the designer's mind and how sensory experiences can shape the creative process in design. Thus, our understanding of the crucial role of sensory perception in design will continue to evolve and become more comprehensive.

With a review of several existing models of human sensory perception, this research ultimately purposively selected the Haverkamp model (Haverkamp, 2013). This choice was made due to the model's foundation in the field of "design." In contrast, other models are often very general and broad in scope, encompassing the sensory experiences of all living creatures. Therefore, the Haverkamp model, rooted in the context of product design, offers a more tailored framework for our research, as seen in Table 1.

Table 1. Haverkamp's Fundamental of Perception

Senses	Modalities
Visual	Seeing
Auditory	Hearing
Olfactoric	Smelling
Gustatory	Tasting
Vestibular	Sense of balance and body movement
Tactile	Touching
Thermoreceptive	Feeling temperature
Proprioceptive	Positioning and movement of the extremities
Introceptive	Body condition and organ activity
Nociceptive	Feeling pain

EMBRACING BEHAVIOUR OBSERVATION

The methodology is devised to explore the phenomenon of design cognition within the unselfconscious design culture, with a particular emphasis on the role of sensory perception in this intricate process. This section delineates the research procedures, encompassing sample selection and data analysis in designing behaviour observation.

Population and Sample

This study's population comprises artisans from the community, employed at UD. Cori Bali, Pengotan. We have purposively selected a sample of 8 artisans. The selection criteria prioritize artisans with the authority to execute tasks, as opposed to mere ‘peladen’ (assistants), during the focal project of this research.

Definition of Observation Instruments

In the collection of video observation data, we employ three distinct instruments: an action camera, an ethogram, and BORIS - Behavioural Observation Research Interactive Software (Friard & Gamba, 2016). The action camera records designing and making actions in MP4 video format. The ethogram identifies samples from video observation data, subsequently transformed into a coding scheme. BORIS serves as event logging software, meticulously documenting occurrences in designing and making activities.

Observation Procedure

The observation procedure is characterised by systematic and objective monitoring of the subjects' activities and behaviours through video recording. Observations occur in two modes: non-participant during video-recorded sessions and participant during non-recorded sessions. This dual approach minimizes biases linked to verbal interpretation and intervention in artisan activities.

Data Analysis

Data analysis encompasses two stages. The first stage entails descriptive analysis, offering a comprehensive overview of the data. This includes activity flowcharts, the distribution of design behaviour codes and their categories, as well as duration and time allocation (time budget). Descriptive analysis results illuminate patterns and trends in design cognitive activities.

The second stage involves inferential analysis, designed to test hypotheses concerning the impact of sensory perception on decision-making within the unselfconscious design culture. Statistical tests are employed to ascertain the significance of the correlation between designing behaviour and sensory support. These findings will address the research questions.

With this comprehensive methodology, we aim to gain deeper insights into the role of sensory perception in the design cognitive process within the unselfconscious design culture. Moreover, we strive to provide a better understanding of the intricate connections between designers and their design objects in this unique context.

THE UNSELFCONSCIOUS DESIGNING BEHAVIOUR

Data Collection Challenges and Methodology

The challenge in acquiring data from this unit of analysis stems from the raw data's format, which primarily comprises video recordings. The use of video recordings to capture real-time design behaviour within its natural context, especially in situations characterised by language limitations (such as local dialects or technical jargon), eliminates the necessity for verbal data from the designers themselves. This predicament is reminiscent of the research challenges encountered by Bateson and Mead during their investigation of the Bali Aga community, which prompted the development of the ethnophotography approach. This innovative method effectively documented various activities of the Balinese individuals, including their movements, postures, daily routines, and even experiences of possession.

In contrast to the protocol analysis procedure that relies primarily on verbalization as a data source, the video recording method of studying designing behaviour necessitates the initial identification of pertinent information while concurrently distinguishing between cognitive processes and observable behaviours. This approach involves the formulation of examination inquiries that specifically inquire about the activities undertaken by artisans during the design process. Aligned with the theoretical framework of ethnophotography, this video analysis methodology entails the interpretation of various activities through the organization of sentence units in a structured manner.

Development of Ethogram and Design Move Codes

To illustrate the process of identifying artisan design activities, consider the following examples:

"Nang Tomi is sawing wood with a machine."

Nang Tomi	is sawing	wood with a machine.
S	v	n

"Nang Sarma is positioning materials to be ready for work."

Nang Sarma	is positioning	materials to be ready for work.
S	v	n

These instances demonstrate the extraction of verbal content from multiple video samples showcasing artisan design activities. This extracted content subsequently underwent analysis, leading to the creation of an ethogram, which serves as a valuable tool for the analysis of additional video data. The ethogram, presented in Table 2, provides a comprehensive overview of the various design activities observed in the videos. The coding of design moves involves the systematic categorisation and classification of various designing activities. In this study's context, the term design objects distinguish these particular objects from those typically recognised as design artefacts. The understanding of the extraction process from this interpreted sentence structure emphasises the inherent and inseparable connection between signs and markers, as initially proposed by Merleau-Ponty (Dreyfus & Dreyfus, 1964). The presence of a noun (n) is necessary for the specificity and uniqueness of a verb (v). The combination of movements and objects, which results in design move phrases or design moves, consists of a total of 27 distinct variations.

Table 2. Designing Move Coding and Their Modifiers

Move	Object (Modifiers)	Definition
(Making) Error		The subject makes an error on the object
	Accuracy	Precision in targeting the work area
	Equipment	Control of tools aiding in the task
	Procedure	Workflow progress that is about to take place
	Process	Workflow progress currently underway
Adjusting		Subject adjusts their position in relation to the artifact
	Position	Particular way in which someone is placed or arranged
Assist		The subject assists others who are currently taking action
	Process	Workflow progress currently underway
Calculating		The subject calculates the level of precision
	Accuracy	Precision in targeting the work area
Command		The subject gives commands or instructions to another subject
	Subject	The main actor in the design activity
Detecting		The subject shifts their focus of work observation
	Target	The focus of work observation
Ending		The subject concludes a series of work processes
	Process	The ongoing flow of work progress

Move	Object (Modifiers)	Definition
Evaluating		The subject evaluates an object in relation to the target work needs
	Accuracy	Precision in targeting the work area
	Composition	Properties of the design related to numbers or dimensions, proportions, geometry, hierarchy, and orientation
	Procedure	Workflow progress that is about to take place
	Tool	Tools or equipment used in the work
Explaining		Subject explains something to another subject about an object
	Artefact	Object of design being processed (in the highest abstraction)
	Composition	Properties of the design related to numbers or dimensions, proportions, geometry, hierarchy, and orientation
	Material	The material of the design object
	Procedure	Workflow progress that is about to take place
	Tool	Tools or equipment used in the work
Loading		The subject searches for something while contemplating the next action
	Ability	The potential for the force of design movement
Marking		The subject marks the material
	Material	The material of the design object
Measuring		Subject measures dimensions or simply draws lines
	Dimensions	Levels that can be measured in something; or mapping sizes in the form of points (1D) or lines (2D)
Monitoring		The subject actively monitors the activities of other subjects
	Process	The ongoing flow of work progress
Observing		The subject observes their surroundings to gather information
	Information	Information intake from the environment, both relevant and irrelevant, in the context of the ongoing work
Prepare		The subject prepares something for the next activity
	Process	Workflow progress currently underway
	Tool	Tools or equipment used in the work
Process		The subject engages in processing materials
	Material	The material of the design object

VISUALISING THE RICH TAPESTRY OF DESIGN DATA

Craftsmanship practices represent a swift response to the challenges of design, involving a reasoning process that is not yet fully understood. There is an ongoing debate regarding whether designing is distinct from making, whether they coexist, or if they are inseparable parts of the culture of design (Dong, 2009; Knight & Stiny, 2015). This raises questions: "Do the activities of these artisans fall under the category of design?" and "What is the position of design within the activities of making in the unselfconscious culture?".

Although design challenges are considered unstructured and vague, making, as a part of the unselfconscious culture of design, remains a significant design process because its activities are visible, and its artefacts are tangible. These activities reflect that artisans design within their minds, even if not always expressed in words but through modalities and awareness during the making process. Event logging software, such as BORIS, assists in identifying the traces of cognition that are unveiled. An example of recording design activities with active sensory identification is shown in Figure 2.

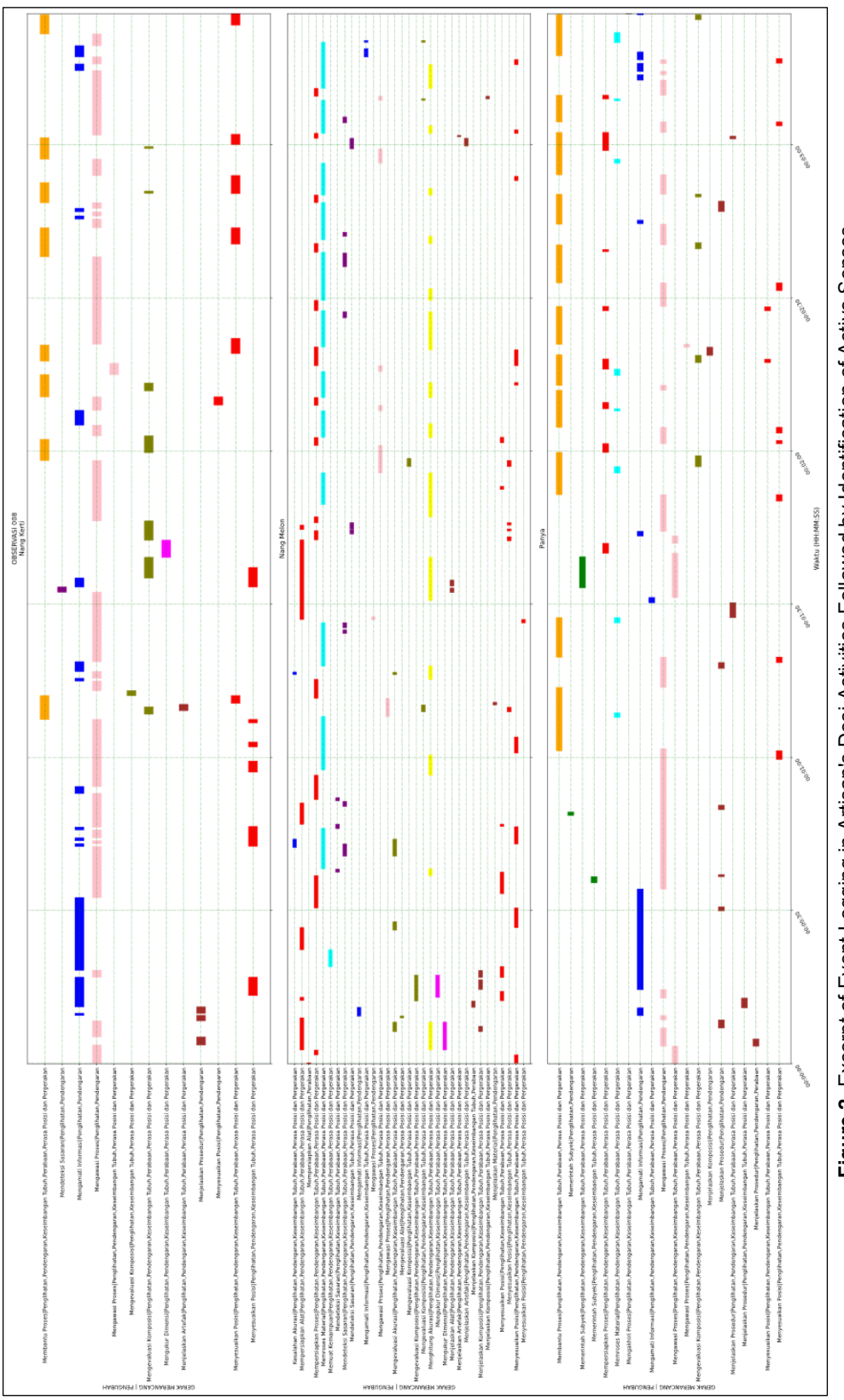

Figure 2. Excerpt of Event Logging in Artisan's Desi Activities Followed by Identification of Active Senses

The figure provides an example of event logging created within a time budget by BORIS, indicating the collaboration of three artisans. Each artisan has their respective activities in the collective work. The number of rows reflects the abundance of unique designing move variations and modifiers, followed by recorded sensory activations observed. Additionally, the coloured bands filling the timeline rows represent sequentially tied records. Here, we can observe that simultaneous layers of moves and objects, as well as modifiers, can occur concurrently. This marks a significant breakthrough in the adoption of behavioural observation techniques for design cognition, complementing other methods. In addition to graphical representation, the data is also recorded in tabular form for further processing through statistical analysis. The example of verbal extraction from the event excerpt above can be seen in Table 3.

The documentation of these events reveals a shift from the activities of making to the activities of designing by the artisan. The recording also captures complex activities that are challenging to identify and process using other methods such as Craig (2011). described. Moreover, this behavioural study allows for the management of more than one participant. These data illustrate the complexity of the cognitive processes involved in true design.

Table 3. Animation and Event Logging of Design Activities

Captured Actions	
Natural Language and Sensory Identification	
	
• "Nang Melon prepares the process: Vision, Hearing, Body Balance, Touch, Position Perception, and Movement Perception." • "Panya observes the process: Vision, Hearing, Body Balance, Touch, Position Perception, and Movement Perception." • "Nang Kerti oversees the process: Vision, Hearing."	• "Nang Melon explains the composition: Vision, Hearing, Body Balance, Touch, Position Perception, and Movement Perception." • "Panya observes information: Vision, Hearing." • "Nang Kerti observes information: Vision, Hearing."
	
• "Nang Melon processes the material: Vision, Hearing, Body Balance, Touch, Position Perception, and Movement Perception." • "Nang Kerti observes the process: Vision, Hearing." • "Panya processes the material: Vision, Hearing, Body Balance, Touch, Position Perception, and Movement Perception."	• "Nang Melon observes the process: Vision, Hearing, Position Perception, and Movement Perception." • "Nang Kerti evaluates the composition: Vision, Hearing, Body Balance, Touch, Position Perception, and Movement Perception." • "Panya assists in the process: Vision, Hearing, Body Balance, Touch, Position Perception, and Movement Perception."

Moves

The distribution of the designing move code (Figure 3) in the observational data reveals essential findings into the behavioural patterns of the unselfconscious design practitioners. Among these actions, 'Explaining' stands out as the most frequently observed, occurring 237 times, highlighting the significance of communication and knowledge-sharing within the design process. 'Evaluating' and 'Adjusting' also appear prominently, with 180 and 115 instances underlining the critical roles of assessment and refinement during design activities. 'Detecting' (82 occurrences) and 'Observing' (89 occurrences) demonstrate the emphasis on perceptive skills in the design process. 'Calculating' and 'Commanding' actions, each occurring 45 times, suggest the importance of precise decision-making and direction. Additionally, 'Monitoring' (58 occurrences) and 'Loading' (58 occurrences) indicate the need for ongoing oversight and resource management. 'Preparing' (113 occurrences) and 'Assisting' (45 occurrences) underscore design work's preparatory and collaborative aspects. 'Marking' (31 occurrences), 'Measuring' (32 occurrences), and 'Processing' (49 occurrences) show attention to detail, measurement, and material handling in design tasks. Finally, 'Ending' (37 occurrences) signifies the conclusion of design activities. This distribution offers significant findings into the multifaceted nature of design behaviours, revealing a complex interplay of actions that contribute to the overall design process.

In summary, the prevalence of explaining and evaluating actions in the design process highlights the significance of communication and assessment. These two actions are integral to the design process, as they likely contribute to a deeper understanding of ideas and the assessment of the quality of design outcomes. Consequently, they can have a significant impact on the results of the design process.

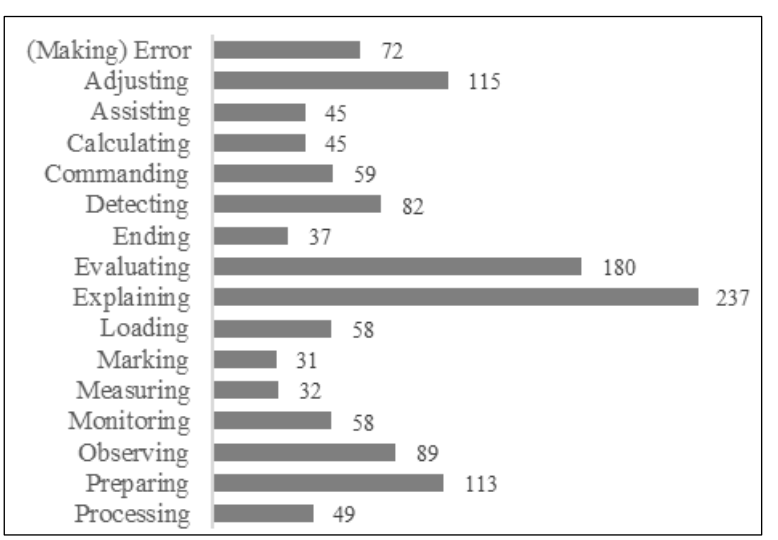

Figure 3. Moves Distribution

Objects

The distribution of 'Objects' (Figure 4) in the design activity within the unselfconscious design culture reveals several noteworthy observations. Firstly, the prevalence of 'Process,' 'Procedure,' and 'Composition' as objects of focus strongly emphasize the planning,

procedural aspects, and overall composition of design activities. This highlights the meticulous attention given to the structuring and organization of design tasks, indicating a structured approach within this cultural context, even it is not prescribed. Secondly, the significant attention to 'Material' and 'Accuracy' as objects reflects the importance of material selection and precision in the manufacturing. It suggests a commitment to achieving high levels of precision and accuracy in the making of artefacts, which aligns with the cultural values associated with craftsmanship and quality. Thirdly, 'Position' and 'Target' receiving substantial attention implies a focus on the design's spatial and directional aspects. It suggests that artisans in this culture pay particular attention to the positioning and alignment of elements within the design, possibly influenced by spatial considerations or functional requirements. Lastly, 'Tool' and 'Ability' also hold a significant place, indicating a recognition of the tools or instruments used in the design process and the skills or abilities required for effective design. This underscores the importance of craftsmanship and expertise within the unselfconscious culture of design.

Overall, this distribution of 'Objects' underscores the multifaceted nature of design within this cultural context, where meticulous planning, material precision, spatial considerations, and craftsmanship skills play integral roles in the creation of artefacts.

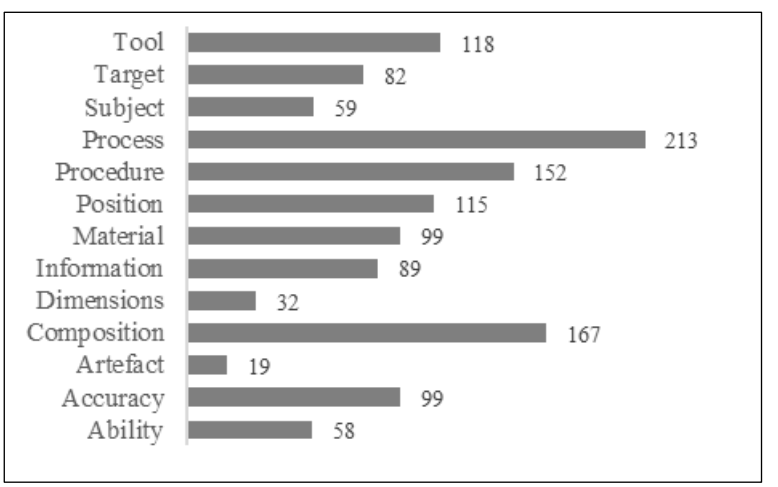

Figure 4. Objects Distribution

Sensory

After analysing sensory activation, five out of the ten Haverkamp sensors are identified as dominant (Figure 5). Visual, proprioceptive, vestibular, auditory, and tactile all appear in roughly equal proportions. Field observations indicate that these five senses aid artisans in designing and adapting to design objects. Meaning it is confirming the closeness and the dialogue between artisan and its creation.

The findings reveal that out of the ten sensory modalities proposed by Haverkamp, only five are actively engaged and observable in the context of design activities within the unselfconscious culture of UD Cori Bali's artisan community. These active sensory modalities are:

- Auditory: With 222 instances, the auditory sense plays a significant role in design activities. This suggests that sound, whether it be the noise of tools, conversations, or other audible elements, is an integral part of the sensory experience during the design process.
- Proprioceptive: This sense, with 285 instances, involves the perception of one's body position and movement. In design activities, it indicates that artisans are highly attuned to their bodily sensations and movements as they interact with the design materials and processes.
- Tactile: With 205 instances, the tactile sense, which involves the sense of touch, is actively engaged. It signifies the importance of physical contact with materials, objects, and tools in the design process.
- Vestibular: The vestibular sense, with 282 instances, relates to balance and body movement perception. Its high prevalence suggests that artisans are keenly aware of their physical stability and movement while engaging in design tasks.
- Visual: This sense is the most dominant, with 308 instances, indicating that visual perception is highly active in the design activities. Artisans rely significantly on their visual senses to assess and interact with design elements.

The dominance of these sensory modalities highlights their crucial roles in the unselfconscious design culture within the artisan community of UD Cori Bali.

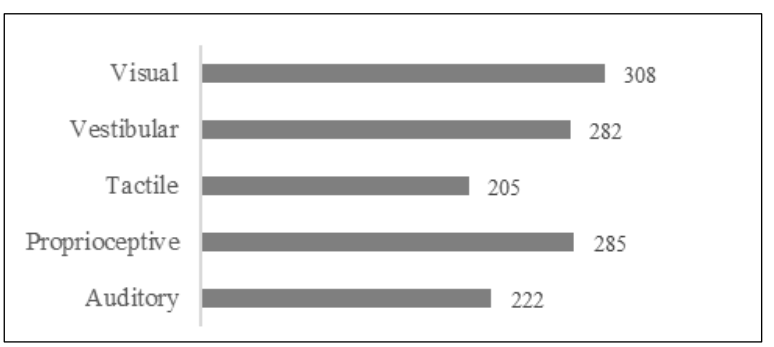

Figure 5. Sensory Distribution

Mapping Sensory Modalities and Design Actions

Modalities serve as tools for communicating design content. There are four modalities in the unselfconscious design culture, two of which are not dependent on specific sensory activation. These modalities influence how design information is externalised into design descriptions.

The sensitivity of artisans to moves, objects, sensory input, and modalities influences the quality of their work, whether ongoing or forthcoming. This sensitivity fosters intrinsic design abilities and aids artisans in addressing the challenges and limitations that arise during the design process.

The hierarchical clustering analysis revealed four distinct clusters (Figure 6) among the sensory aspects and design actions within the unselfconscious design culture of the UD Cori Bali community. Statistical analysis using both Likelihood Ratio Chi-Square (562.442, $p <$

0.0001) and Pearson Chi-Square (483.054, $p < 0.0001$) tests revealed a significant and robust relationship between the move and sensory variables, indicating substantial validity in the observed associations. These clusters clarify on the interplay between sensory modalities and design activities, highlighting the unique patterns and associations within the design process.

- M1 – Physical Actions (Auditory, Tactile, (Making) Error, Prepare, Assist, Marking, Process): This cluster comprises sensory aspects such as Auditory and Tactile, along with design actions like (Making) Error, Prepare, Assist, Marking, and Process. These elements appear to be closely related in the design process, suggesting a significant role for auditory and tactile senses in activities related to preparation, assistance, marking, and process execution.
- M2 – Analytical Movements (Proprioceptive, Vestibular, Detecting, Evaluating, Adjusting, Visual, Calculating, Loading, Measuring): Cluster 2 consists of sensory aspects like Proprioceptive and Vestibular, combined with design actions such as Detecting, Evaluating, Adjusting, Visual, Calculating, Loading, and Measuring. This cluster suggests a strong connection between these sensory modalities and activities related to perception, evaluation, adjustment, and visual representation in design.
- M3 – Instructional Moves (Command, Observing, Explaining, Ending): Cluster 3 encompasses design actions like Command, Observing, Explaining, and Ending. These design actions seem to be closely linked, possibly indicating a pattern where command-driven activities involve observation, explanation, and eventual closure or ending stages in the design process.
- M4 - Supervisory Behaviours (Monitoring): Cluster 4 consists of the design action of Monitoring. This action appears to stand alone in its cluster, suggesting that monitoring activities in the design process may have unique characteristics and do not strongly correlate with other sensory aspects or design actions.

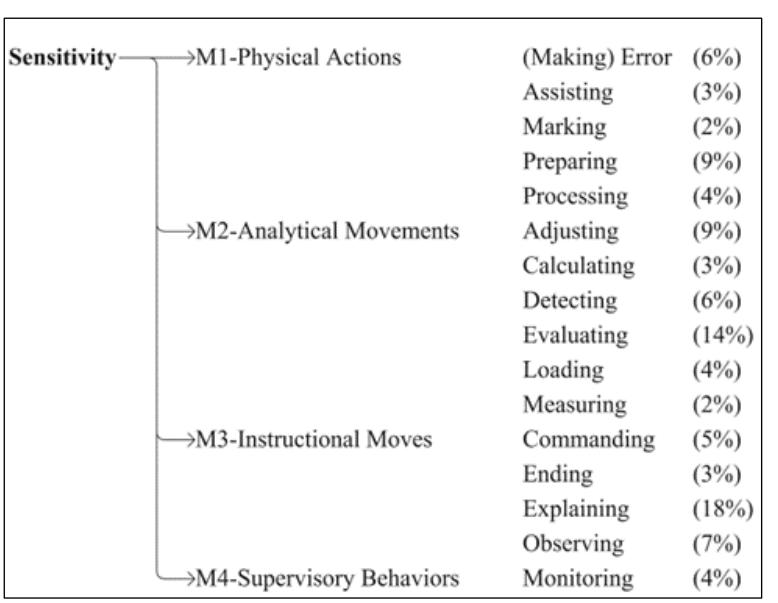

Figure 6. Clustering for Association between Moves and Sensory

The clustering analysis underscores the complex relationship between sensory modalities and design activities within the unselfconscious design culture of the UD Cori Bali community. It reveals that certain sensory aspects tend to be closely associated with specific design actions, implying that artisans rely on particular senses for particular stages of the design process. Notably, auditory, and tactile senses appear to play a central role in activities related to preparation, assistance, marking, and process execution.

Furthermore, the analysis highlights the importance of proprioceptive and vestibular senses in perception, evaluation, adjustment, and visual representation during design activities. The cluster involving command-driven actions, observation, explanation, and ending stages suggests a structured approach to design decision-making. Finally, the distinct cluster for monitoring activities suggests its unique nature within the design process. These findings emphasize the multidimensional nature of design cognition, where sensory inputs and design actions interact intricately to shape the outcome of design endeavours.

Exploring the Interplay of Sensory Modalities and Objects

The clustering analysis is based on the relationships between objects and sensory stimulation in the context of unselfconscious design culture (Figure 7). The data and dendrogram have allowed us to discern distinct groupings within these variables. The Likelihood Ratio Chi-Square (473.010, $p < 0.0001$) and Pearson Chi-Square (390.716, $p < 0.0001$) tests show a significant link between the 'Object' and 'Sensory' variables, indicating strong statistical validity. There are three groups of objects that depend on specific senses, and one group that is not tied to any specific senses. Here is a detailed description of the identified “Objects” (O) clusters:

- O1 - Physical Entities (Auditory, Tactile, Material): This cluster comprises sensory modalities such as auditory and tactile, along with the object category of material. These sensory inputs play a role in how artisans perceive and interact with materials during the design process. Auditory input, in particular, may influence the artisan's ability to assess and work with certain materials, while tactile sensations guide their hands in shaping and manipulating these materials.
- O2 - Quantifiable Aspects (Ability, Dimensions, Accuracy): Cluster 2 includes sensory modality of ability and object categories of dimensions and accuracy. Here, the artisan's sensory perception related to their own abilities is grouped with the dimensions and accuracy of the design objects. This suggests that artisans pay particular attention to their own capabilities and how they align with the dimensions and precision required for the design task.
- O3 - Compositional Elements (Proprioceptive, Vestibular, Composition, Target, Tool, Artefact, Position, Procedure): Cluster 3 encompasses a wide range of sensory modalities, including proprioceptive and vestibular, paired with multiple object categories such as composition, target, tool, artefact, position, and procedure. This cluster highlights the interplay between sensory perceptions of body position and movement (proprioceptive and vestibular) and the various components and processes involved in the design task. It suggests that artisans rely on a combination of sensory inputs to navigate and manipulate design elements effectively.

- O4 - Visual Artifacts (Visual, Process, Information, Subject): Cluster 4 combines the visual sensory modality with object categories related to process, information, and subject. Here, the artisan's visual perception is linked to their engagement with the design process, information analysis, and the subject matter of their work. Visual cues guide their understanding and execution of design tasks, emphasizing the importance of visual input in the design process.

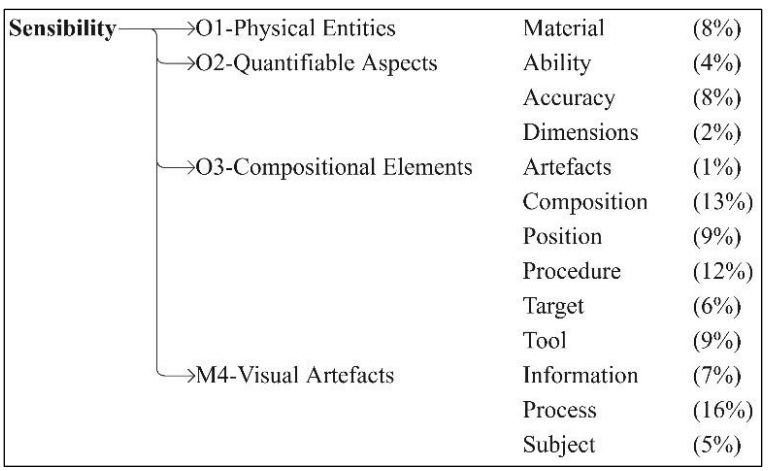

Figure 7. Clustering for Association between Objects and Sensory

Overall, these identified clusters explain on how sensory modalities and object categories are interconnected within the unselfconscious cultural design context. They underscore the adaptability and proficiency of artisans in integrating sensory perceptions with specific design moves. Sensitivity to these design moves, whether it involves auditory and tactile interactions with materials or visual cues in the design process, significantly influences the quality and effectiveness of their design outcomes.

The Role of Sensory Perception in Design Behavior

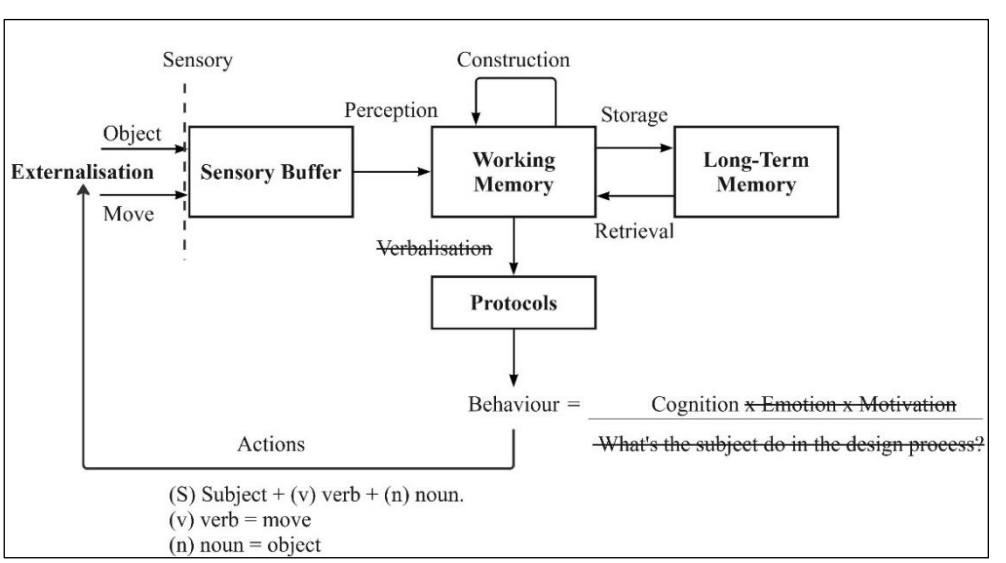

Figure 8. Design Information Processing

Examining the syntactic pattern of (S) + (v) + (n), it can be inferred that the subject's perception occurs subsequent to the presence of the noun, which functions as the object. Vardouli (Vardouli, 2015) offers a lucid exposition of this concept within her ecological framework for artefacts, encompassing the notions of engagement and perception through material objects. Therefore, it becomes apparent that human sensory perception possesses the capacity to discern two distinct inputs from the various stimuli present. Two critical factors warrant consideration: the presence of the object and the stimuli generated by the subject's own movement, as illustrated in Figure 8.

Throughout this research journey, a method has been established for examining one of the many pieces of information that can enter into the construction of design thinking. This method involves the complexity of design signals and introduces an evaluative nature that brings together moves tokens with objects as its considerations.

From the four move groups and the four object groups, a potential of 16 knowledge constructions that influence design thinking can arise. However, from the constellation of available data, we have only uncovered 10 out of the 16 possible combinations, as depicted in Figure 9. Simultaneously, it reveals that this construction of design knowledge signified the capability cultivated within this community of Bali Aga artisans. Surprisingly, there are cognitive developments that has been concealed by the curtain of very intensive physical design activities.

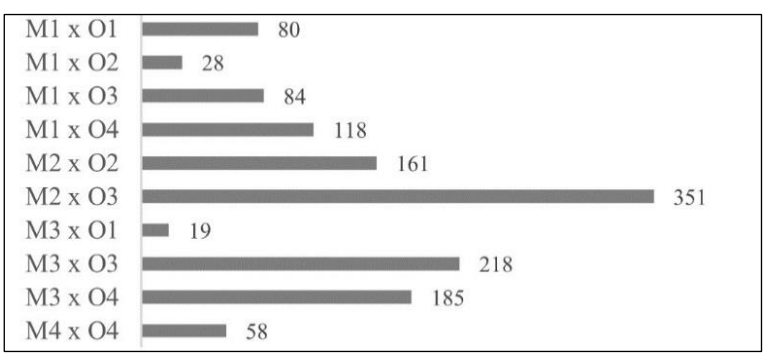

Figure 9. Working Memory Constructions

The analysis of "move x object" concatenations revealed significant patterns in the working memory construction of artisans within the unselfconscious cultural framework. These combinations represent the dynamic interplay between various moves and objects during the design process. The data uncovered specific chains, such as analytical movements (M2) x compositional elements (O3), that occur more frequently, shedding light on the preferred modes of interaction between sensory-driven movements and design objects. While instructional moves (M3) x compositional elements (O3) become a knowledge construct that supports both in the design activity. The instructions serve as steadfast guides amidst the dynamics of the design process. These findings serve as a valuable resource for understanding how artisans navigate their design activities and the sensory modalities that shape their decision-making. Moving forward, these insights inform our discussion on the role of sensory perception in design behaviour and its implications for design cognition within the unselfconscious design culture.

THE VITAL COGNITIVE KEYSTONE

Unveiling the Interplay of Sensory Perception

In our exploration of design cognition within unselfconscious cultural contexts, two fundamental concepts have emerged that uncover on the intricate interplay between sensory perception and design behaviour. The concept of sensitivity underscores the designer's remarkable ability to respond to and harness sensory inputs, particularly within the dynamic context of their movements during the design process. As we delved into the diverse design moves and their associations with distinct sensory modalities, it became evident that sensitivity serves as a guiding force, directing the designer's responses to sensory stimuli and ultimately shaping their design decisions. This concept highlights the integral role of sensory perception in the unfolding narrative of design within these cultural milieus.

Conversely, the notion of sensibility brings forth a different facet of the design landscape. It accentuates the designer's capacity to discern and navigate the intricate tapestry of constraints and potentials inherent in design objects. Our comprehensive analysis of the Objects and their nuanced associations with various sensory modalities has illuminated how sensibility operates as a compass, guiding the designer's interpretations and choices. It underscores the profound influence that the characteristics of design objects exert on the design process, as designers navigate the sensory-rich terrain of their creations.

A Key Cognitive Process

These findings indicate that the ability to be creative and comprehend design has been transformed into a strong cognitive process that integrates analytical movements and compositional elements in unselfconscious design culture with minimal or no reliance on external visual media. The emerging construction of working memory shows that behind this hylomorphism actions this design culture is actively designing in its mind.

This analytical process may encompass a deep understanding of compositional elements used in design, such as proportions, arrangement, or specific patterns. The combination of analytical movements and compositional elements allows designers to detail, scrutinise, and optimise their designs without relying on design prescriptions. This illustrates the designers' ability within this culture to harness sensory experiences and internal concept understanding.

Thus, these findings support the idea that in unselfconscious cultures, where external visual media may not always be available, design can remain a powerful and innovative process. Furthermore, it emphasizes the significance of constructing working memory in connection with designing objects, movements, and sensory aspects, all of which contribute to the successful design process.

Culturally Informed Design Practices

The insights derived from this discussion hold valuable practical implications:

- Cross-Cultural Design: Designers working in unselfconscious cultural contexts can benefit from a deeper understanding of the role of sensory perception and movement in the design process, enabling them to create more culturally relevant design processes as well as enhancing knowledge transfer in the community.
- Resource Optimisation: Recognizing patterns in resource allocation and prevalent design strategies can assist designers in optimising their workflows, leading to more efficient design processes.
- Enhanced Decision-Making: Understanding the transformation of sensory inputs and actions in working memory can enhance designers' decision-making abilities, resulting in better design outcomes, also presenting opportunities that stimulate the continuity of the design process.
- Cultural Awareness: This discussion highlights the importance of cultural awareness in design. Design practitioners can apply this understanding to respect and integrate cultural preferences and norms into their work.

These practical consequences enable designers to approach unselfconscious design culture issues, resulting in enhanced effectiveness, cultural awareness, and efficiency.

SENSORY INSIGHTS

In this study, we embarked on a journey into the world of unselfconscious design cultural, guided by the invaluable contributions of the Bali Aga artisans in the Pengotan community. Their rich cultural context and active participation have been instrumental in advancing our understanding of design cognition within unselfconscious design cultures. As we draw this research to a close, we reflect on the profound insights we have gained, the contributions we have made to knowledge, and the potential paths for future research in this captivating field.

The concepts of sensitivity and sensibility have significantly influenced the understanding of unselfconscious design culture. These concepts highlight the relationship between designers, their sensory perceptions, and the design objects they interact with. They provide a nuanced perspective on how sensory inputs and object-related actions shape design decisions. Sensitivity emphasises the designer's ability to respond to sensory stimuli, particularly in terms of their movements during the design process. This heightened awareness of sensory stimuli challenges conventional notions of design as a purely cognitive endeavour. Sensibility, on the other hand, highlights the designer's ability to interpret the constraints and potentials inherent in design objects. This conceptual framework not only deepens our understanding of unselfconscious design cultures but also opens new possibilities for cross-cultural design research, education, and practice.

Throughout the course of our study attempt, we have encountered specific constraints that necessitate recognition. Although video recording technology is currently at its peak, the process of data collection continues to pose many obstacles. The recorded operations yielded a significant amount of data, necessitating more efforts for analysis.

It is important to acknowledge that the interpretation of sensory activity and culture has the potential to induce biases. Nevertheless, we purposefully choose this course of action in order to delve into information that transcends current limitations with care.

The research has also considered the presence of language difficulties. The potential influence of language disparities between participants and researchers on the comprehension of the identified concepts should be taken into consideration. However, we are optimistic that our findings will be deemed acceptable, and we are receptive to engaging in additional discourse.

Moreover, the projects documented had several phases that occasionally deviated from the established research schedule. This hindered our ability to gather data from all phases of the initiatives.

In the context of future study, there exists considerable potential for the optimisation of data collecting and processing methodologies. We are additionally intrigued by the prospect of contrasting the design methodologies employed in cultures characterised by an unselfconscious with those prevalent in cultures that possess a heightened sense of self-consciousness.

Within the realm of education, there exists the opportunity to enhance the recognition and understanding of design signals. This innovation has the potential to serve as a beneficial contribution to the existing repertoire of knowledge transfer methods in the field of education.

Additionally, we ascertain the practical ramifications that arise from comprehending sensory stimulation in unselfconscious design culture. These implications may serve as a basis for future discussion with artisans.

In conclusion, our study has underscored the pivotal role of sensory perception in unselfconscious design culture. The concepts of sensitivity and sensibility have illuminated how artisans seamlessly integrate their surroundings into their design process.

This research urges us to appreciate the wisdom of unselfconscious cultures, recognizing their innate design abilities. It calls for a more inclusive approach to design education and invites dialogues between designers and artisans to bridge traditional wisdom with contemporary practice.

ACKNOWLEDGMENTS

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BUILDING CONVERSION CONSTRUCTION AND NEIGHBOURHOOD SUSTAINABILITY: BANDUNG CASES

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Abstract
As one of the big cities in Indonesia, Bandung has been attracting people to come and live in the city. Along with the city's development, it has undergone rapid urbanisation in recent years, which has been influencing the city's neighbourhood area. It has led to a demand for facilities for certain urban activities within any neighbourhood. The land scarcity within the city currently creates urban sprawl, overcrowding, housing shortages, and environmental degradation. To tackle these issues, one of the alternatives is to convert vacant buildings. This approach not only helps to provide more facility options but also promotes the preservation of historical buildings and is relatively more sustainable in practice. Regarding this issue, the topic of building conversion and neighbourhood sustainability has been of growing interested and demand among academics, policymakers, and community leaders. Therefore, this paper aims to discuss the building conversion process of selected case studies in Bandung City and identify their neighbourhood sustainability. To understand the notion of building conversion and neighbourhood sustainability, this paper employs descriptive and qualitative methods. The primary data source was obtained from the field survey and building management and expert interviews, supported by secondary data such as aerial photos and literature reviews. The findings of this study can contribute to the development of policies and strategies that promote building conversion and sustainable neighbourhoods as viable urban transformation alternatives. Additionally, this research may well serve as a model for other cities facing similar challenges in terms of building conversion and urban sustainability.

Keywords: *Building Conversion Construction; Neighbourhood Sustainability; Bandung; Transformation; Heritage Building; Adaptive Reuse*

INTRODUCTION: CONVERTED BUILDINGS IN BANDUNG CITY AND THE NEEDS OF NEIGHBORHOOD SUSTAINABILITY EVALUATION

As one of the big cities in Indonesia, Bandung has been attracting people to come and live in the city. Along with the city's development, it has undergone rapid urbanisation in recent years which has been influencing the city's neighbourhood area (BPS, 2020). It has led to demand for facilities for certain urban activities within any neighbourhood. The land scarcity within the city currently creates urban sprawl, overcrowding, housing shortages, and environmental degradation (Prihatin, 2015). To tackle these issues, one of the alternatives is to convert vacant buildings to other functions as the city demands. This approach not only helps to provide more facilities options but also promotes the preservation of historical buildings and is relatively more sustainable in practice given its higher efficiency compared to the alternatives of demolition and constructing anew (Pratiwi, 2022; Jonge, 2017; Živković et al., 2015; Lanz et al., 2022; Remøy et al., 2014).

In Bandung itself, it is found that there are at least two historical buildings once being used as office buildings then being converted into residential functions, namely Gas Block and Vasaka Maison Teraskita Hotel. Transforming urban spaces in this manner can revitalise the area, fostering population growth, and promoting industrial development (Kim and Lee,

2020; Ressler, 2020). However, as the urban population expands, numerous professionals and policymakers acknowledge the significance of devising and executing approaches that result in sustainable urban development within cities, particularly in the context of neighbourhood sustainability (Khatibi M. et al., 2023; Remøy et al., 2011). Regarding the issue above, this paper aims to discuss the building conversion construction process and the contribution to urban context based on the neighbourhood sustainability evaluation, with Bandung City as a case study.

METHODS: DESCRIPTIVE AND QUALITATIVE EVALUATION

To understand the building conversion construction process and the concept of neighbourhood sustainability, this paper employs descriptive and qualitative evaluation. The following are the elements of the conversion construction process of historical buildings that will be discussed based on the literature review: agencies in construction industries, design mechanisms, building construction systems, and management in operation and maintenance (Al Dein et al., 2022). Then, the qualitative evaluation refers to the widely used criteria for sustainable neighbourhood form and morphology evaluation: environmental quality, density, spatial integration and connectivity, mixed-land use, green spaces, and building form and typology (Khatibi et al., 2023; Zhang et al., 2023). The analysis process was conducted through spatial analysis (aerial photos) and chronological history that showed the building conversion process. The data is derived from the authors' familiarity with the case study location, field surveys, building management and expert interviews, and literature studies regarding neighbourhood sustainability, building conversion, urban design guidelines of Bandung, and case studies history.

Figure 1. Case Studies: (Left) Gas Block, (Right) Vasaka Maison Teraskita Hotel

The case studies are carried out at Gas Block Braga and Vasaka Maison Teraskita Hotel. Both case studies are located in Sumur Bandung District but in different corridors. Gas Block is in the Braga corridor (heritage corridor), while Vasaka Maison Teraskita Hotel is in the main corridor of Bandung City named the Asia-Africa corridors. Gas Block is being renovated in 2020 and finished in the same year. Meanwhile, Vasaka Maison Teraskita is being renovated in 2018 and then finished in 2020. Gas Block and Vasaka Maison Teraskita Hotel are heritage buildings that were once used as offices and then were converted into residential functions (hotels) with supporting facilities such as restaurants and cafes. This conversion

activity will be discussed in terms of their construction process and their impact/contribution to the neighbourhood's sustainability. The following figure is the map and the building that will be analysed (Figure 1).

DISCUSSIONS: BUILDING CONVERSION CONSTRUCTION AND NEIGHBORHOOD SUSTAINABILITY EVALUATION OF GAS BLOCK AND VASAKA MAISON TERASKITA HOTEL

Building Conversion Construction

Agencies in Construction Industries

The stakeholders involved in Gas Block Hotel conversion is PT Perusahaan Gas Negara Tbk (PGN) as the building owner. This company is the largest company engaged in the transmission and distribution of natural gas in Indonesia. Initially, the building was designed by Architect Richard Leonard Arnolod (R.L.A) as an office. Now the building has been converted into a hotel and is being developed by PT Permata Graha Nusantara (PGNMAS), the subsidiary of PT PGN, which functions to maintain, develop, and utilise the building.

The conversion of Vasaka Maison Teraskita involved various stakeholders, including the building's owner, PT Waskita Realty, and its parent company, PT Waskita Karya (Persero) Tbk which operates in the construction and property field. The conversion process underwent consultation with the Bandung City Regional Government and the Cultural Heritage Expert Team. The contractor was the building division of PT. Waskita Karya (Persero), Tbk, and PT. Larascipta Architect Internusa Design as the architect to design the hotel and restore the heritage building. Hotel Maison Teraskita consulted with Wyndham Realty, a French hotel operator, to actualize the French building interior concept for the interior.

Design Mechanism

In 1919, architect Richard Leonard Arnold Schoemaker designed the Gas Block Hotel, used as the Bandung Voorult secretariat, and N.V. Becker & Co. as a payment office and showroom on Jalan Braga. In 1928, the building was purchased by the Dutch East Indies Gas Company Nederlandsch Indische Gas Maatschappij (NIGM) Netherlands to be used as a service office. The office was empty and abandoned in 1998 because PGN moved offices to Jakarta. Because it was neglected for 14 years, the first step taken was to open an internal learning center at the Gedung Gas Negara, but this also did not make any profit. Another way to revive the building is to use the building as a space for exhibitions and creative activities. Further development was carried out by PGNMAS by transforming Gedung Gas Negara into the Gas Block Braga using the adaptive reuse method. The building, which was previously only a creative space, was developed into a hotel and restaurant that generated more profits.

Several steps were taken to preserve the Gedung Gas Negara, from changing the function of the building to preserving it using a more profitable adaptive reuse method. Preserving it using adaptive reuse does not change much of the original 1913 facade. Almost all facade elements such as shape, texture, and color have been retained as the original. There is only maintenance such as repainting the walls and door frames to make them look like new again. The Gas Block building conversion timeline is shown in Figure 2.

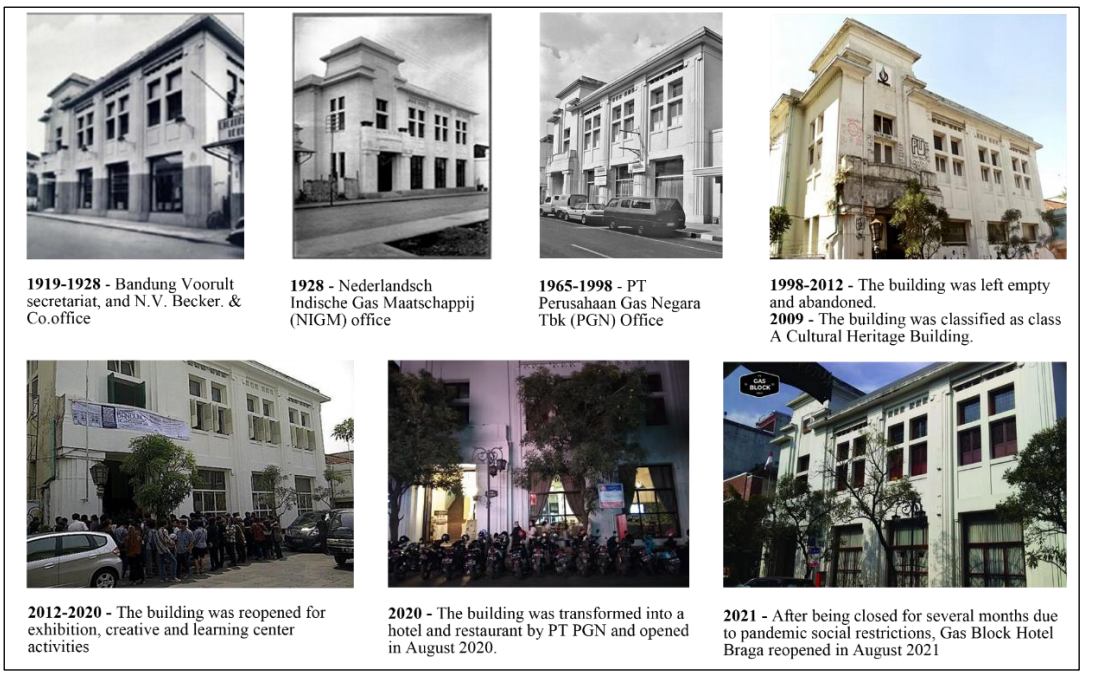

Figure 2. Building Conversion Timeline of Gas Block Hotel

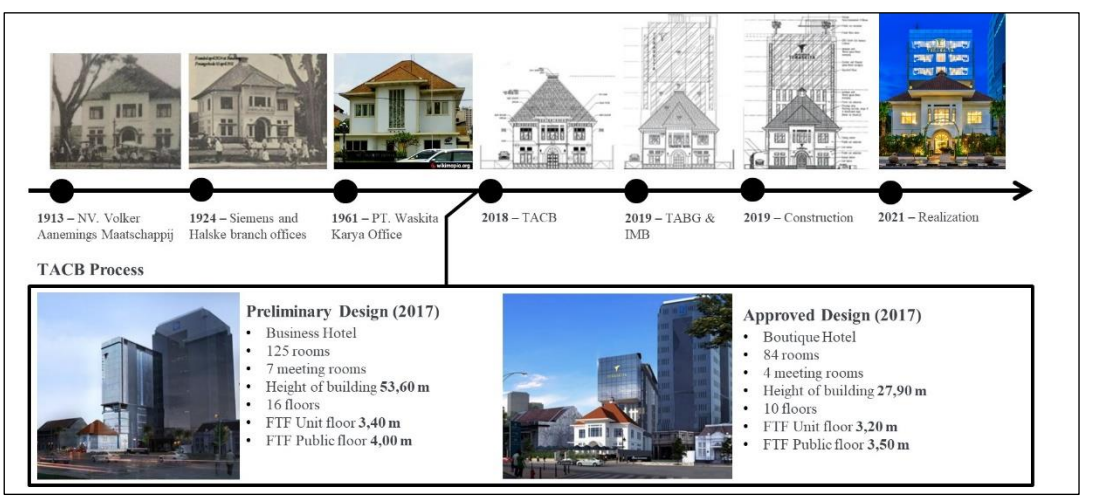

Figure 3. Building Conversion Timeline of Vasaka Maison Teraskita Hotel

Meanwhile for Vasaka Maison Teraskita (as shown in Figure 3), in 1912–1913, NV. Volker Aanemings Maatschappij, a contractor owned by the Volker family (the first owner of the building), constructed a building that had become a branch office for Siemens & Halske, a German company specialising in the electricity and signal sectors. The structure was partially affected during the *Bandung Lautan Api* incident in 1946 when the local community burned down the city to prevent its use as a colonial base. N.V. The Volker Aanemings Maatschappij building was one of the structures impacted. In April 1955, the world's first Asian-African Conference took place in Bandung. The NV. Volker Aanemings Maatschappij building situated in the corridor leading to the KAA Building, required renovation. However, the renovation conducted at that time didn't take into account the original conditions from

1913. Following the conference, under Government Regulation number 23 of 1958, NV. Volker Aanemings Maatschappij underwent nationalisation. On March 11, 1960, it transformed into the Waskita Karya Building Company and later merged into the Waskita Karya State Company.

Due to the relocation of the Waskita office from Bandung to South Jakarta in 1965, those assets of the Waskita Building were unused but required maintenance due to their location in a strategically significant conservation area, adjacent to the city square in Bandung. A proposal has been put forward to both refurbish the Waskita Building to its original 1913 condition and construct a commercial hotel on the premises which was later named Vasaka Maison Teraskita Hotel. The conversion posed various challenges, particularly in obtaining accurate building data to determine the original condition both externally and internally before the damage caused by the *Bandung Lautan Api* incident. The management successfully compiled photos to assess the exterior condition, while for the interior, they made estimations based on the building design prevalent during the same era. The conversion process adhered to regulations such as Local Government Regulation Number 7 of 2018 concerning cultural heritage management, spatial planning functions, and building codes. In summary, the building underwent a functional transformation from an office to a hotel, necessitating additional stories for more rooms. However, regulatory constraints, dictated by the building's location and its status as a cultural heritage site, limited the height expansion. Consequently, the focus remained on maintaining the cultural character of the building, taking into account the imposed building height restrictions.

Building Construction System

Gas Block Hotel is classified as a Class A Cultural Heritage Building, hence the physical appearance of the building is still conserved as it is. Therefore, the adaptive reuse concept is carried out without changing the building' structure. The scope of work for the conversion construction is repainting the exterior and interior as well as interior refinishing, which includes replacing floor coverings, adding walls, and adding other interior elements such as lamps, tables, chairs, etc. Mechanical, electrical, and plumbing works are also carried out according to the functional needs of the building.

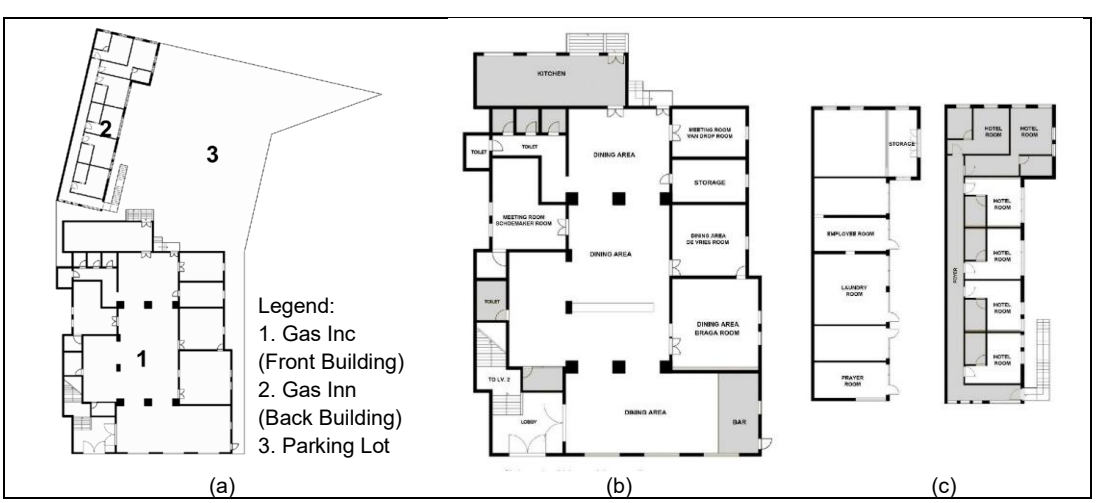

Figure 4. (a) Site Plan of Gas Block Hotel, (b) Plan of Front Building, (c) Plan of Back Building

Gas Block Hotel consists of 2 buildings, the front building and the additional building on the backside (Figure 4). The front building is used as a restaurant and bar area, while the back building is used as a hotel. In general, the front building has not undergone many changes. The changes that occurred on the 1st floor were only the addition of bar tables at the front area, and the addition of wall decoration ornaments at some parts on the walls. There were also changes to ceramics floors and walls in the toilet area for the 1st and 2nd floors, and changes in room function of the room to a kitchen on the 1st floor. All architectural elements such as doors, windows, bouvenlight, skylights, and other ornaments have not been changed and have been conserved as before.

Figure 5. Transformation of Back Building (Hotel) Facade of Gas Block Hotel

The back building is a building that was converted into a hotel (Figure 5). On the ground floor of the building, building interventions cannot be seen due to limited access during surveys. However, a partition was added to one side of the building to be used as a storeroom. On the 2nd floor, the conversion constructions were replacing the floor in the foyer area, adding wall partitions between hotel room units, changing hotel room floors, adding bathroom walls, and adding clean and grey water installations for the bathroom. There were slight changes to the hotel facade, namely the replacement and addition of a canopy and the addition of iron stairs for access for hotel guests.

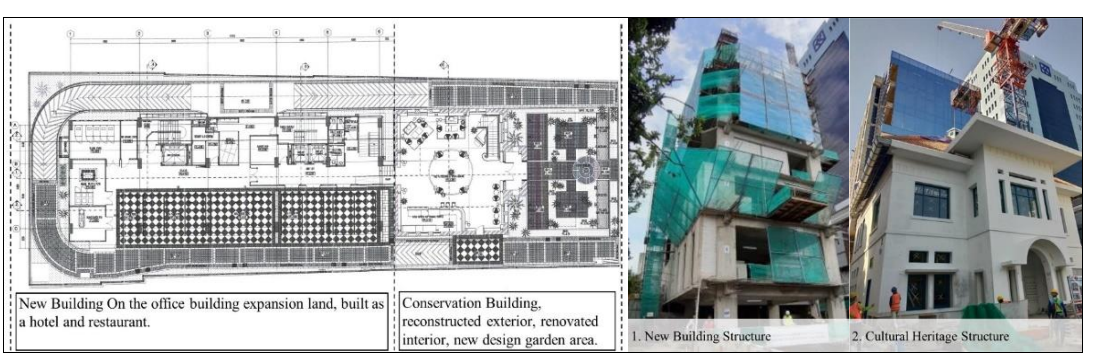

Figure 6. Development of Old and New Building Construction of Vasaka Maison Teraskita Hotel

In comparison to Gas Block Hotel, Vasaka Maison Teraskita Hotel was classified as a Class B Cultural Heritage Building in 2019, indicating this building is allowed to be conserved through restoration. The construction scope included preparation, structural, architectural, mechanical, electrical and plumbing, interior, landscape, special lighting, and FFE (Furniture, Fixtures, and Equipment). The construction phase began on July 4th, 2019 until January 31st, 2021. In general, the construction process began by referring to the City

Plan of Bandung to gain information regarding the spatial planning and the area to construct the buildings. Then, the management asked for recommendations from the Cultural Heritage Building Team to convert the buildings and continued proposing the IMB (Building Permit). After getting permission, they started the construction until they were topping off on June 23rd, 2020, then started a trial stay on December 12th, 2020. Vasaka Maison Teraskita Hotel officially held a soft opening on January 21st, 2021. The new hotel building was strategically positioned 1.5 meters behind the heritage structure, designed with minimal details to accentuate the prominence of the heritage building in the forefront and to minimise any potential effects of development on the original structure (Figure 6). The new building's development proceeded from the rear to the front before finishing with the link construction to the historic building. In general, the building site was transformed from an office building into a hotel development area with 8 floors, which has high commercial value.

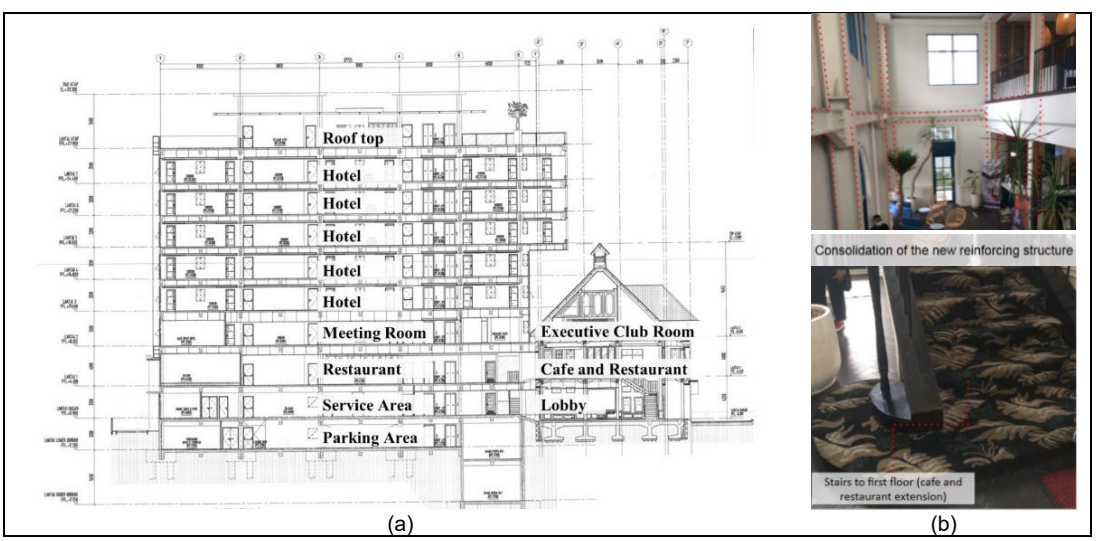

Figure 7. (a) Section Drawing of Vasaka Maison Teraskita Hotel, (b) A White Exposed H-Beam Steel Structure and Additional Stair at The Old Structure

Apart from that, the interior was renovated according to the hotel's functional requirements with a french-style interior. The old Waskita Building has two floors aside from the ground floor, which was transformed into a lobby (ground floor), café (first floor), and an executive club room (attic floor), as shown in Figure 7a. Therefore, reinforcement of the new structure with a white exposed H-beam steel structure in the lobby area was inevitable due to the addition of the first floor as a restaurant extension (connected to the new building) and the Havana Bar on the second floor (attic). Besides, there are additional stair elements with balustrade ornaments that are shaped to suit the French-style interior design (Figure 7b). The stair material uses a steel structure and wood finishing with carpet. An up-ceiling from the ground floor to the attic floor was designed with an indirect light cover and houses the air conditioning inlet and outlet, as well as fire equipment such as smoke detectors and sprinklers. The interior ambience of both old and new buildings was dominated by classical decoration and patterns that were expected to maintain the heritage value. For exterior works, the part of the garden in front of the building that was originally grass has now been converted into a landscaped garden with the addition of a stone path, a fountain, and additional plants in the form of palm trees, shrubs, and so on. Changes were made for the convenience of visitors to the café at the front of the building.

Management in Operation and Maintenance

Both the operation and maintenance of the Gas Block Hotel are managed by BAIO Hotels and Resorts. Meanwhile, Vasaka Maison Teraskita Hotel was once operated by PT Jaya Hartama Hotel Manajemen (2021-2022) and then changed by Artotel Group from May 2022 until now. The daily maintenance of Vasaka Hotel is conducted by the hotel operator starting from the hotel rooms to the gardens. Special care is taken during off-peak times, so as not to disturb guests.

Neighbourhood Sustainability Evaluation

The sustainable neighbourhood form and morphology of the case studies are carefully evaluated according to the widely used criteria, which are (1) environmental quality, (2) spatial integration and connectivity, (3) mixed land uses, and (4) green spaces (Khatibi et al., 2023). The followings are the identifications of Gas Block and Vasaka Maison Teraskita Hotel regarding their neighbourhood sustainability before and after conversion based on each criterion.

Environmental Quality

Environmental quality is defined as the arrangement of regional elements to establish a region or subarea with an informative environmental system, unique character, and specific orientation, making it easier for area users to orient and circulate. Based on the Urban Design Guideline of Bandung, to determine the environmental quality, signage and street furniture are a key factor that will influence the corridor's appearance.

(a) (b)

Figure 8. Gas Block (a) Before Conversion and (b) After Conversion

Before the conversion, the pedestrian way in front of the Gas Block building was spacious but lacked any street furniture (Figure 8a). Because of the absence of street furniture, the front area of the building saw minimal activity. This situation led visitors to either walk straight across or directly enter the building, resulting in an insufficiently vibrant pedestrian space. Besides, the building's signage displayed the owner's name, "PGN," positioned on the wall at the third level, making it visible to both pedestrians and drivers, but it did not adequately represent their function as an office. Furthermore, as time went by and with poor management, the building was abandoned and vandalised (Figure 8a). After the owner transformed the building into a hotel and restaurant, the pedestrian way was enhanced with street furniture

such as benches, street lamps, plants, and bollards with the theme of the old city's cultural heritage area, strengthening the heritage impression along the Braga corridor (Figure 8b). Aside from that, the new signage was added to reflect the building's new branding with attractive lighting. The front side of the Gas Block building is now more livable as a result of this transformation.

Figure 9. Vasaka Maison Teraskita (a) Before Conversion and (b) After Conversion

In Vasaka Maison Teraskita, before conversion, the building had a pedestrian pathway at the front but lacked any street furniture. However, in preparation for hosting the ASEAN event in Bandung, street furniture was enhanced by street lamps, trash cans, markings, and bollards (Figure 9a). After conversion, the front garden of the building provides a pleasant atmosphere by fostering interaction between people and the building due to its transparency (Figure 9b). Through various renovations and changes in ownership, the building consistently features modest signage displaying the owner's or tenant's name, discreetly positioned on the front facade. The signage does not dominate the building's appearance, hence it does not disturb the cultural heritage building impression. In general, the overall building design contributes to the cultural appearance and transparency of the Asia-Africa corridor.

Spatial Integration and Connectivity

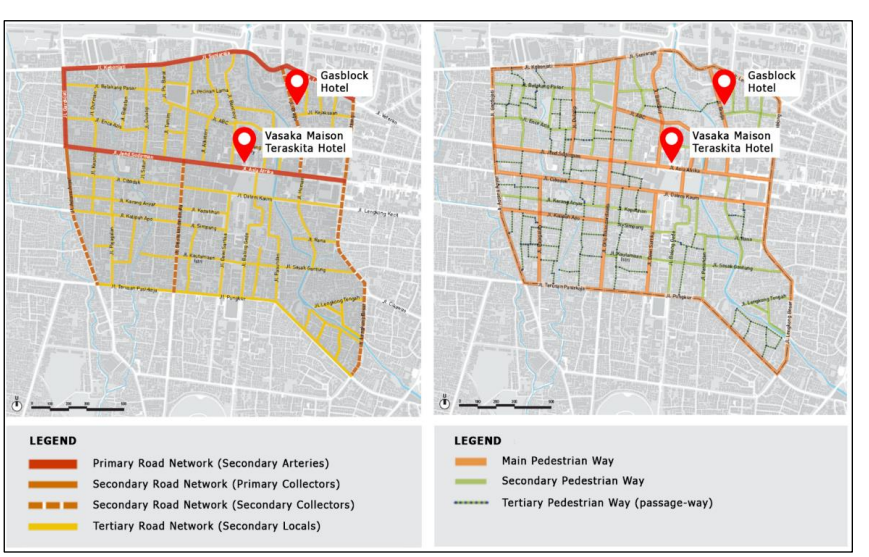

Figure 10. Spatial Integration and Connectivity of Gas Block and Vasaka Maison Teraskita Hotel

The case studies are evaluated for spatial integration and connectivity through their spatial connectivity with adjacent neighbourhoods and distance to the city centre (Figure 10). The gas block's front side is located on Braga Street, one of the secondary collector streets, which has a speed limit for passing vehicles according to the city's urban design guidelines. On this street, building setbacks are 0 (zero) from the parcel's border (GSB 0). Meanwhile, Glas block's backside is located on Morce Street, a secondary local street. However, Vasaka Maison Teraskita is located on Asia Afrika Street, one of the secondary artery streets, which has a higher average speed for passing vehicles according to the city's urban design guidelines. Though having different street hierarchies, both streets of the case studies are equipped with adequate pedestrian sidewalks, before and after the conversions.

Mixed Land Uses

Mixed land uses are evaluated by the diversity in land use, such as the provision of various housing types, services, facilities, and amenities. Various activities surrounding the case studies determine the vibrancy and variety of lifestyles of the two neighbourhoods (Figure 11).

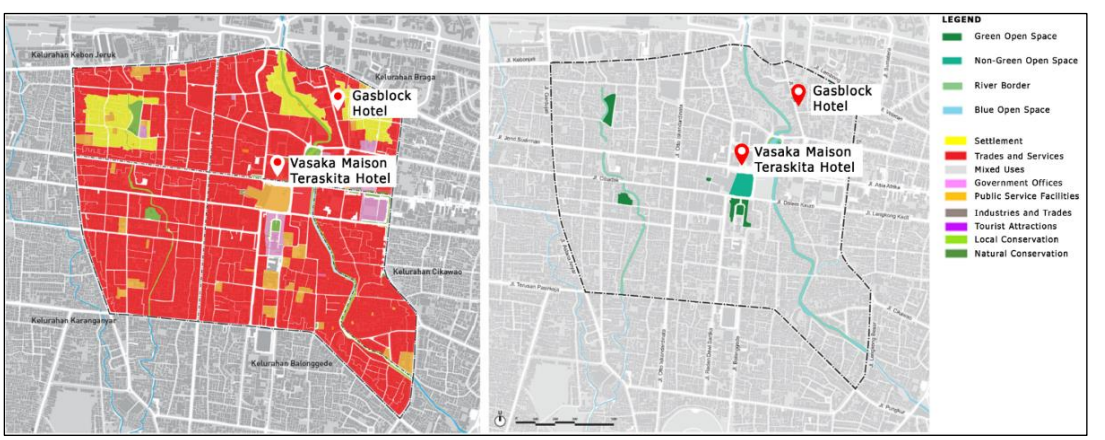

Figure 11. (Left) Mixed Land Uses and (Right) Green Spaces in Case Studies Area

The environment around the Gas Block Hotel is surrounded by buildings for trade and service functions (red) and offices (light red), which if examined more deeply consists of offices, stalls, restaurants, cafés and shops. However, the environment around the Gas Block is also dominated by dense residential areas (yellow). Meanwhile, the neighbourhood around the Vasaka Maison Teraskita is surrounded by buildings for trade and service functions (red) and offices (light red), which if examined more deeply consists of offices, stalls, restaurants, cafés, and shops. On the south side of the Vasaka Maison Teraskita, there is the Grand Mosque of Bandung and Alun-Alun Bandung (orange). On the East side of Vasaka Maison Teraskita, there are several historical buildings such as Gedung Merdeka and Museum Asia Afrika (purple). These vibrant functions can be a magnet for citizens to visit the city centre, especially in cultural heritage areas, and the residential functions provided by case studies contribute to creating a 24-hour activity.

Green Spaces

Green area density and availability of gardens and parks in the area surrounding the case studies will be evaluated. Green area density is explained through the green area per unit area ratio, while the availability of gardens and parks is derived from spatial analysis of aerial photos (Figure 12). There are no significant changes in green area density around the Gas Block Hotel. However, since 2014, small-scale green improvement has been done, namely adding trees in front of the Gas Block Hotel (along the Braga corridors). This improvement has increased the accessibility and view of green spaces. Meanwhile, in the colonial era, Vasaka Maison Teraskita had access to the green space in the city square. However, currently, the city square has been turned into a vast synthetic grass field with limited vegetation. The indirectly nearest green space is on the Cikapundung River riparian. According to the Bandung Guide City Plan 2016, the riparian has great potential to provide green spaces. Nevertheless, the green border of the river is still limited to only a small part of the river.

CONCLUSION

The land scarcity within Bandung City currently creates urban sprawl, overcrowding, housing shortages, and environmental degradation. To tackle these issues, one of the alternatives is to convert vacant buildings. This approach not only helps to provide more facilities options but also promotes the preservation of historical buildings and is relatively more sustainable in practice. Regarding this issue, the topic of building conversion and neighbourhood sustainability has been a growing interest and demand among academics, policymakers, and community leaders. Therefore, this paper aims to discuss the building conversion process of selected case studies in Bandung City: Gas Block and Vasaka Maison Teraskita Hotel, as well as the evaluation of their neighbourhood sustainability.

The analysis results showed that both Gas Block Braga and Vasaka Maison Teraskita Hotel have better improvements after being converted into new functions (residential). In particular, this conversion helps protect cultural values in the buildings from abandonment as well as gives a uniqueness and identity to the area. The conversion process involves several stakeholders such as the Cultural Heritage Building Team to decide the preservation mechanism for the buildings. As a result, Gasblock Braga is preserved without a lot of interventions to the original structure and characters. Meanwhile, Vasaka Maison Teraskita is preserved by restoring it to its original condition with a reinforcement structure using H-beam steel at the cultural heritage building and constructing the new structure behind the old one with building height constraints. In addition, the residential function contributes to providing a 24-hour activity, making the area surrounding the buildings vibrant and liveable. Besides, livability is also created through the enhancement of street furniture, transparency, permeability, and maintaining integration and connectivity. Apart from that, this conversion helps maintain green space in this region, rather than building a new structure in the green space to provide new functions. Overall, the conversion of both heritage buildings encouraged the improvement of neighbourhood sustainability.

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THE ROLE OF ABIKOESNO TJOKROSOEJOSO IN SHAPING EARLY ARCHITECTURAL PRACTICE IN THE DUTCH EAST INDIES

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Abstract
The expansion of infrastructure, architecture, and urban development in Dutch India throughout the early 20th century necessitated a significant influx of proficient civil engineers and architects. It requires advanced technological education for the indigenous elite, the Indo people, and the imported Eastern people. Only a limited number of indigenous individuals are enthusiastic about pursuing higher education due to limitations in language, time, and the financial burden of school. Individuals with practical knowledge in construction engineering but lacking a formal higher education degree must get certification in order to fulfil the engineering profession's professional prerequisites. Abikoesno Tjokrosoejoso, the technician who possesses this certificate, might serve as an exemplification of the prevailing circumstances at that period. What inherent abilities does Abikoesno have, and what extrinsic factors allow him to manifest as a character? This study employs historical methods to provide a socio-political and economic framework for understanding the phenomenon's genesis, as reflected in Abikoesno's ideas and articles in his current journals. Based on this analysis, it seems that his family's influence and convenient access to modern knowledge have positioned him in the roles of an architect and politician.

Keywords: *abikoesno tjokrosoejoso; architects profession; certification; colonial architecture; professionalisation.*

INTRODUCTION

The architectural profession in the Dutch East Indies has undergone a gradual transformation, resulting in the creation of various buildings and urban planning that are still in active use at present. The education systems in the profession still retain components from previous educational frameworks, which continue to shape its core in the present Republic of Indonesia.

This study centres on the rise of autodidactic architects who possess extensive expertise and understanding, showcasing the inclusiveness and flexibility of the industry. Additionally, it illuminates the profession's reactions to changing social and economic forces. The project seeks to analyse the current state of architectural education and practice, promoting a reassessment of established methods and approaches in relation to past examples.

Professionals are often regarded with higher respect and admiration in society compared to individuals in regular work or manual labour positions. Comprehending the growth of a profession, encompassing societal, economic, and cultural aspects, requires a critical understanding of the historical environment in which it was formed.

The historical backdrop of professionalisation provides clarity on how institutions, legislation, and professional organisations have influenced the identity and norms of the profession. This highlights the significance of historical investigation in providing

information for current conversations and decisions regarding professional practice, education, ethics, and regulation.

To understand the development of the architectural profession in Indonesia during the Dutch colonial period, it is important to explore the colonial setting, which includes many socio-cultural factors, imperialistic interventions, and the overall vision for colonial society. Gaining a comprehensive understanding of the socio-cultural dynamics, power structures, and aspirations that influenced the profession during this time period offers valuable insights into the intricate nature of colonialism and its lasting impact on the built environment, architectural practices, and societal norms in post-colonial Indonesia.

Priyayi and Indo: Elite Groups in Colonial Indonesia

During the colonial era, Javanese society had a hierarchical structure with elite segments called "*priyayi*" and a common populace. The priyayi class consisted of distinguished individuals, aristocrats, and colonial bureaucrats (Kuntowijoyo, 2016). Under the guidance of Dutch scholar Snouck Hurgronje, the colonial government emphasized the priyayi's adaptability to Western influences (Ricklefs, 2008:195).

The colonial government expected them to preserve the existing dualistic patterns within traditional Javanese society. As society progressed, a broader category of priyayi, known as "*priyayi baru*" or the New Priyayi, emerged, acquiring characteristics through Western education (Sutherland, 1983:1).

The Indo or "*Indisch*" community group was a prevalent feature of colonial society, characterized by mixed ancestry resulting from unions between Dutch colonisers and local inhabitants. Notably, the Indo community in the Dutch East Indies faced distinctive political and social treatment from both the government and society at large. While officially classified as native, they received partial acknowledgment and attention akin to that afforded to individuals of Dutch descent (Bosma & Raben, 2008).

THE LEGISLATIVE REFORMS

Prior to its formal proclamation in the Royal Speech on September 17, 1901, the concept of establishing a colony had already been developed, with legislative preparations ongoing. During the nineteenth century, the Dutch state passed key legislation that fundamentally altered its relations with its colonial possessions. Key laws and regulations included the *Burgerlijk Wetboek of 1847*, which governed civil law; the *Regeringsreglement of 1854*, which established administrative norms; and the *Drukpersreglement of 1856*, which ensured press freedom for printed works.

Burgerlijke Wetboek 1847

Industrialisation within the colonies intricately linked the notion of labour power regulation. In this regard, the Netherlands lagged behind countries like England, where industrialization had already significantly influenced the conditions of workers, including those in its colonies, such as British India, leading to protests among labourers.

Subsequently, in the Dutch East Indies, the publication of the Burgerlijk Wetboek voor Indonesië (BW) was significant. This legal framework was based on Staatblad No. 23 of 1847 and aimed to regulate labor relations among various citizen groups, including those of European, native, and foreign Eastern (Chinese) descent.

With the enactment of this law, workers gained the ability to establish various organisations, thereby facilitating collective action and the representation of their interests. Conversely, the government, empowered by provisions in the law, could monitor and track developments and movements within the labor force through the press.

Regeringsreglement 1854

The Regeringsreglement 1854 (RR 1854), implemented on September 2, 1854, served as a legislative instrument in the Dutch East Indies, aligning with the principles set forth in the 1848 Constitution of the Netherlands. In 1854, RR embraced five core political-economic principles, drawing inspiration from the ideals of the French Revolution. These principles include the recognition of private property rights, individual freedom, unrestricted trade, the abolition of coerced labour, and the establishment of a just legal system (Furnivall, 2009:62). The statute classified social groups into three distinct categories: Europeans and their descendants, indigenous individuals, and foreign Eastern individuals. In the 1860s, Indo people were classified as European because they exhibited European characteristics (Van der Veur, 1954:125).

The 1892 Law on Dutch citizenship contained a provision that conferred Dutch citizenship to children born to a father who possessed Dutch citizenship at the moment of their birth, as long as they were legitimate, legally acknowledged, or paternally recognised. This advancement allowed individuals of mixed European ancestry, usually known as Indo/Indisch people, as well as indigenous folks, to be eligible for recruitment into the colonial administration, provided that they demonstrated a high degree of fluency in the Dutch language.

Although faced with difficulties in achieving fluency in Dutch, the Dutch school system was established for native children. The enhancement of education for indigenous individuals in the early 20th century expedited the 'Indianisation' process, since numerous offspring of native and foreign aristocrats effectively fulfilled the prerequisites to join the colonial bureaucracy. This educational reform enabled the native gentry or priyayis to have easier access to educational possibilities in the Western style.

Drukpresreglement 1856

This law represented an evolution of the 1854 Regulations, which notably permitted colonists to print and circulate publications, including those intended for native readership. At the time of the implementation of this press regulation, the number of Dutch-language newspapers in the Dutch East Indies remained relatively limited. Examples included *Java Bode*, *Oostpos*t, *Soerabaijasch Nieuws en Advertisementblad*, *Semarangsche Courant*, and *Semarangsche Advertisementblad*. Additionally, there were only two periodicals: *Opwekker*, a missionary journal, and *Indisch Schoolblad* (Adam, 1995: 15).

By the end of the 19th century, the number of journals, magazines, and advertising newspapers (advertising leaflets) had expanded to more than 30 in the Dutch East Indies. During this period, several building engineering journals and printed publications were also circulated in the region. Notably, there were architecture-related journals published in Batavia (now Jakarta City), such as *Nederlandsch-Indie Huis Oud en Nieuw* and *Nederlandsch-Indie Oud en Nieuw* (Stiebbe 1921: p. 459-469). These magazines were popular illustrated publications aimed at promoting a new and modern lifestyle in contrast to the old and traditional housing practices (Mahatmanto, 2015).

THE BIOGRAPHY OF ABIKOESNO TJOKROSOEJOSO

Analysing an architect's biography provides a strategic framework for understanding and interpreting architecture from their time period. Examining the architect's experiences as gained from historical sources might provide insights into the dominant architectural ethos and the desired interpretation of architecture. As a result, this piece will focus on the life of a native architect, Abikoesno Tjokrosoejoso.

Abikoesno's life history includes the process of character development in his family, the educational teachings he got in elementary and secondary school, and the practical experiences he earned via future career endeavours. By delving into these aspects of Abikoesno's life, we want to acquire a better understanding of his contributions to architecture and how his experiences affected his view on the built world.

The Family and His Early Education

Abikoesno Tjokrosoejoso was born on June 15, 1897, in Dolopo, South Madiun. He was the eighth child of retired *Wedana* (Regent) parents named R.M. Tjokroamiseno in Kanigara (Pekerjaan Umum, 1990). However, other sources suggest that Abikoesno was born in 1896 in Magetan (Djawa Baroe, 2604: 27).

Abikoesno Tjokrosoejoso, a prominent Indonesian architect, graduated from the Secondary Technical School in Kediri and pursued further education at the Koningin Emma School in Surabaya. He then enrolled in an architectural course organized by BOW (*Burgerlijke Opernbare Werken,* Public Works Department), honing his skills in architectural design and theory. After completing his coursework, Abikoesno gained practical experience by working in the Semarang municipality office and eventually founded an architectural firm in Bandung, which later relocated to Jakarta.

Abikoesno's transition to Semarang and Bandung provided him with valuable exposure to the architectural profession, distinguishing him from many other architects of his time. He served as a translator for the journal IBT-Locale Techniek, a publication jointly produced by members of the professional associations *Vereeniging van Bouwkundigen voor Nederlandsch-Indië* (VvBNI) and *Nederlandsch-Indie Architectuur Kring* (NIAK).

Upon his relocation to Bandung, Abikoesno's presence helped elevate awareness regarding the significance of urban planning, particularly in advocating for the interests of indigenous *kampungs*. His efforts aligned with the government and city council's objectives to organize these villages in a manner conducive to their development and well-being.

At the age of 19, Abikoesno Tjokrosoejoso played an active role in political movements by spearheading the formation of a drivers' association in Surabaya. In 1921, he moved to Semarang and joined the office of architect Ir. Thomas Karsten. On February 7, 1925, he obtained his qualification as an architect after successfully passing examinations administered by BOW, solidifying his position within the architectural community.

De Architects-examens.

De uitslag van de door het departement van B. O. W. afgenomen architects examens, welke Zaterdag j.l. beëindigd werden, laten we hieronder volgen:

Vijf candidaten hadden zich opgegeven voor architect voor de landsgebouwen. Zij slaagden allen. Het zijn de heeren A van Doorn; J. M. Wingelaar; R. Abikoesno; A. A. Rozenberg en J. Mulschlegel.

Van de 22 candidaten voor architect bij den Waterstaat werden er elf afgewezen, terwijl twee hunner zich terugtrokken.

De negen anderen, die slaagden, zijn de heeren C. P. de Graaff; J. Dingemanse; P J Visser; W. A. Schneider; F. J. Foudraine; E. E. Berretty; J. I. Koreman; F. J. Martens en F. van Ruyssevelt.

Met uitzondering van R. Abikoesno, die in dienst is bij de gewestelijke Werken te Kediri, behoorden alle candidaten tot het B. O. W.-corps.

Figure 1. Abikoesno Tjokrosoejoso and News Regarding His Graduation as a BOW Architect (Algemeen Handelsblad voor Nederlandsch-Inie, Semarang 9 Februari 1925)

Nationalism and Architectural Practices

Abikoesno Tjokrosoejoso's involvement in political activities continued to evolve. In 1934, he began participating in Jong Java, a prominent political organization, and in the same year, he ascended to the position of chairman of PSII. Additionally, he played a pivotal role in the founding of the Indonesian Political Association (*Gabungan Politik Indonesia,* G.A.P.I.) during this period.

During the Japanese occupation, Abikoesno resided in Jakarta and served in a significant capacity as *Djawa Hokokai chuo Honbu Somukyokucho.* His involvement in various political organizations and leadership positions underscored his commitment to the Indonesian independence movement and his enduring legacy in Indonesian political history.

During Indonesia's early years of independence, Abikoesno Tjokrosoejoso held significant governmental positions, including Minister of Public Works in the Presidential cabinet from August 19, 1945, to November 14, 1945, and Minister of Transportation in Ali Sastromijojo I's cabinet from July 30, 1953, to September 29, 1953. His contributions were instrumental in shaping and managing crucial aspects of infrastructure and transportation development in the country, laying the groundwork for the modernization and expansion of Indonesia's infrastructure networks, including roads, bridges, ports, and railways.

One notable achievement was the opening of key transportation routes, including the railway line connecting Jakarta to the Merak seaport. This strategic railway connection facilitated the efficient movement of goods and passengers between the capital city and the

important seaport, thereby boosting trade and commerce activities. Abikoesno's transportation reform program laid the groundwork for modernizing and improving Indonesia's transportation infrastructure, aiming to enhance the efficiency, reliability, and safety of transportation systems across the archipelago.

ABIKOESNO'S PUBLICATIONS AND ARCHITECTURAL WORKS

Abikoesno Tjokrosoejoso's publications and architectural works offer valuable insights into his understanding of the architectural profession and his contributions to the field. His writings and translated articles provide a comprehensive picture of his architectural philosophy, design principles, and professional ethos. His publications cover various architectural topics, including modern architecture, urban planning, and indigenous architecture. His translations of architectural articles from other sources shed light on his engagement with broader architectural discourse and his efforts to disseminate architectural knowledge within the Indonesian context.

Abikoesno's translation approach went beyond mere linguistic conversion; he also engaged in summarizing and extracting crucial points to ensure that readers could grasp the essence of the original content. This approach demonstrated his commitment to making architectural knowledge accessible and understandable to a wider audience, fostering greater understanding and appreciation of architectural concepts and principles within the Indonesian context.

Abikoesno's translations served as educational tools, helping to bridge the gap between international architectural developments and local architectural practices. By presenting information in a format that resonated with readers, he facilitated the assimilation of new ideas and perspectives, fostering a more vibrant and informed architectural community in Indonesia. His translation approach underscored his role not only as a linguistic mediator but also as a facilitator of architectural knowledge exchange, ultimately enriching the architectural landscape of Indonesia.

On Modern Architecture

Abikoesno Tjokrosoejoso's pioneering contribution to architectural discourse in the Dutch East Indies is exemplified by his article titled "*Iets over Moderne Architectuur*," published in the IBT journal on December 31, 1921. This article marked the first instance of a native writer discussing modern architecture in the publication. However, the article sparked a polemic after receiving a response from R. Schlecter, a BOW architect working in Tandjoeng Pandan, Billiton (now Belitung). The polemic revolved around the conceptualisation of modern architecture in the Dutch East Indie, particularly as articulated by the renowned Dutch architect HP Berlage.

Both Abikoesno and Schlecter assessed Berlage's ideas as foundational to the understanding of modern architecture, emphasising its directional aspects and explanatory power. The debate reflected the tensions between adhering to Western architectural paradigms and adapting architectural practices to suit local conditions and contexts. Abikoesno Tjokrosoejoso, expressed dissatisfaction with the lack of public recognition for certain architectural works in the Dutch East Indies. He questioned why buildings like the Jaarbeurs

building in Bandung (Figure 1) and the expansion of the Bandung City Government Office did not receive the acclaim they believed they deserved among Dutch East Indies architects. Abikoesno argued that the works of Schoemaker and AIA exemplified modern architecture, based on his interpretation of HP Berlage's views on architectural style.

He also drew upon the perspectives of RLA Schoemaker and Frank Lloyd Wright regarding the art of form (*kunstvorm*), which he viewed as integral to understanding modern architecture's essence.

(Source: Dullemen, 2010: p.80)

Figure 2. Jaarbeurs Main Building, Bandung, 1920 by Charles Prosper Wolff Schoemaker

Abikoesno evaluated the buildings mentioned above as exemplary instances of architectural art that encapsulated the essence of their era. He contended that these buildings demonstrated a departure from the preoccupation with ornamental embellishments, instead prioritising the design of spatial enclosure. Abikoesno asserted that the architects of these buildings had embraced modern characteristics by eschewing decorative elements and focusing on creating functional and aesthetically pleasing spaces. To bolster his viewpoint on the modern characteristics of these buildings, Abikoesno cited HP Berlage's perspective. Berlage's views provided additional support for Abikoesno's argument regarding the significance of architectural simplicity and functionality in reflecting the spirit of the times.

By quoting Berlage, Abikoesno underscored the alignment of his assessment with established architectural principles and philosophies, thereby reinforcing the validity of his interpretation of modern architecture (Tjokrosoejoso, 1921:477). Abikoesno lamented the loss of this style within contemporary artistic practices and advocated for a return to its essence. He criticised the proliferation of false aesthetics that prioritised superficial appearances over deeper meanings and artistic integrity. Instead, he called for a renewed focus on capturing the essence of art, emphasising substance over superficiality.

This perspective reflects Abikoesno's commitment to preserving the authenticity and integrity of artistic expression, urging artists and creators to prioritise sincerity and depth in their work rather than succumbing to trends or superficialities. From Abikoesno's perspective, there is a pressing need to rid architecture of redundancies and extra elements. He advocates for a radical approach where all unnecessary aspects are eliminated without hesitation.

Abikoesno perceives contemporary architecture as fragmented and compromised, lacking the purity and integrity required to achieve lofty aspirations. He contends that aiming for excellence in architecture necessitates a steadfast commitment to uncompromising standards. Surrendering to mediocrity or allowing things to proceed without intervention is unacceptable, in his view. Abikoesno's stance reflects a call for architects to uphold rigorous principles and strive for excellence in every aspect of their craft without compromise or concession.

Abikoesno, a prominent architect in the early 20th century, emphasised the importance of simplicity and integrity in modern architectural practice. Drawing on the perspectives of HP Berlage, Abikoesno emphasised the significance of honesty and straightforwardness in architectural design. These principles likely echoed Abikoesno's belief in the necessity of prioritising authenticity and sincerity in architectural expression. Abikoesno's architectural views, influenced by Berlage's thoughts, resonated with the principles of *Neue Sachlichkeit* in Germany or *Nieuwe Zakelijkheid* in the Dutch. These architectural movements emphasised functionalism, simplicity, and honesty in design, rejecting ornamentation and embracing straightforwardness and practicality.

The concept of Neue Sachlichkeit was coined earlier by Hermann Muthesius in 1903 (Frampton, 1992:130). Nieuwe Zakelijkheid emerged in the early 20th century, particularly in Germany, as a response to the need for cost-effective housing construction. This architectural movement prioritised functionalism and efficiency, advocating for buildings that served their purpose without unnecessary adornments or embellishments. Architects associated with the New Objectivity movement aimed to achieve clarity and honesty in their designs, emphasising the essential form of the building mass while eschewing superfluous elements.

The economic and social conditions of the time, including the aftermath of World War I and the need for affordable housing solutions, fueled the rise of New Objectivity. Architects such as Walter Gropius, Ludwig Mies van der Rohe, and Erich Mendelsohn embraced these principles, leading to the development of functionalist architecture characterised by clean lines, geometric shapes, and rational planning.

However, critics like Schlecter criticised Abikoesno for excessively relying on the ideas of renowned foreign architects, which imposed Western architectural principles on the context of the Dutch East Indies without adequately considering the architectural heritage and principles inherent to the region. Schlecter argued that Abikoesno failed to recognise how principles such as honesty, straightforwardness, and simplicity could be found in local architecture within the Dutch East Indies itself. Schlecter questioned whether the architectural spirit of the Dutch East Indies' society was adequately represented in the architectural discourse dominated by imported ideas. He contended that at that time, Dutch East Indies society had not yet developed a distinct architectural style in Berlage's sense, suggesting a gap between imported architectural principles and the architectural expression of the local context.

In response to Schlecter's criticism, the editor who acted as the moderator of their debate, labour the evolutionary nature of architectural style and the quest for individuality by contemporary architects. Modern architects seek to express their individuality within the

framework of established architectural principles and concepts, and studying their contributions and innovations is essential to understanding the works of modern architects. Furthermore, the editor contested the notion of attributing a distinct style to indigenous architecture, arguing that it did not possess a unified architectural style. Indigenous architecture was deemed picturesque but not characterised by a unified stylistic identity.

In response to Schlecter's criticism of indigenous architecture, Abikoesno acknowledged that he was in a learning process and expressed interest in studying HP Berlage's ideas on modern architecture. He likely aimed to refute the notion that indigenous houses do not have the meaning of style at all and emphasised its aesthetic qualities and potential architectural value beyond mere visual appeal. Abikoesno may have argued that indigenous architectural forms, while distinct from Western architectural styles, could still embody meaningful design principles and cultural significance deserving of recognition and study.

Schlecter's final reply provided a concluding perspective on the debate surrounding the existence of style in indigenous architecture. He likely emphasised that indigenous architecture should be appreciated primarily for its visual beauty rather than analysed through the lens of architectural style. By closing the polemic in this manner, Schlecter may have sought to reaffirm his position that indigenous architectural forms should be understood and valued on their own terms, separate from Western architectural conventions.

Schlecter's final perspective reflects optimism regarding indigenous architecture, suggesting that while indigenous architectural forms may lack traditional stylistic coherence, they have the potential to evolve and integrate with modern architectural principles. His mention of "developing to a higher level with rationality and new building science" indicates a belief in the capacity of indigenous architectural traditions to adapt and incorporate modern advancements in architectural theory and technology.

This optimistic view implies that indigenous architecture can undergo a transformative process, enhancing its functionality and architectural quality through the integration of rational design principles and advancements in building science. By embracing modern architectural concepts and technologies, indigenous architecture can adapt to contemporary needs while preserving its cultural heritage. In summary, Schlecter's final viewpoint underscores the belief that indigenous architecture can grow and thrive within the framework of modern architectural discourse, contributing to a dynamic and evolving architectural landscape. It suggests that indigenous architecture has the potential for development and refinement, incorporating rational design principles and scientific knowledge to improve functionality, sustainability, and overall architectural quality. By embracing modern innovations and approaches, indigenous architecture can evolve into a more sophisticated and relevant architectural expression that reflects both cultural heritage and contemporary design sensibilities.

This polemic serves to illuminate discussions surrounding the modernization of indigenous architecture, emphasising the importance of adapting architectural practices to local contexts rather than imposing foreign architectural styles. Both Abikoesno and Schlechter concur on the rejection of transplanting Western architectural norms to tropical regions. They both emphasise the need to preserve the essence of indigenous architectural traditions while incorporating modern principles and technologies. It entails revitalising

traditional architectural cores within indigenous structures to meet the demands of evolving societal needs and intellectual progress.

In essence, the polemic underscores a shared vision for the evolution of indigenous architecture, emphasising a fusion of tradition and modernity that respects local identity and responds to contemporary challenges. It highlights the imperative for architectural practices to be rooted in cultural contexts and responsive to local climates and conditions rather than imposing external standards.

The Public Housing Improvement Program

Concerning urban development and the promotion of urban planning as a shared concern, it's notable that the *Sociaal-Technisch Vereeniging* or the Dutch East Indies Society for Town Planning (STV) organised two People's Housing Congresses in Semarang in 1922 and 1925. This congress has been crucial in capturing the perspectives of stakeholders on the reorganisation of urban kampongs. Abikoesno attended both meetings and notably, he aggressively articulated his sharp insights during the second congress in 1925.

The following paragraphs are based on reports written by the head of the STV ir. Ruckert (1923;1926). From this report, it appears that there is an incentive for architects not only to think of the building but also its impact on the urban problems surrounding it.

The STV's emphasis on developing the architectural profession centred on linking housing concerns to a broader political agenda aimed at highlighting housing challenges within the colonies. This strategic approach sought to garner the attention of both the government and architects towards addressing housing issues. The discussion at the congress was particularly significant against the backdrop of decentralisation, as cities and their respective city councils required expertise in urban design and management. It underscores the recognition of the pivotal role of architectural knowledge and urban planning in addressing the evolving needs of colonial cities.

The congresses orchestrated by the STV served as platforms for disseminating information about the decentralisation law, with a particular focus on addressing the socio-technical aspects of housing challenges. These events encompassed a range of activities, including exhibitions, discussions, the exchange of ideas, and field visits. The inaugural congress on public housing convened from April 14th to 16th, 1922, in Semarang. Through such gatherings, stakeholders engaged in constructive dialogue and sought to deepen their understanding of the complex issues surrounding housing and urban development, thereby contributing to more informed policymaking and practical solutions.

The First Congress of People's Housing 1922

The inaugural congress of the STV was attended by delegates from various government services, prestigious institutions, and military representatives. The congress focused on addressing housing and urban development challenges comprehensively.

The congress covers topics such as environmental health, urban planning, financing for social and political endeavours, architecture, and engineering. The committee invited experts

to share their insights and expertise on the various facets of urban development and societal welfare. The selection process for presenters was meticulous, taking into account several key considerations. The organising committee intentionally included Maclaine Pont's proposal, which deviated from the congress's overarching theme, due to its relevance and importance to the participants.

During the first day of the congress, Frumau and Gerhard Jobst delivered an introductory exploration of urban challenges, particularly from an architectural standpoint. Participants were encouraged to explore the exhibition and engage in subsequent question-and-answer sessions. Later, participants embarked on a city tour alongside their companions, further enriching their understanding of urban landscapes and contextualising discussions from earlier sessions.

On the second day, a field inspection was conducted to assess the condition of indigenous houses, distinguishing between those deemed healthy and those classified as unhealthy. After completion of the field inspection, participants reconvened at the congress venue to attend sessions guided by R. Heida and J.J. van Lonkhuijsen.

On the third day, the outcomes of the discussions based on the presentations from the preceding two days were reviewed.

Maclaine Pont's presentation garnered significant attention due to his innovative approach to addressing the challenge of providing housing for indigenous populations. He emphasised the importance of preserving the building traditions of Javanese society while introducing enhancements to construction techniques that residents could undertake themselves at minimal expense. Maclaine Pont's goal was to demonstrate that ensuring that Javanese houses meet health standards should not solely rely on government regulations but should also be achieved through community initiatives, as has been customary in traditional practices. He showcased several innovative solutions, such as utilising woven bamboo for constructing house walls, which were then coated with mortar to ensure durability and solidity. These walls were designed to be modular in size, allowing for easy replacement or adaptation based on the community's needs.

Maclaine Pont's congress presentation focused on empowering communities to improve their housing conditions using traditional methods and modern techniques. Architects play a crucial role in this process by providing education, design guidance, collaboration, innovation, and advocacy. They can educate community members on innovative construction techniques and materials, provide design guidance tailored to the local context, facilitate collaboration between community members, government agencies, and other stakeholders involved in housing development, conduct research and innovation initiatives, and advocate for policies and regulations that support sustainable and inclusive housing development.

J.J. van Lonkhuijzen and Ir. J.T. Bethe emphasised several key recommendations for improving the environmental health of native housing environments in the Dutch East Indies. These include 1. conducting comprehensive assessments of native housing environments to identify existing challenges and areas for improvement, 2. building roads to improve access to native housing areas, 3. controlling wastewater channels, 4. providing clean water, and implementing measures for waste management, sanitation, and public hygiene.

The recommendations for improving the environmental health of native housing environments include designing houses to be cool and dry with good ventilation, maintaining tidiness and cleanliness in the city, prompt removal and disposal of human waste products, installing sewerage systems, and establishing a clean water pipe network. Urban planners, architects, and policymakers can integrate these recommendations into their city planning strategies, incorporating green spaces and landscaping to promote natural ventilation and cooling in residential areas.

Architects play a crucial role in designing buildings and housing structures that align with environmental health principles, such as adequate ventilation, natural lighting, and sustainable materials. They can collaborate with urban planners to incorporate these features into larger-scale urban development projects and develop building codes and standards that prioritise environmental health considerations in housing construction. Policymakers are responsible for enacting regulations and policies that support the implementation of these recommendations, developing building codes and standards that prioritise environmental health considerations in housing construction, and allocating funding for the development of essential infrastructure, such as sewerage systems and clean water networks, in native housing areas.

By working together, urban planners, architects, and policymakers can contribute to the creation of healthier and more sustainable communities where residents can thrive. This collaborative approach is essential for addressing the complex challenges associated with improving environmental health in native housing environments. Overall, architects play a crucial role in empowering communities to improve their housing conditions and creating sustainable and resilient housing solutions that meet the needs of diverse communities.

Ir. Bethe's recommendation emphasises the importance of prioritising clean water supplies as a fundamental aspect of improving living conditions in native housing areas. By focusing on providing clean water before addressing sewage systems, cities can address immediate health concerns and lay the groundwork for more comprehensive infrastructure development.

This approach can be beneficial for several reasons: 1. Immediate Health Impact: Access to clean water is essential for basic hygiene, cooking, and sanitation, which can immediately improve the health and well-being of residents, reducing the risk of waterborne diseases and improving overall quality of life. 2. Incremental Infrastructure Development: Installing clean water supplies can be implemented relatively quickly compared to developing comprehensive sewage systems, which require extensive planning, construction, and investment. By starting with clean water infrastructure, cities can make tangible improvements to residents' lives while laying the groundwork for future development. 3. Community Engagement and Support: Prioritising clean water supplies demonstrates a commitment to addressing immediate needs and improving living conditions in native housing areas, garnering support from the community and stakeholders, and fostering trust and cooperation in future development initiatives. 4. Long-Term Planning: While clean water supplies may be prioritised initially, this approach acknowledges the need for phased and strategic infrastructure development, allowing cities to plan for the long term while addressing immediate priorities.

In summary, ir. Bethe's recommendation underscores the significance of addressing the most pressing needs of residents in native housing areas while also planning for comprehensive infrastructure development. By prioritising clean water supplies, cities can make meaningful improvements to residents' lives while laying the foundation for future growth and development.

F.C. Frumau's explanation highlights the historical context and evolution of urban planning in European cities, emphasising the growing recognition of the need for government intervention to address urban development challenges. The Congress of German Engineers and Architects in 1874 catalysed the establishment of urban planning schools in several German cities, providing education and training for professionals in the field. Important figures such as Ir. Stübben, Professor Henrici, and Camillo Sitte underscore the growing recognition of urban planning as a discipline in Europe during the late 19th and early 20th centuries.

However, challenges remained in translating this awareness into effective legislation and planning practices. Frumau's observations highlight the importance of urban development and housing improvement initiatives during this period, encompassing both European and native populations. He emphasises the need for comprehensive refurbishment in European cities in the Dutch East Indies, as well as traditional native housing. Hygienic improvements are also a key aspect of housing renovation efforts, reflecting a growing awareness of the importance of sanitation and cleanliness in promoting public health and well-being.

Frumau's recommendations highlight the importance of strategic planning and regulatory frameworks in driving effective urban development and housing improvement initiatives. He recommends prioritising initiatives in alignment with comprehensive plans for city expansion, building arrangements, housing laws, and centralised information services.

Building regulations serve as instrumental tools for translating urban development plans and housing policies into tangible outcomes on the ground, ensuring compliance with established standards and guidelines. Frumau advocates for the establishment of a centralised agency responsible for overseeing public health programmes and urban development initiatives. This agency would play a pivotal role in developing general regulations, providing technical guidance, and monitoring the implementation of policies and standards.

By centralising these functions, the government can streamline decision-making processes and enhance accountability in urban governance. The recommendations and guidelines formulated during the congress hold significant potential for enhancing the provision of public housing and promoting sustainable urban development in the Dutch East Indies. By transmitting these suggestions to the Governor General and institutionalising them as technical guidelines, authorities can pave the way for positive change and improvement in future housing initiatives.

The implementation of these guidelines can lead to tangible benefits such as improved housing standards, enhanced urban planning, regulatory compliance, capacity-building and governance, and public health and well-being. Access to clean water, proper sanitation facilities, and adequate ventilation can help prevent the spread of diseases and enhance the quality of life in urban areas. Overall, the transmission of congressional recommendations to

the Governor General and their subsequent adoption as technical guidelines signify a proactive approach towards addressing housing challenges and promoting sustainable urban development. By translating these recommendations into actionable policies and practices, the government can make significant strides towards achieving its goals of equitable housing provision and inclusive urban growth.

The Second Congress of People's Housing, 1925

The second public housing congress in Semarang in August 1925 saw a significant increase in the participation of native representatives, indicating a growing awareness and engagement of indigenous communities in addressing housing issues and advocating for improved living conditions. The presence of a more diverse range of delegates at this congress reflects a concerted effort to ensure broader representation and inclusivity in discussions related to public housing policy and urban development.

The significant increase in the number of native participants, comprising more than half of the total attendees, highlights the importance of incorporating indigenous perspectives and priorities into the discourse on housing solutions. By actively involving native communities in the congress proceedings, policymakers and planners could gain valuable insights into the specific needs and challenges faced by these populations, thereby facilitating more targeted and effective interventions. Moreover, the greater diversity among the delegates suggests a broader coalition of stakeholders coming together to address housing issues, transcending traditional boundaries, and fostering collaboration across different sectors and interest groups.

This inclusive approach not only enriches the dialogue but also strengthens the collective resolve to find equitable and sustainable solutions to housing challenges. The use of both Dutch and Malay languages during the congress reflects a conscious effort to ensure effective communication and inclusivity among diverse participants. The provision of translation services for presentations delivered in Malay, while not offering the same for presentations in Dutch, suggests a recognition of the linguistic diversity among attendees and a commitment to accommodating the needs of native speakers.

However, the lack of translation for presentations in Dutch may indicate a presumption that Dutch was widely understood among attendees or that those who primarily spoke Malay were expected to comprehend Dutch presentations with the assistance of translation services. The availability of the Semarang Regency Hall (*pendapa*) as the venue for the congress was fortunate for the organising committee, as it provided a suitable space for the event in the absence of the Regent of Semarang, who was away on holiday in Europe. The utilisation of the Semarang Regency Hall and the exhibition of sketches, photos, and architectural models during the congress contributed to the exchange of ideas and knowledge about native housing among participants.

The provision of low-cost housing for natives emerged as a significant topic of discussion during the second congress. Mayor ir. D. de Iongh's presentation on the involvement of afdeelingbanken (regional branch banks) in providing housing loans ignited a heated debate among participants. Key points of discussion may have included:

1. Government Support: Participants may have discussed the extent to which government policies and initiatives could support the financing of low-cost housing projects. It could involve exploring subsidies, incentives, or regulatory frameworks aimed at encouraging private investment in affordable housing.
2. Private Sector Participation: The role of the private sector, including regional branch banks, in financing housing projects may have been a focal point of debate. Participants may have assessed the willingness of private entities to invest in low-cost housing developments and the potential benefits and challenges associated with such investments. 4. Loan Accessibility: Ensuring accessibility to housing loans for native communities might have been a central concern. Discussions may have revolved around designing loan programmes tailored to the needs and financial capacities of native populations, as well as mechanisms to streamline the loan application and approval processes.

In general, Mayor Ir. D. de Iongh's presentation ignited the debate and created an opportunity for participants to share their viewpoints, recognise difficulties, and investigate possible resolutions regarding the intricate matter of funding affordable housing for indigenous communities. The government's approach of offering rental accommodations to indigenous residents in Semarang was deliberated over during a congress, with the objective of meeting housing demands while taking into account financial limitations.

Ir. Maclaine Pont supported the idea of increasing housing credit for urban residents, while also highlighting the need to carefully analyse how this concept may be applied in rural areas. He said that policymakers and stakeholders may create more inclusive and successful methods for enhancing access to affordable housing in varied communities by customising housing policies and initiatives to the unique requirements and circumstances of different locations. Maclaine Pont's viewpoint emphasises the distinct socio-economic circumstances that were widespread in rural Java during that period, specifically with the building procedures of houses. In rural regions, the requirement for funds during the construction phase is modest, as the majority of expenses are related to procuring materials rather than manpower. Hence, the allocation of capital loans does not provide substantial difficulties, as seen by the seamless execution of projects like the Mauk (Tangerang) renovation, which was accomplished within a three-year repayment timeframe.

Maclaine Pont's suggestion underscores the significance of harmonising financial interventions with preexisting socio-cultural practices and economic realities in rural communities. He suggests that the primary function of the People's Credit System should be to facilitate credit for the acquisition of materials, in accordance with the longstanding Javanese village tradition of collaboration. This approach leverages existing community networks and practices and ensures that financial interventions are tailored to meet the specific needs and dynamics of rural areas. Maclaine Pont's emphasis on the preservation of the traditional Javanese splice tradition underscores his commitment to maintaining the cultural and social fabric of Javanese society. He lamented the deviation from traditional building methods, which he believed had led to the erosion of social relations within Javanese communities. He viewed Javanese society as one rooted in communal values, where collective well-being and cooperation took precedence over individual interests.

Moehammad Hoesni Thamrin's critique underscores the fundamental challenge of aligning banking institutions with the social objectives of public housing provision. He questioned the efficacy of relying on regional banks as the primary source of credit for public housing, pointing out that their profit-driven mindset and lack of inherent interest in housing initiatives could hinder their effectiveness in providing meaningful assistance. Thamrin advocated for a paradigm shift in approach, suggesting that meaningful assistance for public housing could only be achieved by removing the profit motive from the equation. Abikoesno's perspective on the Dutch East Indies' housing policies is based on his critique of the *Afdeelingsbank* as the primary source of credit for housing repairs and the lack of meaningful support from state banks. He argues that state banks in the Dutch East Indies have failed to adequately support public housing efforts, suggesting a systemic failure to address the housing needs of indigenous populations.

Abikoesno's criticism underscores broader concerns about social inequality and disparities in colonial governance, highlighting the need for more equitable policies and initiatives to address the housing needs of indigenous populations.

Abikoesno advocates for a different approach to improving public housing, emphasising the importance of embracing the principles underlying the *Woningwet* (Housing Act) of 1901. He highlights the stark contrast between the provision of credit for housing in the Dutch East Indies compared to the Netherlands, where the government was actively engaged in addressing public housing needs and recognised its responsibility in this regard. By drawing attention to the Housing Act of 1901, Abikoesno suggests that the Dutch East Indies should adopt similar legislative frameworks and governmental initiatives to address housing issues. He emphasised the need for the government to take a more proactive role in providing support and resources for public housing projects rather than relying solely on bank loans.

Abikoesno's perspective underscores the importance of governmental intervention and policy frameworks in addressing housing challenges, particularly in colonial contexts where indigenous populations may face systemic inequalities and barriers to accessing adequate housing. His advocacy for aligning housing policies in the Dutch East Indies with those in the Netherlands reflects a broader call for equity and social justice in housing provision. The Dutch government significantly intervened with the Woningwet of 1901 to address the pressing urban challenges Dutch society faced in the late 19th century. It aimed to improve the quality of housing stock and promote better living standards for urban residents by introducing regulations and standards for the construction and maintenance of dwellings, emphasising aspects such as ventilation, sanitation, and living space per capita. The law signalled a shift toward more proactive governance in addressing social and public health challenges arising from rapid urbanization and industrialization.

The Woningwet was a response to the pressing need to address substandard housing conditions and ensure the construction of safe and habitable dwellings for urban residents. To ensure compliance with government-established building regulations and standards, the Woningwet required individuals seeking to build new houses to obtain a building permit from City Hall. The City Council was responsible for reviewing and approving house plans, guaranteeing that the proposed construction adhered to safety and habitability standards. One key provision of the Woningwet was the mandate for the demolition of old housing areas declared uninhabitable. This measure aimed to clear dilapidated and unsafe housing stock,

making way for the development of new, improved housing units. The city government assumed the responsibility of constructing new housing areas to house displaced residents, ensuring they had suitable living spaces for affected individuals and families.

By introducing regulations and oversight mechanisms through the Woningwet, the Dutch government sought to prioritise public health and safety in urban housing development. The implementation of the Woningwet led to the establishment of the municipal building and housing regulations, known as the 'gemeentelijke bouw en woonverordening,' in 1906. These regulations were instrumental in further standardising and enforcing construction practices to ensure compliance with safety and habitability standards. Key provisions included building height restrictions, sanitation standards, and the requirement for every new house to be equipped with a toilet. These regulations played a crucial role in shaping urban development policies and practices, ultimately contributing to the improvement of living conditions for residents across the Netherlands.

During the congress, objections were made by M.H. Thamrin and Abikoesno regarding the government's efforts in public housing. The moderator countered Abikoesno's criticism by stating that the government had indeed taken steps to address public housing challenges. Municipal officials disputed M.H. Thamrin's assertion that the sole goal of the people's credit system was to generate profit, arguing that banking institutions also serve broader societal goals, such as facilitating access to financial resources for housing development.

Maclaine Pont's closing presentation at the end of the congress emphasised the significance of home improvement as a collective endeavour and a grassroots movement. He emphasised the pressing health issues associated with inadequate housing conditions and the importance of collective action to address this critical issue. Maclaine Pont's presentation likely advocated for a holistic approach to home improvement, incorporating elements of community involvement, government support, and resource mobilization. By transforming the endeavour into a people's movement, he aimed to galvanise widespread support and commitment to addressing housing challenges in Java.

THE ARCHITECTURAL WORKS OF ABIKOESNO TJOKROSOEJOSO

Abikoesno's architectural portfolio is rather restricted, although it has significant projects like as the Asy-Syura Mosque (1936) in Cipari, West Java, the Open Park in Prinselaan (1939), and the now-demolished Cinde Market (1958) in Palembang. All of them demonstrated the impact of his past mentors, including Thomas Karsten and Wolff Schoemaker.

The Mosque in Cipari, Garut

The *Asy-Syura* Mosque in Cipari, Garut, holds significant historical and architectural importance as the oldest mosque in the city (Figure 3). Designed by Abikoesno and completed in 1936, it stands as a testament to his architectural vision. It serves as the headquarters of the Garut branch of PSII (*Partai Sarekat Islam Indonesia*), also known as the Indonesian Islamic Union Party. Abikoesno, who assumed the role of General Chair of PSII, succeeded his older brother Tjokroaminoto as the party's chairman.

One distinguishing feature of the Asy-Syura Mosque is its departure from traditional ornamental symbols commonly found in mosques. Instead, Abikoesno opted for a design characterized by pure geometric shapes, reflecting a minimalist aesthetic. This design choice extends to the mosque's interior, which eschews the intricate Middle Eastern ornaments typically associated with mosques. As a result, the Asy-Syura Mosque is often hailed as one of the most unique mosques in Indonesia, standing out for its contemporary architectural style and departure from conventional design motifs.

(Source: radargarut.jabarekspres.com)

Figure 3. The Asy-Syura Mosque, Cipari Garut by Abikoesno, 1936

The mosque's architectural simplicity and emphasis on geometric forms not only contribute to its visual distinctiveness but also symbolize a departure from traditional architectural norms. By embracing a minimalist approach, Abikoesno sought to create a space that embodies modernity while still serving its fundamental purpose as a place of worship. As such, the Asy-Syura Mosque stands as a testament to Abikoesno's innovative architectural vision and his commitment to redefining traditional architectural paradigms.

Prinsenpark Open Park, Batavia

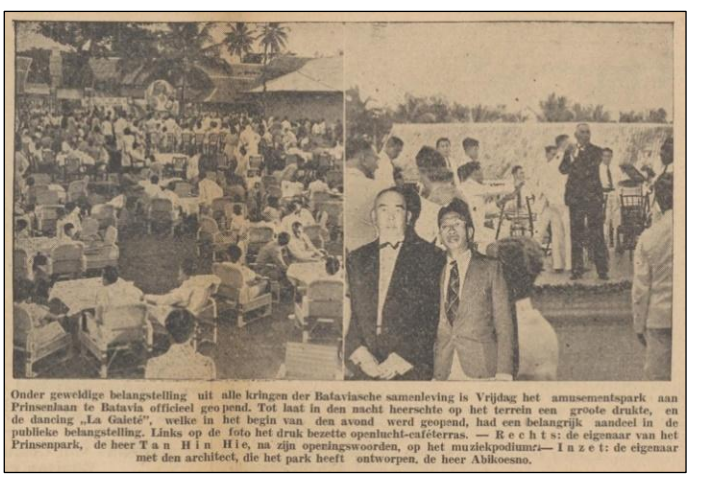
The opening of the open park at *Prinsenlaan* in Batavia was a significant event that garnered widespread interest across various segments of Batavian society. According to the report from *De Locomotief* dated 3rd April 1939, the park's inauguration on Friday was met with enthusiasm and attended by a large crowd (Figure 3). The presence of numerous attendees throughout the day, extending into the late hours of the night, attested to the public's keen interest in the newly opened park.

One notable highlight of the event was the inclusion of the dance "*La Gaiete*," which commenced in the afternoon and played a pivotal role in capturing public attention and engagement. The dance likely contributed to the festive atmosphere of the occasion, adding to the overall excitement surrounding the park's official unveiling.

The report suggests that the park's opening was a well-received and celebrated event, drawing participation from various segments of society. The presence of a diverse crowd

underscores the significance of the park as a communal space that brings people together for leisure, recreation, and social interaction.

Overall, the successful inauguration of the open park at Prinsenlaan in Batavia marked a significant milestone in the city's urban development and provided residents with a new venue for relaxation and enjoyment amidst the bustling urban landscape.



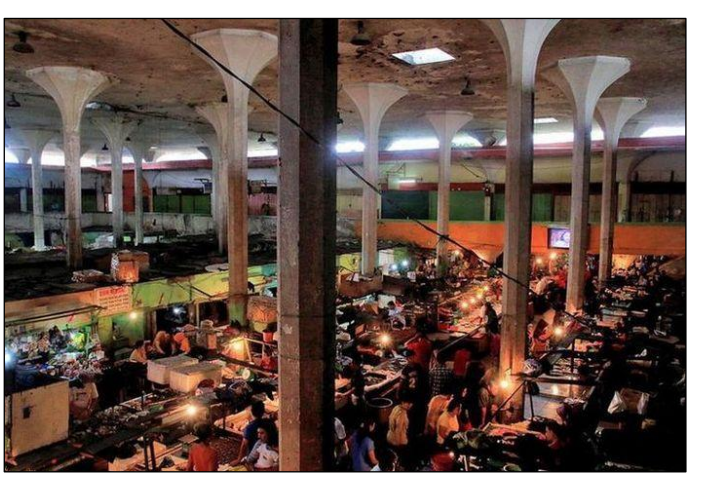
Onder geweldige belangstelling uit alle kringen der Bataviasche samenleving is Vrijdag het amusementspark aan Prinsenlaan te Batavia officieel geopend. Tot laat in den nacht heerschte op het terrein een groote drukte, en de dancing „La Gaieté", welke in het begin van den avond werd geopend, had een belangrijk aandeel in de publieke belangstelling. Links op de foto het druk bezette openlucht-caféterras. — Rechts: de eigenaar van het Prinsenpark, de heer Tan Hin Hie, na zijn openingswoorden, op het muziekpodium.— Inzet: de eigenaar met den architect, die het park heeft ontworpen, de heer Abikoesno.

(Source: De Locomotief, 3rd April 1939)

Figure 4. Abikoesno at The Opening of An Open Park He Designed in Prinsenpark, Batavia

Pasar Cinde, Palembang

Pasar Cinde was built in 1958 during the tenure of Mayor H. M. Ali Hamin, who envisioned a modern market inspired by the architectural style of Pasar Djohar in Semarang, designed by Thomas Karsten. The market was demolished in 2017 due to structural deterioration and safety concerns, and a modern market was constructed in its place. Architecturally, the market clearly adopted the modular mushroom column concept previously implemented by Thomas Karsten in Pasar Djohar Semarang (1938).



(Source: National Geographic.grid.id, October 2017)

Figure 5. Pasar Cinde, Palembang Inspired by Abikoesno's Previous Mentor Thomas Karsten

CONCLUSION

BOW with its professional association of building engineers VvBNI, has been instrumental in promoting inclusivity within the architectural profession by actively recruiting members from indigenous circles. VvBNI has organized courses and examinations tailored to the specific needs of indigenous individuals, providing them with the necessary knowledge, skills, and qualifications to obtain architect attributes within the profession.

Abikoesno Tjokrosoejoso's status as an educated priyayi has played a crucial role in shaping the trajectory of the Indonesian nation-state. His intellectual contributions, advocacy and activism, leadership role in political organizations, and cultural representation in his designs may have contributed to the promotion of Indonesian culture and nationalism through architectural expression.

Abikoesno's life offers valuable insights into the early development of the architectural profession in Indonesia, particularly during the Dutch colonial period. His journey reflects the historical roots and evolving dynamics of the profession within the socio-cultural and political context of the time.

The Emergence of Indigenous Elites: Abikoesno's representation as a priyayi figure highlights the emergence of local social groups with influence and agency within colonial society. The priyayi class, comprising indigenous elites, played a pivotal role in various aspects of colonial governance, including architecture and urban development.

Abikoesno Tjokrosoejoso's journey in the architectural profession during colonial Indonesia reflects the complex interplay of socio-cultural dynamics, legislative reforms, and individual agency. His upbringing in an environment that valued education, and independence greatly influenced his character and approach to learning. The emphasis on education within his family instilled in him a sense of curiosity and a proactive attitude towards acquiring knowledge. This foundation of independent learning contributed to his later achievements and ability to navigate the complexities of the architectural profession.

The presence of freedom of the press during Abikoesno's time allowed natives like him to access a wide range of literature and information, enabling individuals to broaden their perspectives, engage in critical thinking, and participate in intellectual discourse.

Ethical politics, aimed at promoting freedom of expression, association, and access to education, achieved its intended targets by empowering indigenous individuals like Abikoesno to actively participate in intellectual, professional, and societal spheres. Through education, access to information, and the freedom to associate and express themselves, indigenous people were able to assert their presence, contribute to intellectual discourse, and advocate for their rights within the colonial context.

Abikoesno's writings and active engagement in architectural discourse offer valuable insights into the intellectual and professional landscape of the colonial period. His critiques of Western architectural imposition and advocacy for indigenous architectural development highlight the tensions and complexities inherent in architectural practice during this time. His designs, such as the Prinsenpark open park in Batavia, the Cipari Mosque, and Pasar Cinde

exemplify his commitment to modern architectural concepts while staying true to indigenous sensibilities. His approach to mosque design serves as a testament to his belief in the relevance of indigenous architectural traditions in the contemporary context.

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COMMUNITY PERCEPTION REGARDING THE UTILIZATION OF BAMBOO AS A SUSTAINABLE BUILDING MATERIAL

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Abstract
Bamboo, recognized as a sustainable building material with a history of utilization, faces limited adoption in residential construction due to the prevailing perception of its poor durability. Since the emergence of global warming concerns, the discourse surrounding bamboo as a building material has garnered substantial attention among architectural practitioners and academics, leading to a notable increase in bamboo construction. However, public misunderstandings about bamboo materials continue to occur, thus preventing the widespread use of bamboo in residential construction. This research aims to reveal people's perceptions regarding the use of bamboo as a building material while exploring its correlation with the respondents' backgrounds and perceptions of the material itself. This research uses a mixed-methods approach, combining qualitative and quantitative methodologies, to investigate perceptions related to bamboo materials. 133 respondents were surveyed online, and their responses about bamboo perception were categorized into five distinct perception groups: architecture, ambiance, materials, cost efficiency, and high-value impressions. It is evident that perceptions of bamboo materials are evolving in a positive direction. This study reveals that only monthly income significantly influences perceptions of bamboo materials. Furthermore, the perception of bamboo as a high-quality material emerged as a crucial influence across all perception variables, highlighting the pivotal role of material perception in shaping attitudes toward bamboo as a sustainable building material.

Keywords: *Bamboo; Building Material; Community; Design; Perception*

INTRODUCTION

Bamboo is a sustainable material that has been used for building construction for a long time ago. However, the discovery of building material with better durability, such as concrete, steel, bricks, and glass, the use of bamboo as a building material began to abandon. After the issues of global warming and sustainability surfaced, the existence of bamboo as building material began to be discussed and used by architects and building practitioners (Nurdiah, 2016). It can be seen by the number of architectural works made from bamboo as building material such as the green school, OBI great Hall, and Dancing Mountain. The utilization of bamboo as building material is motivated by inherent characteristics of elasticity, flexibility, abundance in Indonesia, Fast-growing resource with 3-5 years to fully mature, very cheap building material and in some cases free (Lopez, 2003; Maurina, 2015; Damayanto and Fefirenta, 2015; Auman et al., 2018). In addition, bamboo construction emerges as nature-based solution to mitigate the climate change mitigation and adaptation, align with objective of carbon neutrality, and possessing a low environmental impact, merely half of concrete (Murphy et al., 2004; Zuraida and Larasati, 2015; Liua et al., 2022).

Advancements in bamboo preservation allow bamboo material to last for 30 years (Sarfo, et al., 2017). The development of material utilization technology has led to innovations in bamboo joints, preservation techniques, and processed materials. Bamboo is commonly used for structural elements, exterior elements, and interior elements.

However, bamboo's popularity as a building material has not shown an encouraging phenomenon. Bamboo is used for non-residential buildings. It caused some to perceive bamboo as impractical material, outdated material, and less sturdy material (Maslucha et al., 2020). Bamboo is referred to as poor man's timber and considered semi-permanent building material (Larasati et al., 2014; Lobokivov et al., 2019). Predominant perception held by majority, asserts that bamboo material may not be universally substitutable for all components of building construction, especially on main structural element (Putra, 2012; Zuraida and Larasati, 2016). According to the Pandey (2005), There are misconceptions circulating in societies regarding the utilization of bamboo as a building material. Hence, the perception of bamboo material within the community does not align with the results of research conducted by architectural practitioners or academics.

Unexpectedly, research on bamboo building perceptions is still rare. In similar research conducted by Gaputra and Lubis (2017), have focused on user preferences related to the utilization of general building material. In a similar vein, Martens (2019) delved into perceptions of bamboo as a residential building material but concentrated solely on user perspectives, overlooking any examination of the relationships between these perceptions and respondent's background. Conroy et al. (2018) highlighted the impact of user familiarity and experience with materials on their perception, specifically in the case of wood. Furthermore, Florez et al. (2010) demonstrated how the visual attributes of materials can significantly affect users' emotional responses. Hence, there is a pressing need for research that comprehensively describes individuals' perceptions of bamboo as a building material, considering both respondent attributes and perceptions of bamboo material.

The primary objective of this research is to describe the connections between people's perceptions of bamboo as a building material, the respondent's background, and their perceptions of bamboo as building materials. Additionally, this research aspires to serve as a valuable resource for evaluating the evolution of community perceptions regarding bamboo as a sustainable building material.

METHODOLOGY

This study uses a mixed-method approach (Creswell, 2008), comprising qualitative-exploratory and quantitative-explanatory research phases (Groat and Wang, 2002). The qualitative-exploratory research phase aims to collect information to respondent's perception about bamboo building. The quantitative explanatory aims to reveal the relationship between the perception data obtained in the first phase against respondent's attribute and bamboo material perceptions. The number of respondents used was 133 for each research phase.

The data collection method for qualitative research uses an online questionnaire form distributed between February 11, 2023, until February 17, 2023. Open-ended and closed-question structure use for qualitative question. In this study, respondents were asked to express their interest in using bamboo as building material either residential or non-residential

building. Following this, respondents were asked to articulate the reasons for their choice in the closed-ended question textually.

The results of the first phase were analysed using an open coding method to extract keywords. These keywords were then organized into several categories (axial coding). The resultant categories consist of architectural impression, ambience impression, material impression, cost-efficiency impression, and economic value impression (Table 1).

Table 1. Categories from Qualitative Research

	Variable	
Architectural Impression	Aesthetic	Unique
	Tropical Building	Natural Building
	Modern Building	Elegant
Ambience Impression	Terrify	Cool
	Comfort	Warm
	Calm	Relax
Material Impression	Easy to Process	High Flexibilities
	Easy to Apply	High Durability
	Easy to Maintain	Sustainable
	High quality material	
Cost-Efficiency Impression	Cost-Saving in Construction	Cheap Material
	Time-Saving in Construction	Affordable Material
High Value Impression	Strong Attraction	Photo spot
	High marketability	

In the second phase of the quantitative research, the study incorporated variables derived from the outcomes of the initial qualitative research phase, as well as variables from a previous investigation by Gaputra and Lubis (2017). Variables from the previous research were combined and collectively referred to as structural impression, encompassing dimensions such as high-quality structure, sturdy structure, long-lasting structure, and masculine structure.

The quantitative research was conducted by online questionnaire from April 11, 2023, to July 30, 2023. This questionnaire adopted a structured format with closed-ended questions to gather quantitative data. Respondents were requested to furnish information about their personal attributes through a series of multiple-choice closed-ended questions. The respondent's attributes included educational level, job profession, monthly income, and familiarity with bamboo buildings.

The educational attainment questions presented four options for respondents to select from: Elementary school, Junior high school, Senior high school, Diploma degree, bachelor's degree, master's degree, and Doctoral degree. Questions regarding the respondent's profession, particularly those related to planning and design, offer two answers: yes or no. The inquiry regarding monthly income featured five response categories: less than Rp.5,000,000, Rp.5,000,000 to Rp.7,500,000, Rp.7,500,000 to Rp.10,000,000, Rp. 10,000,000 to Rp.12,500,000, and more than Rp.12,500,000. Assessing the level of respondents' familiarity with bamboo buildings involved four response options: have seen on TV/social media, have seen directly, have used, and have bamboo buildings.

Furthermore, respondents' perceptions were evaluated using a Likert scale, which was administered through closed-ended questions. This scale ranged from 1 to 5, enabling respondents to express their degree of agreement or disagreement, as outlined in Table 2.

Table 2. Example of Closed Question with Likert scale

Variables	Scale						
Aesthetic	Bamboo Building Has High Aesthetics Impression						
	Strongly Disagree	1	2	3	4	5	Strongly Agree

The numerical data resulting from the assessment of each measured variable was analysed quantitatively using factor analysis (FA). This approach, derived from principal components analysis (PCA), uses varimax rotation to obtain latent variables that effectively summarize multiple measured variables. Determination of these latent variables is based on the eigenvalues that emerge during the factor analysis procedure for each group of variables examined. Latent variables characterized by eigenvalues exceeding the threshold of 1 were selected for the next stage of analysis.

The latent variables identified earlier are subsequently assigned a name related to the associated variable it represents. Subsequently, a bivariate analysis of variance (ANOVA) was performed to ascertain the statistical significance of the relationships between these latent variables and respondent attributes, while also explaining the distribution patterns of responses. Finally, a multivariate correlation analysis was conducted to explaining relationships between the latent variables within the material impression category and those encompassed within the domains of architectural impression, structural impression, ambient impression, cost efficiency impression, and economic value impression.

RESULTS AND DISCUSSION

Correspondence Analysis

Principal Component Analysis (PCA) is performed on the measure's variables in the next stage of data analysis. 33 measurable variables are grouped into 6 categories, consist of architectural impression, structural impression, ambiance impression, material impression, cost-efficiency impression, and economic value impression. Each group of variables was carried separately by PCA to facilities the naming of latent variables. After that, the 6 group of variables are analysed by Factor Analysis (FA) with varimax rotated component method.

Architectural Impression

Based on Principal Component Analysis (PCA) for architectural impressions, three principal components have been obtained, each characterized by a latent variable with an eigenvalue exceeding 1. These three main components were used as latent variables to represent ten measured variables from architectural impression, as detailed in Table 2. The resultant latent variables can be described as follows: High Aesthetic, Tropical Building, and Modern Building.

Table 3. Factor Analysis of Architectural Impression

Laten Variable	α-Cronbach	Mean	Variance	Cum Percent
High Aesthetics	0,799	4,29	37,43	37,44
Tropical Building	0,416	4,43	13,41	50,85
Modern Building	0,553	3,08	11,20	62,10

Table 4. Mean and Loading Factor of Each Architectural Impression Variables

Laten Variable	Variable	Mean	Loading Factor
High Aesthetics	Aesthetic	4,39	0,86
	Artistic	4,47	0,79
	Unique	4,53	0,72
	Elegant	3,77	0,70
Tropical Building	Complex Building	4,17	0,67
	Natural Building	4,77	0,66
	Tropical Building	4,34	0,57
Modern Building	Modern Building	3,08	0,81
	Neat Building	3,08	0,78

Factor analysis revealed that the latent variable tropical buildings have the highest average value compared to other latent variables. This observation shows that bamboo buildings are often considered as tropical buildings. Additionally, the perceptions of tropical building among individuals encompasses nations of complexity, natural building and tropical building.

The latent variable whose average value is lower than tropical buildings is high aesthetics. In this context, the term of high aesthetics includes attributes such as beauty, artistic, unique and elegant. Notably, the variable unique obtained the highest mean score, indicating that bamboo buildings are mostly considered unique by the public.

Modern buildings are latent variable that has the lowest average value compared to the two previous latent variables. In this scenario, modern buildings relate to contemporary and well-organized structures. The two variables measured have identical average values. This underlines that buildings made from bamboo are in principle considered modern and well-structured construction by the general public.

Based on the three architectural latent impression variables, it can be seen that the public's perception of bamboo-constructed buildings regarding architectural aesthetics and tropical style, shows that the average value of the latent variable is above the median. However, it is important to consider other measured variables that are not dominant in this perception but still have mean values above the median. This includes aspects such as aesthetic, artistic, complex, and the natural building.

Table 5. Comparison of Architectural Ambience

Martens (2019)	Author (2023)
Artistic	High Aesthetics
Unique	
Natural	Tropical Building
Classic	-
Traditional	
Local	

When comparing these results in relation with previous study conducted by Martens (2019), this investigation revealed that several variables in the current findings are in line with previous study. As articulated by Martens (2019), the general perception of bamboo building is that they are esteemed for their aesthetic, artistic, and unique, consistent correspondence with the measurable variables encapsulated in the High Aesthetic. Furthermore, our research outcomes appear to harmonize with the observations made by Laroque (2007) and Opoku et al. (2016), where it is substantiated that bamboo constructions manifest a pronounced degree of architectural aesthetics. Additionally, the Unique dimension corresponds with the measured variable encapsulated within the Tropical Building. However, it is important to acknowledge that three variables identified in previous research, namely, Classical, Traditional, and Local, were not previously discerned in our analysis. Further elaboration on this can be found in Table 5, presented above.

Structural Impression

Based on the results of factor analysis regarding structural impressions, two main components were obtained, each of which had an eigenvalue exceeding 1. These two main components were used as latent variables representing four measured variables (see Table 6). The latent variables that represent the community's structural impression of bamboo as a building material are high structural quality and masculine structure.

Table 6. Factor Analysis of Structural Impression

Laten Variable	α-Cronbach	Mean	Variance	Cum Percent
High Structure Quality	0,821	3,43	64,68	64,69
Masculine Structure	0,810	3,11	16,29	80,98

Table 7. Mean and Loading Factor of Each Structural Impression Variables

Laten Variable	Variable	Mean	Loading Factor
High Structure Quality	High Quality Structure	3,74	0,88
	Sturdy Structure	3,56	0,82
	Long Time Structure	3,00	0,72
Masculine Structure	Masculine Structure	3,11	0,96

Derived from the outcomes of the factor analysis (FA), it appears that high structural quality has the highest average value compared to masculine structure. Therefore, it can be concluded that the prevailing perception in society regarding bamboo structures is indicative of high-quality structures. This alignment is consistent with the measured variable of high-quality structure, which exhibits the highest average value when compared with sturdy structure and longtime structure.

Next, the latent variable whose average value is below high structural quality is masculine structure. This latent variable represents only one measured variable, namely masculine structure. From this result, it can be concluded that the general public perceives building structures constructed from bamboo embodying masculine structural characteristics.

Based on this phenomenon, it is noted that public perceptions of bamboo building regarding structural impression, encompass both high structural quality and the perception of

a masculine structure. Furthermore, it is important to acknowledge measurable variables that, while not dominant, retain significance, such as sturdy structure and long time structure.

Table 8. Comparison of Structural Impression

Martens (2019)	Author (2023)
Earth-Quakes Resistant	High Structure Quality
	Masculine Structure

When comparing these findings with those of previous research (Martens, 2019; Liu, et al., 2017; Villegas, 2014), noteworthy similarities were observed in one variable: earthquake resistance. This variable correlates with high structural quality due to a shared perception of the structural strength of a building. However, the variable identified in this study, namely masculine structure, was not identified in previous research. More detail can be seen in Table 8 above.

Ambience Impression

Based on the results of factor analysis regarding the ambience impression, there are two main components that have eigenvalues exceeding one, which effectively represent the six measured variables (see Table 9). The main components were converted into latent variables, namely comfortable ambience and warm ambience.

Table 9. Factor Analysis of Ambience Impression

Laten Variable	α-Cronbach	Mean	Variance	Cum Percent
Comfortable Ambience	0,818	4,31	47,42	47,42
Warm Ambience	0,063	2,99	17,54	64,96

Table 10. Mean and Loading Factor of Each Ambience Impression Variables

Laten Variable	Variable	Mean	Loading Factor
Comfortable Ambience	Calm	4,32	0,84
	Relax	4,31	0,79
	Cool	3,76	0,76
	Comfort	4,14	0,75
Warm Ambience	Terrify	2,23	0,93
	Warm	3,76	0,36

The results of factor analysis show that comfortable ambience has a higher average value compared to warm ambience. Comfortable ambience represents several different measurable variables, including calm, relax, cool, and comfort. In Table 10 it can be seen that the variable calm has the highest average value, followed by relax, comfort, and cool. This implies that the general public perceives the ambiance within bamboo buildings to be calming.

Moreover, warm showed a lower mean value than comfortable. The name of this latent variable comes from the variable warm which has a higher value compared to terrify. In addition, this latent variable only includes two measured variables, namely warm and terrify. Therefore, most people view buildings made of bamboo as having a warm ambience.

Within the two categories of Ambience impression regarding the utilization of bamboo as a building material, a noticeable perception of comfort and warmth emerges. Additionally,

attention should be given to non-dominant measured variables that surpass the median in mean value, including measured variable of calm and relax.

Table 11. Comparison of Ambience Impression

Martens (2019)	Author (2023)
Good	Comfortable Ambience
Cool	
Comfortable	

In reference to previous investigations, Martens (2019) delineated three distinct public perceptions regarding the ambiance, specifically highlighting the descriptors of good, cool, and comfortable. This alignment with our present research findings enables their classification within the wider concept of a comfortable ambience. Furthermore, our research's findings align with previous study conducted by Dewi (2020), who observed that unassuming bamboo structures possess the capacity to evoke emotions characterized by relaxation, happiness, and heightened focus, thereby facilitating the appreciation of the present moment. Notably, the present research represents an advancement in the understanding of emerging ambience, unveiling a novel latent variable corresponding to a warm ambiance. For further explanation regarding this, we direct readers to Table 11, provided above.

Material Impression

Based on the results of factor analysis regarding Material Impression, there are three main components, each of components has an eigenvalue exceeding one. These components effectively represent seven measurable variables (see Table 12) regarding community perceptions of the use of bamboo as a building material, specifically focusing on perceptions of the material itself. These main components were converted into latent variables, namely high quality materials, practical materials, and innovative materials.

Table 12. Factor Analysis of Material Impression

Laten Variable	α-Cronbach	Mean	Variance	Cum Percent
High Material Quality	0,712	3,15	37,46	37,46
Practical Material	0,866	3,03	22,56	60,01
Innovative Material	0,475	4,18	15,15	75,17

Table 13. Mean and Loading Factor of Each Material Impression Variables

Laten Variable	Variable	Mean	Loading Factor
High Material Quality	High Durability	3,23	0,86
	Easy to Maintain	2,69	0,77
	High quality material	3,53	0,76
Practical Material	Easy to Apply	3,01	0,93
	Easy to Process	3,06	0,91
Innovative Material	Sustainable	4,57	0,84
	High Flexibilities	3,80	0,76

The results of factor analysis show that innovative material has the highest average value compared to the other two latent variables. The latent variable innovative materials includes two measurable variables, namely sustainable and high flexibility. In particular, sustainable

achieved the highest mean score when compared with high flexibility. Based on this, it is clear that most people consider bamboo to be an environmentally friendly material.

Moreover, of noteworthy significance is the latent variable denoted as high material quality, which exhibits the second-highest average value among the constructs under investigation. This latent variable (high material quality) signifies the utilization of building materials of exceptional characteristics, characterized by material attributes such as high durability, easy to maintain, and high-quality material. Within this classification, it is essential to highlight that bamboo is widely regarded as high quality material. This recognition is supported by empirical evidence, where the average value of high material quality more higher than others measured variable.

Last, practical material is a latent variable that has the lowest average value among the three variables. This latent variable itself includes two measurable variables, namely easy to apply and easy to process. In particular, the variable easy processing achieves the highest mean value. From this analysis, it can be concluded that the dominant community perspective positions bamboo as a practical material, especially because of the ease of processing it into building materials.

Concerning the general public's perception of bamboo building materials, three latent variables were identified: high-quality materials, practical materials, and innovative materials. Through an examination of the mean values relative to the median, a noteworthy emphasis on the perception of distinguished by high-quality and innovative materials. Additionally, it's essential to consider non-dominant measured variables with mean values surpassing the median, such as high durability and high flexibility.

Table 14. Comparison of Material Impression

Martens (2019)	Author (2023)
Short-live Material	High Quality Material
Weathered	
Weak	
Termites	
Simple Maintenance	Practical Material
Eco-Friendly	Innovative Material
Unsuitable for Housing	-

In comparison to a previous study, it is apparent that six of the measured variables in the present research demonstrate alignment with their perspective dimensions. Martens (2019) found 9 emerging perceptions concerning the utilization of bamboo as a construction material. Notably, certain variables found in this study, such as short-lived, weathered, weak, and termite, represent distinct attributes and diverge from the measurable variables encapsulated within the high-quality materials. These findings relating to high quality structural variables align with the results of Shah et al. (2012) research, which confirms the potential of bamboo as a strong alternative building material due to its inherent strength.

Furthermore, the Simple maintenance variable corresponds to one of the measured variables categorized as practical materials, while the Eco-Friendly variable aligns with one of the variables within the Innovative materials category. It is a noteworthy to highlight that bamboo is widely regarded as a sustainable material due to its rapid growth characteristics

(Shen et al., 2019). Comparing with variable from earlier research, namely unsuitable for housing, did not emerge as a significant factor in the present study. Further details can be seen from the comprehensive presentation in Table 14, as provided above.

Cost-Efficiency Impression

Based on the results of cost efficiency factor analysis, two main components were obtained, each of components had an eigenvalue exceeding 1. These main components were subsequently transformed into latent variables, which were able to represent four measurable variables (see Table 16) regarding community perceptions of cost efficiency. The resulting latent variables are effective construction and affordable materials.

Table 15. Factor Analysis of Cost-efficiency Impression

Laten Variable	α-Cronbach	Mean	Variance	Cum Percent
Effective Construction	0,733	3,93	59,27	59,27
Affordable Material	0,655	3,61	17,78	77,05

Table 16. Mean and Loading Factor of Each Cost-Efficiency Impression Variables

Laten Variable	Variable	Mean	Loading Factor
Effective Construction	Time-Saving in Construction	3,35	0,88
	Cost-Saving in Construction	3,43	0,83
Affordable Material	Affordable Material	3,81	0,89
	Cheap Material	3,40	0,76

The results of factor analysis show that effective construction has a higher mean value compared to affordable materials. effective construction mean include the variables of time saving and cost saving in construction. In addition, the variable time savings in construction has a higher average value than the other variables. Form this analysis, it can be concluded that the dominant community considers the time used to build bamboo structures to be more efficient.

On the other hand, affordable materials have a lower average value when compared to the previous latent variable. Affordable materials refer to the ease of obtaining materials and the reasonable price of materials. This latent variable consists of two measured variables, namely affordable material and cheap material, with affordable material having a higher average value. Therefore, it can be concluded that the dominant community considers bamboo as an affordable material due to its accessibility. This observation aligns with previous investigations undertaken by Martens (2019), emphasizing the existence of bamboo plants throughout Indonesia.

Table 17. Comparison of Cost-Efficiency Impression

Martens (2019)	Author (2023)
Cheap	Affordable Material
	Effective Construction

If we compare the results with previous research (see Table 17), consistent perceptions emerged, namely affordable materials. In this study, cheap materials are represented as affordable materials. In addition, a new perception emerged in this research, namely effective construction. Effective construction in this context refers to efficient construction time and

cost management during the development and implementation process. Nevertheless, the findings of this study diverge from the opinion of Ernawati et al. (2020), who asserted that bamboo material incurs higher processing costs compared to wood materials.

Economic Value Impression

Based on the results of factor analysis regarding economic value, two main components were obtained, each of components had an eigenvalue exceeding 1. These main components were then transformed into latent variables, which were able to represent three measurable variables (see Table 13) regarding public perceptions of utilization bamboo as a building material with a focus on economic value. The resulting latent variables are strong attraction and high marketability.

Table 18. Factor Analysis of Economic Value Impression

Laten Variable	α-Cronbach	Mean	Variance	Cum Percent
Strong Attraction	0,818	4,38	50,30	50,30
High Marketability	0,785	3,79	22,78	73,08

Table 19. Mean and Loading Factor of Each Economic Value Impression Variables

Laten Variable	Variable	Mean	Loading Factor
Strong Attraction	Photo Spot	4,36	0,88
	Strong Attraction	4,43	0,85
High Marketability	High Marketability	3,79	0,96

The results of factor analysis show that strong attraction has a higher average value compared to High marketability. Strong attraction itself includes two measurable variables: photospot and strong attraction. The nomenclature of this latent variable is in accordance with the name of the variable being measured, strong attraction, because the average value is higher when compared to the measured variable photospot. This shows that the majority of people consider buildings made from bamboo to have a strong attraction for their users. Next latent variable is High marketability. This latent variable's naming is in accordance with the measurable variable it represents, namely High marketability. The findings of this research are in light with Ernawati et al. (2020) opinion, where the utilization of local materials (bamboo), is identified as an important strategy employed to support the sustainability of the OMunity-Homestays business.

Anova Variable laten and Attribute Respondent

The study continued with a bivariate analysis, specifically Anova, to assess the statistical significance of the correlation between respondent attributes and latent variables. The analysed respondent attributes included education, job profession, monthly income, and familiarity. The latent variables chosen for examination met the criterion of having a Cronbach's α value greater than 6. These latent variables encompassed High aesthetics, high structural quality, masculine structure, comfortable material, high-quality material, practical material, effective construction, affordable material, strong attraction, and high marketability. In this analysis, a correlation was considered significant when the p-value (P) was less than or equal to 0.05 (Fisher, 1925).

The outcomes of the Anova test revealed that only one respondent attribute, namely monthly income, exhibited a significance level with P<0.05 (Figure 1). These findings diverged from those of a previous study conducted by Florez et al. (2010), which explored the perception of wood materials and their association with user familiarity. This study did not identify a significant relationship between the level of familiarity and how individuals' perceptions the use of bamboo as a building material.

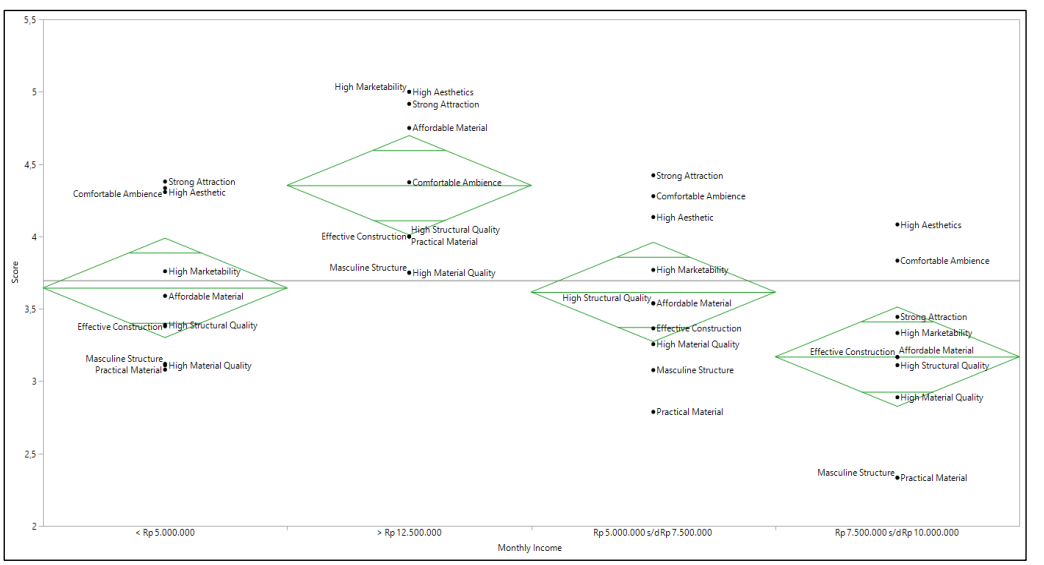

Figure 1. Anova Monthly Income Against Laten Variables

Based on the findings derived from the bivariate analysis, a distinct pattern of perceptions concerning the use of bamboo as a building material emerged among respondents in different income brackets (as illustrated in Figure 1).

Respondents with a monthly income less than 5,000,000, it was observed that they tended to perceive bamboo buildings as having a high level of attractiveness (mean score of 4.38), followed in descending order by a comfortable ambiance (4.33), high aesthetics (4.31), high marketability (3.76), affordability of materials (3.59), high structural quality (3.39), effective construction (3.38), a masculine structural design (3.12), high material quality (3.11), and practicality of materials (3.08).

Continuing the bivariate analysis for respondents with a monthly income greater than 12,000,000, the results indicated a positive perception of bamboo as a building material (scores above 3.5). Notably, high marketability and high aesthetics garnered the highest scores (5.00), followed by strong attraction (4.92), affordability of materials (4.75), comfortable materials (4.38), high structural quality (4.00), and effective construction (4.00). Meanwhile, practicality of materials, a masculine structural design, and high material quality all received scores of 3.75.

The analysis was extended to respondents with monthly incomes ranging from 5,000,000 s/d7,500,000. In this case, respondents appeared to hold the perception that bamboo buildings possessed strong attraction (4.42), with a subsequent perception hierarchy including a comfortable ambiance (4.28), high aesthetics (4.13), high marketability (3.77), high structural

quality (3.54), affordability of materials (3.54), effective construction (3.37), high material quality (3.26), a masculine structure (3.07), and practical materials (2.79).

Respondents with monthly incomes falling between 7,500,000 s/d 10,000,000, the highest-rated perception regarding bamboo buildings was their high aesthetic appeal (4.08). Following this, respondents indicated comfort (3.83), strong attraction (3.44), high marketability (3.33), effective construction (3.16), affordability of materials (3.16), high structural quality (3.11), high material quality (2.89), a masculine structure (2.33), and practical materials (2.33) in descending order of importance.

Significantly, it is discernible that respondents, regardless of their respective income brackets, consistently displayed the highest degree of agreement with the perception of high aesthetic. Moreover, across all three income groups, there was a notable consensus among respondents in their positive evaluation of the notion of strong attraction. Furthermore, the distribution pattern of perceptions exhibited correlations with factors such as structural masculinity, practicality, and high material quality.

These findings align with Zhou et al (2009), where economic considerations play a pivotal role as the primary indicator in the selection of building materials. In this context, it is evident that varying economic capabilities give rise to divergent levels of confidence in material-related perceptions. Additionally, the outcomes of this research are congruent with the insights provided by Akadari et al. (2012), underscoring the significance of economic factors as pivotal indicators in the decision-making process associated with the selection of sustainable construction materials.

Correlation Between Material Impression and Grup of Laten Variable

Furthermore, multivariate correlation analysis was conducted to determine the relationship between the five groups of variables and the material impression group. The selected variables had a Cronbach's α-value exceeding 0.6, including High aesthetics, high structural quality, masculine structure, comfortable material, high-quality material, practical material, effective construction, affordable material, strong attraction, and high marketability. The detailed results of the multivariate correlation analysis can be found in Table 20. Higher correlation coefficient values indicate a stronger correlation, ranging from 0 to 1, either positive or negative. An asterisk placed next to the correlation coefficient value indicates its significance level.

Table 20. Multivariate Correlation of Material Impression Towards Grup of Laten Variable

		Material Impression	
		High Material Quality	**Practical Material**
Architecture	High Aesthetics	0.19*	0.15*
Structural	High Structure Quality	0.60***	0.17*
	Masculine Structure	0.40***	0.09
Ambience	Comfortable Ambience	0.10	-0.03
Cost-Efficiency	Effective Construction	0.30**	0.44***
	Affordable Material	0.19*	0.43***
High Value	Strong Attraction	0.16*	-0.01
	High Marketability	0.35***	0.29**

Note: ***p<0.0001, **p<0.001, and *p<0.09

The analysis results (Table 20) show substantial impact of material impressions, particularly high material quality, on the latent variables of high structural quality, masculine structural design, and high marketability. This finding aligns with prior studies (Shen et al., 2019; K.J. Mate, 2006; Zhou et al., 2009) where a profound understanding of materials significantly shapes the decision-making process when selecting construction materials, displaying a discernible inclination towards bamboo usage.

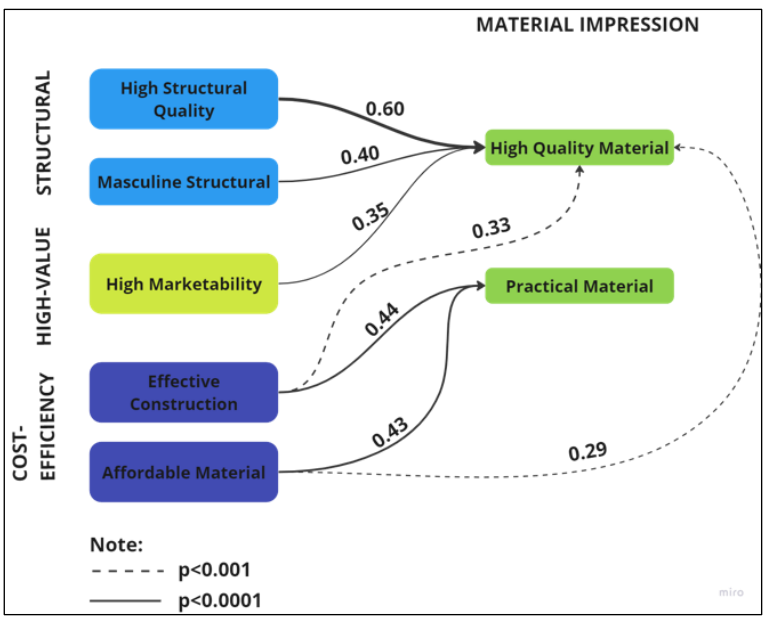

Figure 2. Correlational Relationship Between Material Impression and Grup of Variable

Moreover, the perception of practical materials exerts a notable influence on the latent variable group associated with cost-efficiency. This observation corresponds with earlier research (Villegas, 2014) that pertains to the utilization of more practical materials to expedite building construction processes. Nevertheless, previous research conducted by Akadiri (2017) also brought to light an interesting facet, revealing that in their quest to reduce construction time, professionals often didn't the use of sustainable materials due to a lack of knowledge regarding these sustainable materials (Bond, 2017). To simplify the analysis, a model was created that represented the result of multivariate correlation analysis (Figure 2).

Perceptions of high-quality materials, as exemplified by a statistically significant correlation ($r = 0.60$; $p < 0.0001$), exert a substantial influence on the formation of perceptions related to high structural quality. Furthermore, this particular perception significantly impacts the way individuals perceive the masculine structural attributes ($r = 0.40$; $p < 0.0001$) and is also closely linked with favourable perceptions of high marketability ($r = 0.35$; $p < 0.0001$). Moreover, the perceptions of high-quality materials exhibit correlations with perceptions of effective construction ($r = 0.33$; $p < 0.001$) and affordability of materials ($r = 0.29$; $p < 0.001$). These findings underscore the pivotal role of perceiving bamboo as a high-quality building material in shaping individuals' perceptions of the structural soundness of bamboo constructions, the perceived value of such buildings, and their cost-effectiveness.

This observation maintains consistency with previous research conducted by Villegas (2014), which underscores that the visual characteristics of materials have the potential to evoke an emotional response in the user. Furthermore, in accordance with the insights expressed by Shen et al. (2019), it became clear that considerations of durability and production costs had a clear influence on long-standing biases in bamboo construction. This convergence is mirrored in our research outcomes, where the perception of bamboo material as a high-quality substance significantly shapes the overarching user perception.

In addition, perceptions of practical materials have a significant impact on perceptions of cost efficiency in bamboo buildings, with the greatest influence seen on perceptions of effective construction ($r = 0.44$; $p < 0.0001$), followed by perceptions of affordable materials ($r = 0.43$; $p < 0.0001$). These results emphasize that the perception of bamboo as a practical building material is related to its cost effectiveness, therefore highlighting its potential to be viewed as an effective and affordable construction resource. This is in line with the sentiment expressed by Akadiri (2015), who observed that practitioners in the construction industry tend to prioritize the use of familiar and practical materials, because this approach is considered to save time and budget.

CONCLUSION

This research highlighted those perceptions concerning the utilization of bamboo as a construction material remain consistent with previous findings and demonstrate a tendency to evolve positively over time. Key recurring aspects within these perceptions encompass architectural considerations, structural attributes, ambiance, material characteristics, as well as cost-related factors encompassing time, maintenance, and construction. These observations collectively indicate a heightened public awareness and understanding of bamboo's applicability as a building material.

Moreover, the bivariate Anova analysis results reveal that perceptions related to bamboo's use as a building material are primarily influenced by the monthly income of the community. Interestingly, despite variations in the highest recorded agreement scores, the distribution pattern of responses remains consistent. This consistency suggests a prevailing positive perception regarding the use of bamboo in construction.

Furthermore, the multivariate correlation analysis emphasizes the influence of material-related perceptions on the overall assessment of bamboo as a construction material. Notably, it underscores that enhancing the perception of bamboo as a high-quality material is a pivotal factor in elevating the overall acceptance of bamboo as a viable construction resource. However, this research did not detect significant environmental concerns within the perceptions that emerged. This may suggest a relative lack of awareness among respondents regarding contemporary global environmental issues.

It is essential to acknowledge the limitations of this study, notably in terms of sample size, respondent diversity, variations in respondent profiles across divergent phases, and analytical methodologies employed. These limitations restrict this research's ability to fully capture the entire phenomenon under investigation. Future studies can address these shortcomings by expanding the sample size, incorporating a more diverse pool of respondents,

and refining the analytical approaches to provide a more comprehensive understanding of this subject matter.

ACKNOWLEDGMENT

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CFD SIMULATION ON THE ALLOWABLE AIRTIGHTNESS FOR BALANCING THE SPLIT-SYSTEM AIR-CONDITIONING EFFICIENCY AND FRESH AIR INTAKE

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Abstract
Airtightness is beneficial to the energy efficiency of air-conditioner (AC); on the other hand, it could limit the fresh air intake, particularly when the split-AC system is used. Although the recent development of split-AC is able to introduce fresh air into the room, the majority of AC used in residential buildings, especially in developing countries, do not have such sophisticated features. Hence, this study aims to investigate the desirable ventilation rate in a particular indoor space that still could allow fresh air intake when split-AC system is operating yet the energy-efficiency can be maintained fairly. A review on building regulations, guidelines, and standards was conducted to map the existing requirements related to ventilation in buildings. In addition, to assess the effects of the ventilation rate on the AC's energy consumption, Computational Fluid Dynamics (CFD) simulation was employed. The literature review found that the required ventilation rates for indoor air quality (IAQ) (≥4 ach) are mostly higher than those required for energy efficiency of AC (≤5.3 ach). Nevertheless, if the desirable ventilation rate is calculated considering the room's physical properties and occupancy (based on ASHRAE 62.2), the desirable ventilation rate for IAQ does not necessarily need to surpass the energy-efficiency requirement. For instance, the desirable ventilation rate for IAQ in the typical room of residential buildings ranges from 0.61-1.02 ach. Applying such ventilation rate consistently throughout the day will result in higher daily energy consumption by 2.3 kWh compared to a room without ventilation. Nevertheless, the increment could still be suppressed by considering a shorter window operation and higher COP of AC.

Keywords: *Airtightness; Air-conditioning; Air Quality; Energy Consumption*

INTRODUCTION

In recent years, the energy consumption of residential buildings has been increasing. Meanwhile, cooling appliances, like AC, contribute the most to the total energy consumption (Sukarno et al., 2013). This aligns with a study that found more than 77% of the discomfort period was observed in apartment buildings in the hot humid climate of Indonesia (Alfata et al., 2015). This undesirable indoor thermal environment would lead to more excessive AC usage in order to satisfy the occupants' thermal comfort. Therefore, buildings should be planned and designed by considering how to improve the energy efficiency of AC so that excessive energy consumption can be prevented.

In order to increase the efficiency of AC usage, the air-conditioned space must have good airtightness to suppress the heat loss and/or gain through the building's envelope. In regard to the hot and humid climate, the unwanted air infiltration from relatively warm outdoor air would increase the cooling load. Therefore, several standards have regulated the permissible outdoor ventilation rate for the air-conditioned room. The requirements vary depending on the regulation/standard in each country. For instance, the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) and PassivHaus (Germany) stipulate that the maximum air change rate (ACH) must be below 1.5 and 0.6 ach, respectively

(ASHRAE, 2016) (Lambea et al., 2019). Overall, most of the standards suggest a relatively low ventilation rate to maintain good energy efficiency of AC.

On the other hand, lack of ventilation could lead to poor indoor air quality, especially in a room where AC is frequently used. Moreover, some AC systems are not equipped with fresh air intake features, such as the split-AC system, which is very popular due to its affordability and practicability. Hence, the dirty air continuously recirculates inside the room and would be the major cause of sick building syndrome (SBS). Some studies have identified the occurrence of SBS in Indonesia (Hildebarant et al., 2019) (Murniati, 2020) (Hikmat et al., 2021). An investigation on typical apartments in Indonesia observed that the concentrations of formaldehyde and Total Volatile Organic Compounds (TVOC) were above the existing standards during a particular period (Hildebarant et al., 2019). Moreover, lack of ventilation (window opening behaviour) was identified as the source of high concentrations of pollutants in those apartment buildings.

The Indonesian government has regulated the required ventilation rates for IAQ (Badan Standarisasi Nasional (BSN), 2001) and energy efficiency of cooling systems (BSN, 2020). However, those requirements are partial. For instance, the minimum ACH to be provided to meet indoor air quality standards is 4 ach; however, this value will lead to inefficiency of AC. This also applies for the way around. Hence, providing a required ventilation rate that could meet these two objectives is necessary. However, most of the existing standards and guidelines overlook this approach. Therefore, this study aims to investigate the permissible outdoor ventilation rate for the AC room that aims to balance between indoor air quality and energy efficiency of AC. In order to obtain a full understanding of this context, this study will focus on the following research objectives:

1. Investigate the required ventilation rate in the existing standards.
2. Investigate the effect of outdoor ventilation rate, outdoor thermal condition, and position/location of ventilation or window on the energy consumption.
3. To obtain the permissible ventilation rate for balancing the indoor air quality and energy.

DATA AND METHODOLOGY

In general, a literature review and CFD simulation were conducted in this study. The main goal of the literature review is to obtain the required ventilation rate in the AC room, while the CFD simulation aims to investigate the effect of several variables on energy consumption. Firstly, the literature review of the existing standards in several Southeast Asian countries such as Indonesia, Malaysia, Singapore, and Vietnam was carried out. The literature review also covers some international standards, such as ASHRAE and PassivHaus.

Secondly, a simple computational fluid dynamic simulation using scSTREAM (Yao et al., 2012) was carried out to investigate indoor thermal performance. The transient mode was employed using linear low-Reynolds number as the turbulence model; a more detailed simulation setting is listed in Table 1. Three simple room models were used to represent bedroom (BR), master bedroom (MBR), and living-dining-kitchen (LDK), respectively. The room dimension varies depending on the room function, as shown in Figure 1 (a).

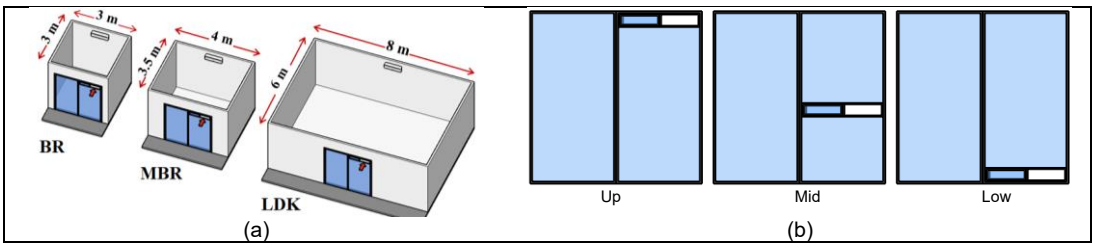


Figure 1. Simulation Model: (a) Room Model and (b) Opening Position

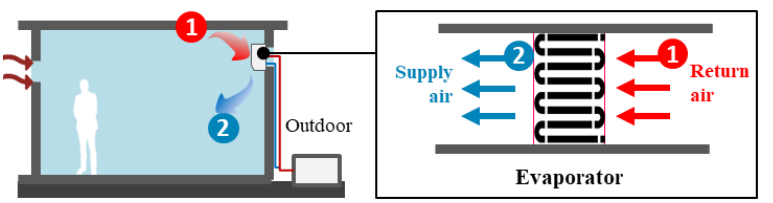


Figure 2. Split-AC System

Table 1. CFD Simulation Setting

Variable	Description
Outdoor Condition	Air Temperature and Relative Humidity depend on the cases
Indoor Condition	25°C/ 55%
Mesh	301, 320 (standard length 0.05 m for x, y, z axis)
Turbulence Type	Linier low-Reynolds-number
Analysis Type	Transient (1 hour per minute)

In order to obtain a full understanding of the effect of ventilation rate on the energy consumption of AC, this simulation was divided into two phases, i.e., Phase 1 and Phase 2, respectively. Phase 1 aims to investigate the several parameters of ventilation rate that affect energy consumption, including the variations of outdoor ventilation rates, outdoor weather conditions (i.e., air temperature and humidity), and location/position of ventilation/window. The position of window is illustrated in Figure 1 (b). Table 2 lists the case design in Phase 1. As shown in Table 2, Case 1 is a parametric study to assess several infiltration rates. Furthermore, in Phase 1, the outdoor ventilation rate was assumed to be continuously injected into the room for five minutes and the simulations were only carried out using the BR model.

Meanwhile, the main objective of Phase 2 is to obtain the daily energy consumption of AC in BR, MBR, and LDK. Table 3 describes the case design in Phase 2. As shown, several variations of infiltration rates and window opening duration were assessed for each room. In addition, the types of AC in each room were decided based on the room dimension (i.e., larger room, bigger COP).

Figure 2 illustrates the split-AC system, which is divided into indoor and outdoor units. The cooling process occurs in the indoor unit by cooling the return air through evaporation and then supplying it back to the indoor space. In general, the cooling capacity of the AC could be defined by calculating the enthalpy difference between the return and supply air (see Equation 1) (O'Neal et al., 2022). The enthalpy is defined by using the psychometric table based on the thermal environment condition of the particular air. With a higher difference between the enthalpy of supply and return air, the cooling capacity of the AC is also higher.

Table 2. Case Design Phase 1

Case	AC Specification				Opening Position	Outdoor Condition	Infiltration Rate (/h)
	CAP[a] (kW)	COP[b] (-)	Flow (m³/min)	P Input (kW)			
Case 1 (A-F)	2000	0.9	9	0.6	Upper	29.8ºC / 69.2%	0 (-A), 2(-B), 4 (-C), 6 (-D), 8 (-E), and 10 (-F)
Case 2A	2000	0.9	9	0.6	Upper	20ºC / 100%	4
Case 2B						25ºC / 91.1%	
Case 2C						27ºC / 84.4%	
Case 2D						29.8ºC / 69.2%	
Case 2E						36ºC / 52%	
Case 3A	2000	0.9	9	0.6	Upper	29.8ºC / 69.2%	4
Case 3B					Middle		
Case 3C					Lower		

Table 3. Case Design Phase 2

Case	AC Specification				Outdoor Condition	Window Condition	
	CAP (kW)	COP (-)	Flow (m³/min)	P Input (kW)		Infiltration Rate (/h)	Operation Duration (min/hr)
BR	2000	0.9	9	0.6	29.8ºC/ 69.2%	0, 2, 4, 6, 8, 10	5, 15, 30
MBR	3480	4.2	10	1.03			
LDK	5220	4.1	13	1.5			

[a] CAP : Cooling Capacity
[b] COP : Coefficient of Performance
[c] WO : Window Operation

$$CAP_{eff} = m_{return}h_{return} - m_{supply}h_{supply} \quad (1)$$

$$COP_{eff} = \frac{CAP_{eff}}{P_{tot}} \quad (2)$$

CAP_{eff} effective capacity, m mass flow rate for air entering and exiting the evaporatore, h enthalpy of air entering and exiting evaporator; COP_{eff} effective coeeficient performance, and total power consumption.

RESULT AND DISCUSSION

Literature Review on The Existing Regulations

The literature review is divided into two categories, i.e., the national and international standards/guidelines, respectively. In regard to the national standards in some Southeast Asian countries, it was found that the required ventilation rates for the air-conditioned room are relatively similar among countries, which ranges from 4-10 /h (Nurjannah and Trihamdani, 2022). In addition, the required values mainly aim to dilute indoor pollutants, while the objectives to maintain energy efficiency are not taken into account. On the other hand, the international standards stipulate relatively lower ventilation rates compared to the national standards. As listed in Table 4, the maximum permissible ventilation rate is 5.3 ach as stipulated in the International Energy Conservation Code Study Companion (IECC) (ICC, 2012). Moreover, PassivHaus has the lowest permissible value, which is below 0.6 ach.

Table 4. Recommended Infiltration Rate in The Existing Standards

Energy Efficiency	
Standard	**AC Space**
ASHRAE 90.1	1.5
EN ISO 9972	3
IECC	5.3
LEED	2.2
PassivHaus	0.6

Indoor Air Quality		
National Standard	**General Room**	**Kitchen**
Brunei	4-6	20
Indonesia	4-6	20
Singapore	4-10	
Thailand	4-7	>5

Table 5. Required Infiltration Rate for Indoor Air Quality Based on ASHRAE 62.1

Room Type	R_p $(L/s \cdot person)$	P_z $(person)$	R_a $(L/s \cdot m^2)$	A_z (m^2)	V_{bz} (L/s)	ACH $(/h)$
BR	2.5	2	0.3	9	7.7	1.02
MBR	2.5	2	0.3	14	9.2	0.78
LDK	2.5	4	0.3	48	24.4	0.61

$$V_{bz} = R_p P_z - R_a A_z \quad (3)$$

$$ACH = \frac{3.6 V_{bz}}{Vol} \quad (4)$$

V_{bz} breathing zone outdoor airflow, R_p outdoor airflow rate required per person, P_z zone population or number of people, R_a outdoor airflow rate required per unit area, and A_z zone floor area.

Most national standards set the permissible ventilation rates based on the ASHRAE 62.1 (ASHRAE, 2017). According to the ASHRAE 62.1, two approaches can be used, which are the ventilation rate and indoor air quality procedure, respectively. The ventilation rate procedure aims to provide sufficient outdoor air to dilute the indoor contaminant to a safe level. This type of approach is commonly implemented in the national standard. However, this approach might not always be the best method considering the uncertainty of the outdoor air quality. A study reported that the air quality in the ten largest cities in Indonesia was not at a safe level, with PM2.5 ranging from 8-59 μg/m^3 (Greenstone and Fan, 2019), which was beyond the World Health Organization (WHO) threshold of 10 μg/m^3. On the other hand, the indoor air quality approach directly aims to reduce and control the air through diluting and enhancing air cleaning by using air filtration technology. By using an air filtration system, natural ventilation is not necessarily needed to meet good indoor air quality.

Since the desirable ventilation rate should be calculated by considering the room occupancy and environmental condition, a simple calculation was conducted by using the ACH calculation formula (Equation 3). For this calculation, the room and occupancy properties were assumed as listed in Table 5, while the required value for ventilation refers to the ASHRAE 62.1. The calculation result shows that the required ventilation rate for indoor air quality is relatively lower than the existing standard, which ranges from 0.61-1.02 ach. Based on the calculation, there is potential to provide a relatively low ventilation rate to provide adequate indoor air quality while maintaining a fair AC energy consumption.

CFD Simulation Results: Profile of Indoor Air Temperature and Energy Consumption

Figure 3 shows the effects of the outdoor ventilation rate on the indoor temperature, temperature difference return-supply AC, and AC energy consumption. As shown in Figure

3 (a), the sudden drop is observed in the first five minutes; then, the indoor air temperature becomes relatively steady afterward. This phenomenon shows that the compressor does not run all the time to cool the room. Instead, it runs and cools the room until the targeted temperature is reached, and then it stops. This cycle will occur when the room receives relatively warm outdoor air due to ventilation. In addition, the result shows that a larger rate of outdoor air leads to longer compressor work, thus increasing AC energy consumption. For instance, the ventilation rate of 2 and 10 ach resulted in supply-return air temperature difference by up to 5 and 6 minutes, respectively (see Figure 3 (b)). As mentioned in the principle of the AC split system, the occurrence of the temperature difference between supply and return air indicates the operation of the AC's compressor (i.e., 0°C indicates the compressor is off and no electric energy is used). Consequently, the longest operation of the compressor was observed when the window was opened for 5 minutes per during 12-hour AC usage. Under this condition, the AC consumption could reach 4.78 kWh and 6 kWh per day.

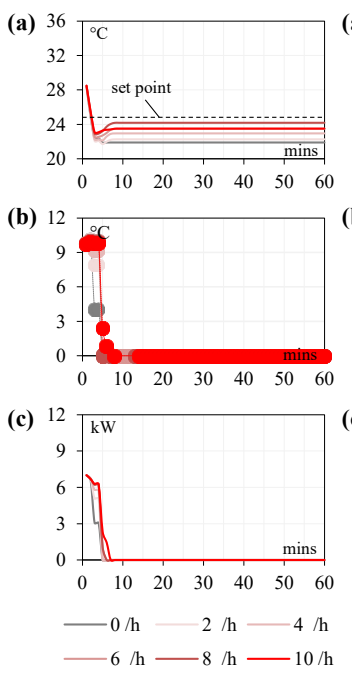


Figure 3. Effect of the outdoor ventilation rate on (a) indoor air temperature, (b) temperature difference return-supply AC, and (c) energy consumption

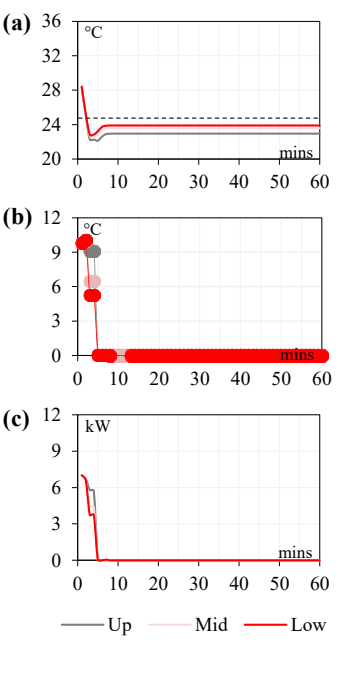


Figure 4. Effect ventilation position on (a) indoor air temperature, (b) temperature difference return-supply AC, and (c) energy consumption

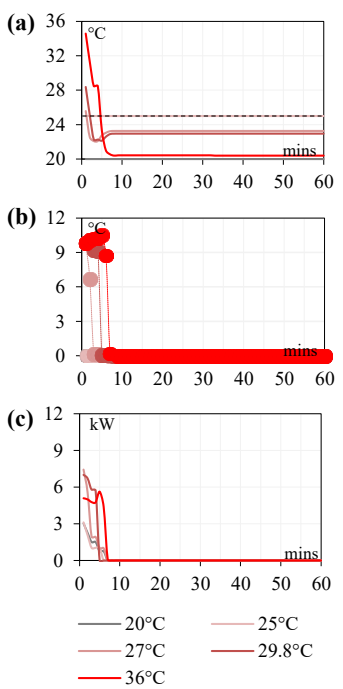


Figure 5. Effect of the outdoor weather condition on the indoor air temperature, temperature difference return-supply AC, and energy consumption

This study also found that the AC location significantly affects energy consumption. As shown in Figure 4, the energy consumption is higher with a shorter distance between the source of outdoor air and the AC position. For instance, the source at the upper part has a higher supply-return air temperature difference compared to the middle and lower opening positions by up to 2.5 and 3°C, respectively. Consequently, the daily energy consumption will increase by up to 0.55 and 0.8 kWh higher than the opening at the middle and lower part, respectively. This phenomenon mainly occurs due to the closer distance between the opening and the AC, which brings more hot outdoor air to the compressor, thus leading to more excessive work of the cooling system.

In addition, Figure 5 reveals the effect of outdoor weather conditions (i.e., air temperature and humidity) on the AC performance. The result shows that a lower or closer outdoor air temperature to the set-point temperature of AC (e.g., during night-time) entering the indoor space has no significant impact on energy consumption where the daily energy consumption is 1.66 kWh. On the other hand, if the incoming outdoor air temperature is higher than the AC set-point temperature, the energy consumption will significantly increase. For instance, the outdoor air temperatures of 27 and 36ºC result in 3.78 and 5.95 kWh/day, respectively.

CFD Simulation Results: Outdoor Ventilation Rate on The AC Energy Consumption

This section shows the daily energy consumption of AC under several window operations. The result found that a longer window operation period would lead to higher daily energy consumption. For instance, as depicted in Figure 6 (a), by injecting the same outdoor ventilation rate of 2 /h, BR with Window Operation (WO)-1 consumes the energy of 4.78 kWh per day, while the WO-2 and -3 have a total energy consumption of 5.18 and 6.25 kWh per day, respectively. It would directly affect the electricity bills around IDR 2.52, 2.73, and 3.3 mil. per year, respectively (see Figure 7 (a)). As shown in Figures 6 (b) and (c), this phenomenon is constantly observed in the MBR and LDK.

In addition, the result shows that AC specification also significantly affects energy consumption. As shown in Figure 6, AC with a higher COP (i.e., MBR and LDK) has relatively lower energy consumption than the small COP (i.e., BR). Under a similar outdoor ventilation rate of 10 ach and window operation of 15 min/hour (WO-2), BR consumes the energy up to 11.2 kWh per day, while the MBR and LDK with higher COP consume the cooling energy up to 1.92 and 2.88 kWh per day, respectively. Furthermore, Figure 7 shows that the estimated cost in BR is up to IDR 6 mil. per year, while the cost in MBR and LDK are less than IDR 3 mil. per year. The results indicate that the AC specification has a significant role in AC performance and energy consumption.

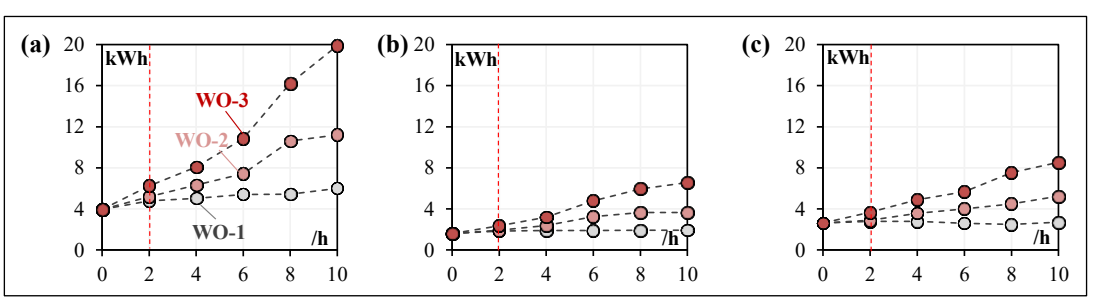
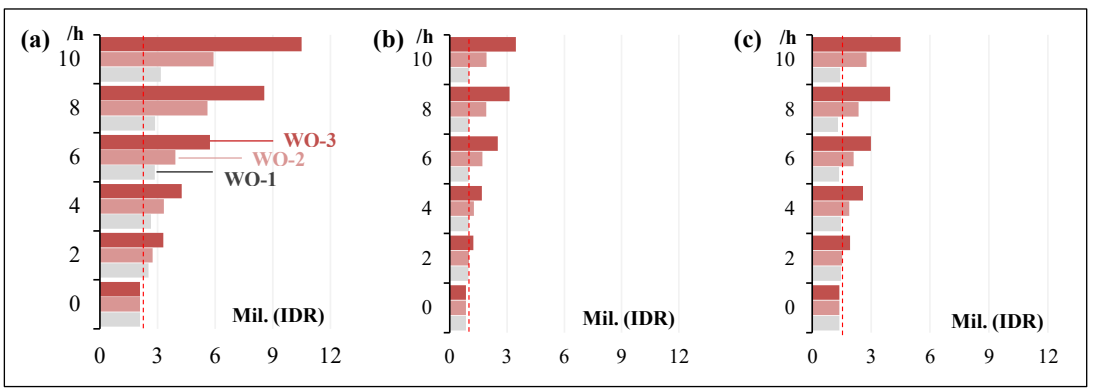


Figure 6. Daily Energy Consumption Under Several Window Operations in (a) BR, (b) MBR, and (c) LDK

In general, the result shows that the increase in energy consumption is inevitable when providing fresh air from outdoor, especially when the outdoor air is higher than the set-point air temperature of AC. The higher energy consumption would directly increase the electricity bill. Nevertheless, the result shows that by referring to ASHRAE 62.1, under the ventilation rate of 0.61-1.02 ach, the total energy consumption can still be considered tolerable. It is because the benefit of opening the small ventilation window could become an alternative to the sophisticated air purifier with an additional annual cost of less than IDR 3.3 mil. per year.

Moreover, the total energy cost varies depending on the AC specification and amount of outdoor air penetrating the indoor space. Therefore, the combination between AC's COP and window opening duration can improve both indoor air quality and energy efficiency in buildings with split-AC system.



Notes: Assuming AC Is Used For 12 Hours in A Day with Cost Estimation of IDR 1444.7/kWh

Figure 7. Annual Estimated Cost Under Several Window Operations in (a) BR, (b) MBR, and (c) LDK (in Indonesian Rupiah (IDR)

CONCLUSION

This study reveals that AC consumption is not only affected by the outdoor ventilation rate; other parameters such as weather conditions, AC specification, and position of opening are also influential to the energy performance of AC. The result shows that the increase in energy consumption is in line with the infiltration rate. For instance, introducing the outdoor infiltration rate of 2 and 10 ach would consume cooling energy up to 4.78 kWh and 6 kWh per day, assuming the window operation period of 5 minutes per hour for 12-hour AC usage. In addition, the distance between the fresh air intake/opening location and the AC position should also be considered since the shorter distance would bring relatively hot air closer to the AC's evaporator. Moreover, since the AC's compressor will work to meet the room's set point, i.e., 25 ºC, the penetration of outdoor air higher than the AC set point temperature should be carefully controlled by adjusting the duration ventilation or opening the window.

This study also found that an increase in energy consumption is unavoidable when introducing fresh air into the room. Therefore, this study suggests the permissible infiltration rate and recommended ventilation duration to balance between the AC efficiency and IAQ. Based on ASHRAE 62.2, the desirable infiltration rates for indoor air quality range from 0.62-1.02 ach depending on the room dimension and occupancy. By applying this value to the AC room, the increased energy consumption would be maintained up to 2.3 kWh per day. This value would be further lowered if the fresh air intake duration is shorter.

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LITERATURE REVIEW ON THE CORRESPONDENCE OF BREATHING WALL DESIGN PARAMETERS AND BUILDING PERFORMANCE

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Abstract
The substantial energy consumption within the building sector significantly contributes to carbon emissions, a primary driver of global warming. A considerable portion of these emissions arises from the reliance on fossil fuels for energy, a reliance that persists prominently in Indonesia's current energy landscape. Consequently, it becomes imperative to institute energy conservation strategies throughout the entire life cycle of buildings. Efforts directed at conserving energy in buildings hold the potential to impact building performance, particularly in the realm of creating optimal thermal comfort for occupants. As such, it becomes essential to incorporate design initiatives that can achieve thermal comfort without exacerbating carbon emissions, emphasizing the integration of sustainable building design concepts. One notable approach to building envelope design is the application of the breathing wall concept. This design strategy actively and passively influences humidity, air, and heat transfer, thereby positively impacting overall building performance. To discern the specific influence of breathing walls on building performance, this study undertook a comprehensive review of 67 articles published in reputable journals and proceedings. The primary objective was to evaluate the extent to which each parameter associated with breathing walls contributes to the enhancement of building performance. Employing a qualitative method with a statistical approach, data from the 67 articles underwent rigorous collection and analysis using the content analysis method. The outcomes of the analysis indicate that certain parameters associated with the breathing wall concept exert a significant influence on building performance. These parameters encompass aspects related to the building itself, the broader environmental context (including climate, location, and surrounding conditions), materials (covering shape, dimensions, type, and characteristics), as well as the ventilation system and air properties. Moreover, the analysis demonstrates a robust correlation between various breathing wall design parameters and critical aspects such as thermal performance, indoor air quality (IAQ), energy consumption, costs, and carbon emission levels. This study endeavours to provide comprehensive insights into the implications of breathing wall design parameters within a practical context. It is anticipated that the findings of this study will not only enhance our understanding of breathing wall design parameters but also serve as a foundational resource for the development of environmentally responsive building designs. By prioritizing sustainability considerations, it is hoped that improvements in building performance can be achieved without compromising environmental principles.

Keywords: *Breathing Wall; Content Analysis; Parameter; Building Performance, Thermal Comfort*

INTRODUCTION

Energy consumption in the building sector has risen significantly, accounting for 40% of total consumption and surpassing contributions from the industrial and transportation sectors (Aste et al., 2022; Pérez-Lombard et al., 2009). This heightened consumption is a major factor in the escalation of carbon emissions, the primary catalyst for global warming. Consequently,

the development of effective strategies to curtail the energy load associated with heating and cooling within this sector becomes imperative.

Efforts directed at reducing energy loads necessitate a comprehensive consideration of various factors, particularly their impact on occupant comfort, with a specific focus on thermal comfort (Al-Khatri, 2014). Optimizing energy use within the building sector not only mitigates carbon emissions but also enhances energy efficiency, thereby positively impacting the environment. As such, the formulation of a holistic and integrated strategy is imperative to effectively and sustainably achieve the goal of reducing energy loads in the building sector.

Simultaneously, energy consumption in buildings is influenced by several physical parameters, including building orientation, window-to-wall ratio, level of transparency, and geographical conditions (Bateni, 2023). The quest to diminish energy consumption in buildings can be actualized through the application of high-performance building envelope technology that aligns with energy-efficient building principles (Kasem, 2022).

The building envelope serves as a conduit for heat transfer between the interior and exterior of the building, emerging as a pivotal element in diminishing the energy load on buildings. The design and selection of envelope materials assume a crucial role in regulating the heat transfer process (Krope & Goričanec, 2013). Therefore, a profound understanding of the physical parameters and the application of these technologies and principles provide the foundation for designing energy-efficient and sustainable buildings.

One type of building envelope that has undergone development is the breathing wall, functioning both as a building envelope system and a component within the ventilation system. This system is characterized by the use of porous materials with the capability to passively or actively channel air into the building (Shalaby et al., 2020). The notable advantage of this sheathing system lies in its ability to conserve energy by reducing conductive heat loss and energy associated with pressure drop (Zhang & Wang, 2021). Breathing walls find particular suitability in areas with predominantly hot climates, as they enhance indoor air quality by controlling air flow and reducing humidity levels (Alongi et al., 2020). The implementation of this system manifests a positive impact on building performance, evident in the achievement of optimal Indoor Air Quality (IAQ), reduced energy consumption, and alleviated urban air pollution (Zhai, 2016). Consequently, the utilization of Breathing Walls emerges as a sustainable solution, supporting not only energy efficiency but also enhancing the overall environmental quality surrounding the building.

The efficacy of breathing walls in influencing building performance is contingent upon various physical parameters intrinsic to the design. Prior research has identified several factors shaping the effectiveness of breathing walls, encompassing the number of layers of internal insulation, wall thickness, the level of air flow through the wall, and the diameter or distance between openings in each insulation layer (Yoon et al., 2000). A separate study utilizing timber material in breathing walls (Craig et al., 2021) pinpointed determining parameters such as channel/hole diameter, wall thickness, and the distance between channels/holes.

Investigations into breathing wall design parameters play a pivotal role in comprehending the behaviour and performance of breathing walls (Rincon-Tabares et al., 2022). Therefore,

the objective of this research is to identify factors significantly influencing breathing wall parameters and their impact on building performance. It is anticipated that insights into these parameters will serve as the foundation for developing and optimizing breathing wall designs, ensuring their alignment with specified building performance standards.

METHODOLOGY

This research employs a qualitative-exploratory method with a grounded theory approach, a qualitative research methodology designed to formulate and test theories based on empirical data (Kosasih, 2018). The process encompasses data collection, systematic analysis, and the application of results to either test or develop new theories. The research methodology comprises four primary stages, with a focus on the selection and analysis of pertinent articles relevant to the study.

In the initial stage, keywords pertaining to breathing walls as a building envelope and their impact on building performance were identified. The chosen keywords encompass terms such as breathing wall, breathing facade, breathing architecture, ventilated wall, porous screen, and dynamic insulation. These combinations of words were generated through the use of boolean operators (AND, OR, NOT).

The second stage involved manual searches of online databases, including Google Scholar, Jstor, and databases from major publishers such as Elsevier, Taylor & Francis, Sage, Springer, and Wiley.

The third stage encompassed sorting articles based on specific criteria, specifically focusing on journal or conference articles directly addressing building envelopes and breathing walls. During this stage, literature was selected that met the established criteria, with verification through a review of keywords and abstracts. A total of 67 journals were subsequently selected for further analysis.

In the final stage, data extraction was conducted from the identified journals, encompassing variables such as the type of writing, year of publication, country of origin of the author, type of publication, and the type of research. Additionally, analysis was performed based on keywords and abstracts utilizing the content analysis method. The content analysis involved defining variables, coding content, analysing data, and modelling findings. The content analysis method employed is directed content analysis, involving stages such as open coding, axial coding, and selective coding (Creswell, 2014). The outcomes of content analysis are utilized to identify the dominant parameters of breathing walls and their relationship to building performance, aligning with the research objectives.

RESULT AND DISCUSSION

Overview of Articles as Objects of Study

Out of the 67 journal and conference articles chosen, the selection criteria were grounded in their relevance to the discourse surrounding breathing walls as building envelopes and their impact on building performance. This selection limitation was imposed due to the scarcity of articles specifically addressing this particular topic. Among the selected articles, 56 (84%)

were identified as research articles, whereas 11 articles (16%) were classified as review articles, as illustrated in Figure 1.

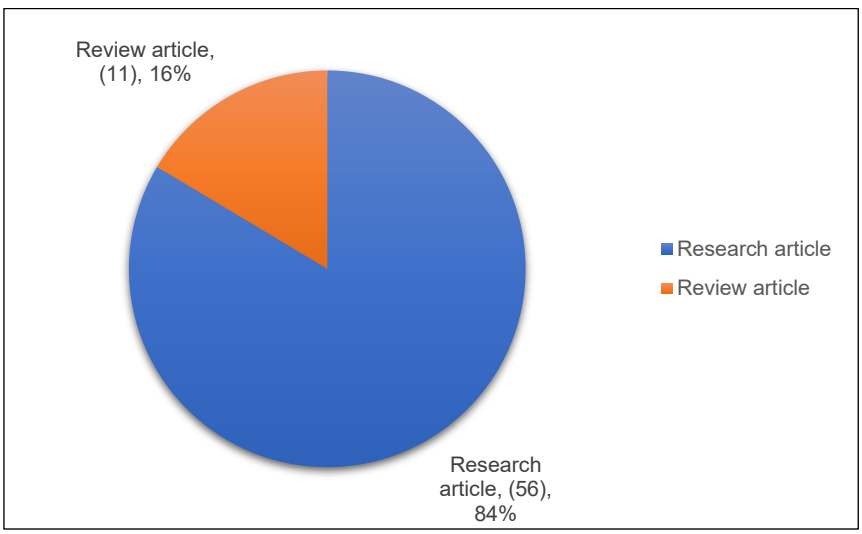

Figure 1. Percentage of Articles Based on Research Type

Regarding the publication type, the preponderance of articles originates from journals indexed in Scopus, with proceedings and conferences following in prominence. Additionally, a subset of articles emanates from journals indexed in various platforms such as Google Scholar, DOAJ, Magiran, KSCI, along with several journals not indexed or of unknown origin, as depicted in Figure 2.

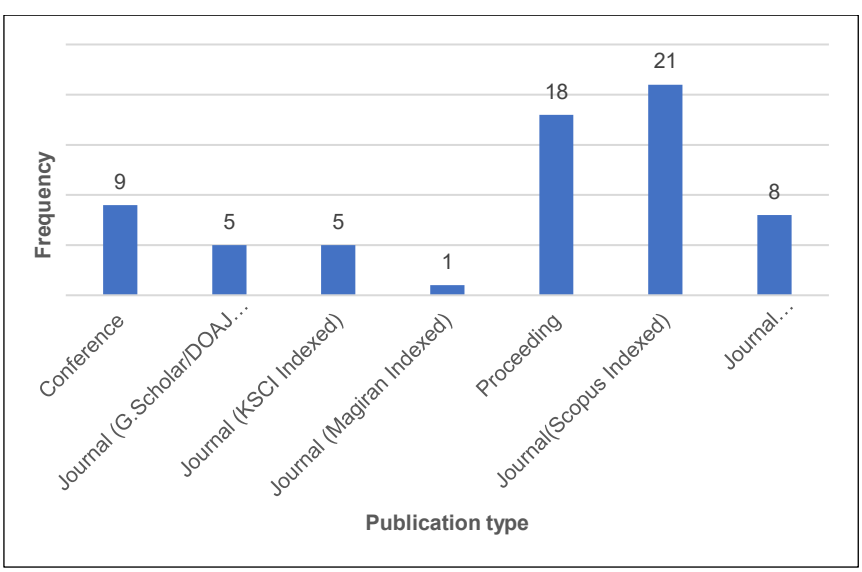

Figure 2. Number of Articles Based on Publication Type

In terms of author's country of origin, the articles are dominated by researchers from Japan and Italy, followed by Scotland, South Korea, and the United States, as seen in Figure 3. This analysis provides an overview of the geographic distribution and types of articles related to breathing walls in the context of building performance research.

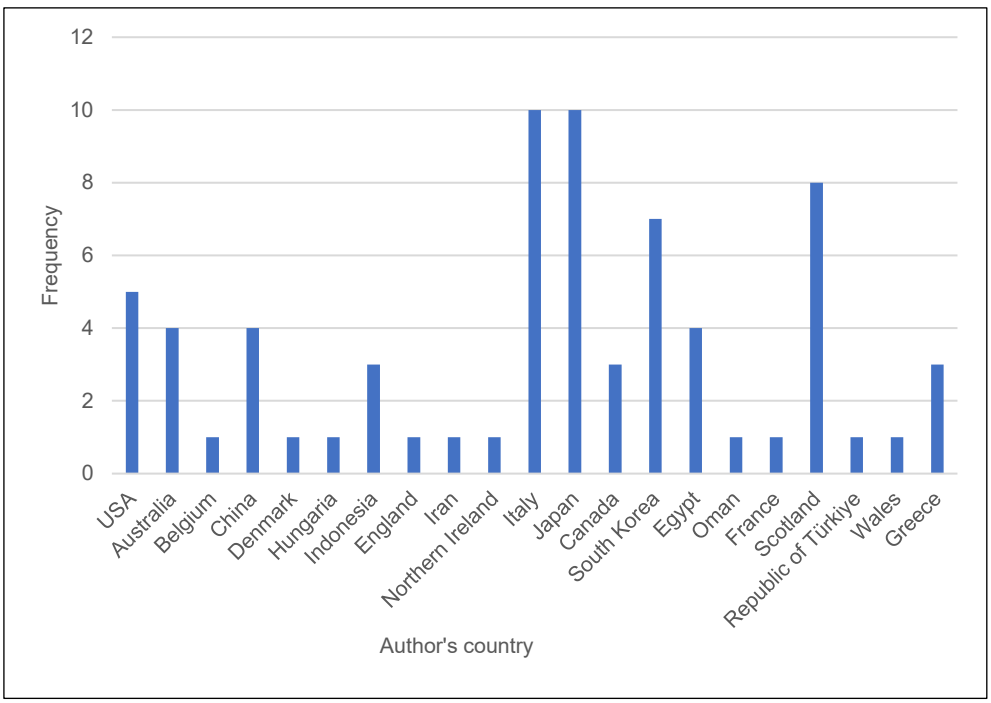

Figure 3. Number of Articles Attribute Based on Author's Country

Figure 4 illustrates the distribution of articles based on the year of publication, encompassing publications from 1995 to 2022. The earliest publication, authored by Hoyano et al. (1995), involved a review of multi-layer aluminium foil construction, focusing on its transitional and thermal characteristics for developing passive breathing walls in temperate climate areas. The development featured a 70 mm thick wall with 8 layers between aluminium foil sheets, separated by spacers installed horizontally at 10 cm intervals from top to bottom.

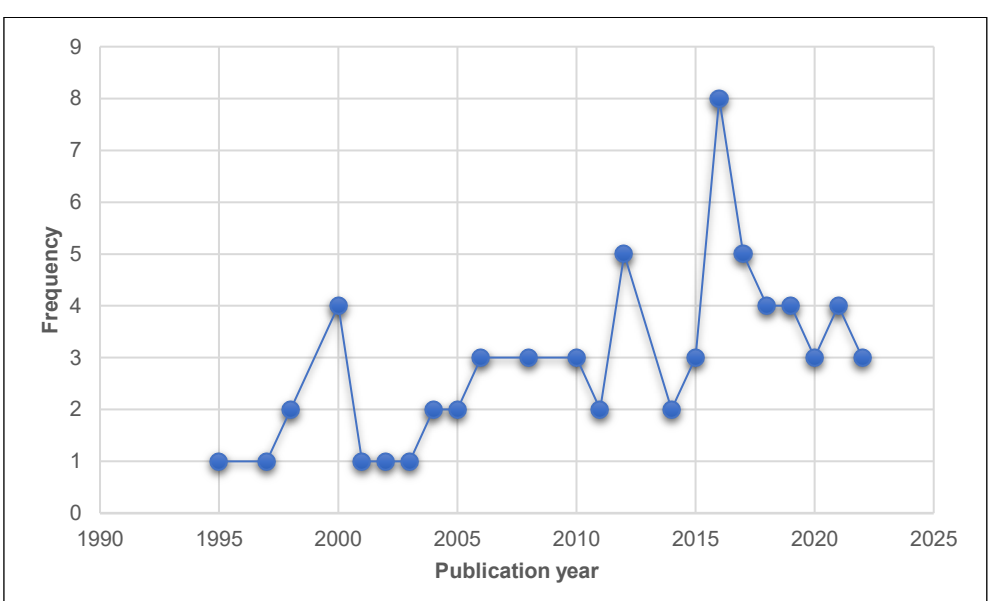

Figure 4. Number Articles Attribute Based on Publication Year

The volume of publications experienced an increase post–2010, with a notable peak in 2016–2017. This surge in publications is comprehensible as a response to a growing array of objectives that necessitate exploration under diverse conditions.

In the publications from 2010 onwards, active research on breathing walls gained momentum. Craig & Grinham (2017) developed a breathing wall functioning as a heat exchanger, incorporating various materials to efficiently withstand low levels of heat while minimizing conduction losses. Zhang et al. (2019) conducted tests on exhaust air insulation walls utilizing breathing walls for heat recovery from the building envelope. Parametric methods were employed to determine the influence of key parameters on changes in Exhaust Air Insulation Wall (EAIW) thermal performance, including hourly temperature field, heat gain, decrement factor, and time lag. The thickness and exfiltration rate of porous materials emerged as pivotal factors in preventing heat conduction through the EAIW to interior spaces. Subsequent research by Craig et al. (2021) utilized low-carbon timber material to develop a more sustainable breathing wall.

Figure 5 presents a review of articles categorized by research methods. Among the 67 articles, a well-balanced distribution of research methods is observed. Specifically, there are 22 articles employing experimental-laboratory methods, 21 employing field experimental approaches, and 19 utilizing digital simulation techniques. The remaining articles are reviews that employ theoretical study methods.

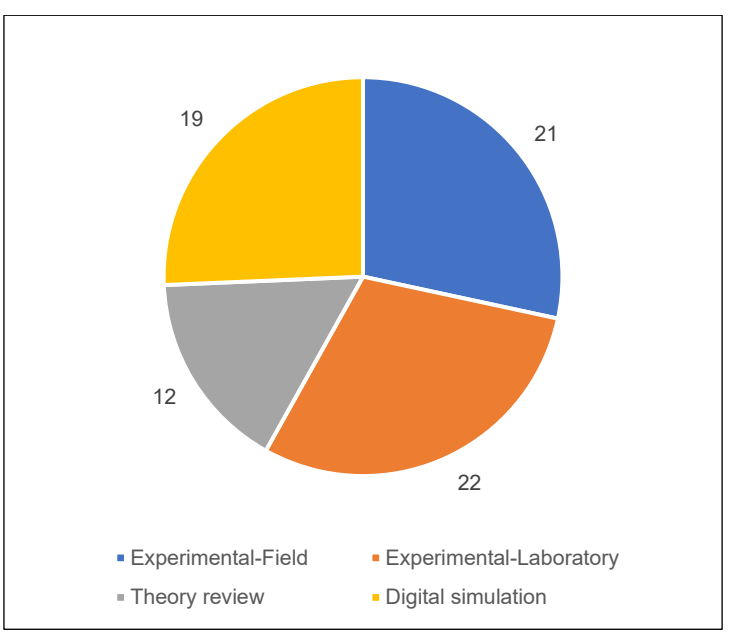

Figure 5. Pie Chart Diagram of Articles Attribute Based on Research Method

In the subsequent stage, keywords extracted from each journal undergo grouping into sub-categories, which are then further condensed into overarching categories. This phase corresponds to the open coding stage, where the identification of categories is grounded in existing theories, researcher rationale, or what is termed as directed content analysis (Creswell, 2014). Keywords unrelated to the discussion are deliberately excluded during this categorization process.

Analysis of Breathing Wall Parameters and Performance Categories Based on Content in Article Keywords

Following the identification of keywords, several parameter categories have been discerned. These categories encompass a variety of groupings based on keywords, delineated as research parameters/input and research objectives/output. A comprehensive presentation of these categories is provided in Table 1.

Table 1. Results of Open Coding on Breathing Wall Parameters (Input) Based on Article Keywords

No.	Category and Subcategory		Frequency	Percentage
1	**Building Envelope Parameter**		**35**	**21%**
	A)	Breathing Wall	20	
	B)	Building envelope	10	
	C)	Active building envelope	5	
2	**Material Parameter**		**33**	**20%**
	A)	Material characteristic	26	
	B)	Material type	7	
3	**Thermal Parameter**		**29**	**17%**
	A)	Thermal insulation	22	
	B)	Thermal characteristic	4	
	C)	Thermal condition	3	
4	**Design Concept Parameter**		**29**	**17%**
	A)	Architectural concept	2	
	B)	Sustainable concept	17	
	C)	Passive design concept	10	
5	**Ventilation Parameter**		**18**	**11%**
	A)	Natural ventilation	12	
	B)	Ventilation system	3	
	C)	Ventilation	3	
6	**Air Parameter**		**14**	**8%**
	A)	Air exchange properties	10	
	B)	Air characteristic	4	
7	**Scope Parameter**		**9**	**5%**
	A)	Surrounding condition	5	
	B)	Building	2	
	C)	Location	2	

Based on the keywords in the articles, the Building Envelope parameter has the highest frequency category, accounting for 21% of the total keyword frequency, followed by the Material parameter. Although the Material parameter is in the second category, the sub-category for material characteristics has the highest percentage compared to all other sub-categories of parameters (16% of the total frequency).

Table 2 delineates the outcomes of coding the research objectives pertaining to breathing walls and their correlation with building performance. The table provides a breakdown of the frequency of occurrence for each identified category. According to Table 2, the prevalent mention of the influence of breathing walls is associated with thermal performance, with a frequency reaching 38%, followed by Indoor Air Quality, which reaches 32%.

Table 2. Results of Open Coding on Breathing Wall Research Objectives (Outputs) That Affect Building Performance Based on Keywords

No.	Category and Subcategory		Frequency	Percentage
1	**Thermal Performance**		**20**	**38%**
	A)	Thermal performance	8	
	B)	Heat transfer	6	
	C)	Humidity	6	
2	***Indoor Air Quality***		**17**	**32%**
	A)	Indoor Air Quality	9	
	B)	Filtration	4	
	C)	Pollution	4	
3	**Energy Performance**		**9**	**17%**
	A)	Energy efficiency	5	
	B)	Cooling load energy	3	
	C)	Energy consumption	1	
4	**Carbon Emission Performance**		**5**	**9%**
	A)	Carbon reduction	2	
	B)	Carbon utilization	1	
	C)	Carbon type	1	
	D)	Carbon footprint	1	
5	**Ventilation Performance**		**2**	**4%**
	A)	Ventilation performance	2	

The initial stage of open coding from article keywords yielded the identification of 7 categories related to breathing wall parameters and 5 categories associated with building performance. These categories were discerned through an examination of keywords within the content of the articles. To validate the outcomes of the initial stage, data processing was conducted utilizing the same methodology employed in the article abstract.

Analysis of Breathing Wall Parameters Based on Content in Article Abstracts

In the subsequent stage, keywords from each journal are clustered into sub-categories based on the terms found in the abstract. This stage is analogous to the earlier open coding keyword stage. Various categories are formed based on the abstract, representing both the research parameters/input and research objectives/output. These divisions are illustrated in Tables 3 and 4. Specifically, Table 3 presents the coding results of breathing wall parameters, including the frequency of their occurrence within the identified categories.

The analysis of abstract keywords yielded a total of 680 coding keywords, each categorized and subcategorized. The coding results align with the keyword analysis, highlighting the Building Envelope parameter as the category with the highest frequency, followed by the Material parameter. Within the Building Envelope category, building envelope characteristics stand out as the highest subcategory, with a frequency value reaching 22%, followed by material characteristic parameters with a frequency value reaching 10%. This indicates that these two parameters are pivotal in breathing wall design.

Table 3. Results of Open Coding on Breathing Wall Parameters (Input) Based on Article Abstract

No.	Category and Subcategory		Frequency	Percentage
1	**Building Envelope Parameter**		**216**	**32%**
	A)	Building envelope characteristic	150	
	B)	Building envelope	21	
	C)	Placement position	17	
	D)	Opening dimension	8	
	E)	Building component	8	
	F)	Opening shape	7	
	G)	Building characteristic	5	
2	**Material Parameter**		**186**	**27%**
	A)	Material characteristic	66	
	B)	Material type	49	
	C)	Thermal characteristic	19	
	D)	Material shape	15	
	E)	Number of layers	11	
	F)	Perforation rate	11	
	G)	Material thickness	9	
	H)	Material component	6	
3	**Scope Parameter**		**116**	**17%**
	A)	Building type	38	
	B)	Climate	32	
	C)	Location	23	
	D)	Surrounding condition	14	
	E)	Experiment room	9	
4	**Air Parameter**		**69**	**10%**
	A)	Air pressure	26	
	B)	Air velocity	25	
	C)	Air	14	
	D)	Air direction	3	
	E)	Air distribution	1	
5	**Ventilation Parameter**		**56**	**8%**
	A)	Natural ventilation	22	
	B)	Artificial ventilation	20	
	C)	Ventilation	8	
	D)	Air change rate	5	
	E)	Hybrid ventilation	1	
6	**Thermal Parameter**		**40**	**6%**
	A)	Thermal insulation	40	

Table 4 presents the outcomes of data coding concerning the research objectives of utilization breathing walls, along with the categorized frequency of their occurrence.

From the keywords in the abstract, a total of 392 words were coded, reaffirming the findings of the previous analysis. The Thermal Performance category was identified with the highest frequency, reaching 44%, followed by Indoor Air Quality at 17%. These diverse categories of design and performance parameters can serve as a foundation for establishing design variables aimed at achieving optimization with the best performance.

Table 4. Frequency of Breathing Wall Objective That Related to Building Performance

No.	Category and Subcategory		Frequency	Percentage
1	**Thermal Performance**		**176**	**44%**
	A)	Heat transfer	73	
	B)	Humidity	37	
	C)	Thermal performance	29	
	D)	Temperature	15	
	E)	Room temperature	9	
	F)	Thermal comfort	6	
	G)	Surface temperature	3	
	H)	Outdoor temperature	2	
	I)	Radiation level	2	
2	**Indoor Air Quality**		**68**	**17%**
	A)	*Indoor Air Quality*	24	
	B)	Pollutant	10	
	C)	Air filtration	9	
	D)	Particle concentration	9	
	E)	PM	9	
	F)	CO2	4	
	G)	Indoor Air Quality performance	3	
3	**Energy Performance**		**60**	**15%**
	A)	Energy efficiency	34	
	B)	Cooling load energy	12	
	C)	Energy consumption	7	
	D)	Heating load energy	5	
	E)	Energy performance	2	
4	**Ventilation Performance**		**49**	**12%**
	A)	Ventilation performance	25	
	B)	Air change rate	24	
5	**Building Quality Performance**		**29**	**7%**
	A)	Health	10	
	B)	Sustainable	9	
	C)	Environment quality	8	
	D)	Comfort	2	
6	**Economy Performance**		**10**	**3%**
	A)	Cost	8	
	B)	Economy	2	
7	**Carbon Emission Performance**		**4**	**1%**
	A)	Carbon management	4	

Correspondence Analysis Between Parameters and Breathing Wall Performance Based on Article Keyword and Abstract

The subsequent step involves identifying the correspondence between breathing wall parameters and building performance, based on the prior analysis conducted. The distribution of correspondence between the results of open coding on parameters and breathing wall performance based on article keyword and abstract can be seen on Table 5.

The distribution of correspondence results reveals that the input variable, represented by the parameter category, is linked to the performance output category, indicating a dominant frequency position in the relationship between building envelope parameters as input and ventilation performance as output parameters.

Table 5. The Distribution of Correspondence Between The Results of Open Coding on Parameters and Breathing Wall Performance Based on Article Keyword and Abstract

	Category	Output								
		Indoor Air Quality	Building Quality	Economy performance	Carbon emission performance	Energy performance	Ventilation performance	Thermal performance	Total frequency	Percentage
Input	Design Concept Parameter	2	4	0	0	0	0	0	**6**	**9%**
	Scope Parameter	2	4	0	0	0	1	0	**7**	**10%**
	Material Parameter	0	3	0	3	1	4	1	**12**	**17%**
	Ventilation Parameter	0	1	0	2	0	6	1	**10**	**14%**
	Building Envelope Parameter	5	6	1	1	1	3	5	**22**	**31%**
	Thermal Parameter	0	1	0	0	0	2	4	**7**	**10%**
	Air Parameter	0	0	0	0	0	5	1	**6**	**9%**
	Total Frequency	**9**	**19**	**1**	**6**	**2**	**21**	**12**		
		13%	**27%**	**1%**	**9%**	**3%**	**30%**	**17%**		**100%**

In order to ascertain the relationship between parameters and the performance of breathing walls, axial coding is conducted at this stage, utilizing correspondence analysis. The method employed for this analysis is ward hierarchical clustering. The outcomes of this analysis are presented in the ensuing dendrogram. The dendrogram visually illustrates trends in a hierarchical manner, allowing for the grouping of parameters with closely aligned performance, see Figure 6.

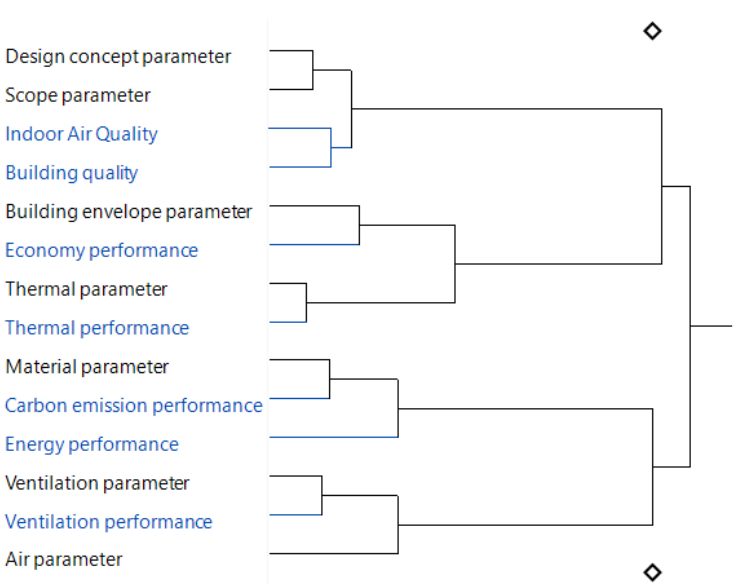

Figure 6. Correspondence Analysis Between Parameters (Black) and Breathing Wall Performance (Blue) (p= 0.0267)

The significance of the results from the correspondence analysis between parameters and breathing wall performance is indicated by a p-value of 0.0267, as depicted in Table 6.

Table 6. Statistic Results of Correspondence Analysis Between Parameters and Breathing Wall Performance

Test	ChiSquare	Prob>ChiSq
Likelihood Ratio	58.89832539	0.00938176
Pearson	54.11830397	0.02672395

This value indicates a prediction accuracy of 97%. This value denotes a high correlation between these two variables. The correspondence results reveal a discernible tendency for grouping between parameter variables and performance variables. These tendencies can be categorized into four main clusters, as outlined below.

Cluster 1: Design Concept and Quality

This cluster centres on research discussing design concept (f=6) and scope (f=7) parameters influencing the quality performance of buildings. These qualities encompass indoor air quality performance (f=9) and building quality (f=19). These findings align with Tong (2018), who asserted that a green building concept can reduce indoor pollution and enhance indoor air quality comfort. Additionally, Levin (1991) emphasized that building design enhancements, conducted by professionals, contribute to the improvement of indoor air quality.

Cluster 2: Building Envelope, Economy, and Thermal

Research within this cluster delves into the influence of building envelope parameters (f=22) and thermal factors (f=7) on the economic (f=1) and thermal (f=12) performance of buildings. Singhaputtangkul (2014) similarly emphasized that building envelope design can impact economic and environmental aspects. According to Aoul et al. (2021), construction failures in the building envelope can lead to financial losses.

Cluster 3: Materials, Energy, and Carbon

This cluster focuses on research that discusses material parameters (f=12) with implications for carbon emissions (f=6) and energy (f=2) performance. Prior studies have indicated that the composition of building materials can mitigate the negative environmental impact of buildings (Eberhardt et al., 2018). Furthermore, as highlighted by Singhaputtangkul (2014), the materials employed in building envelopes can influence environmental impact.

Cluster 4: Air and Ventilation

This cluster addresses research on ventilation (f=10) and air (f=6) parameters impacting ventilation performance (f=21). Song et al. (2018) noted that urban air flow influences natural ventilation conditions in buildings. External pollutant conditions significantly affect ventilation usage (Chen et al., 2019). Swiercz (2017) also emphasized that external conditions can influence natural ventilation. system hybrid ventilation.

Visual Hypothesis Model

Based on the results of the correspondence analysis described previously, a pattern of relationship was found between parameters and breathing wall performance carried out by previous research.

This pattern is depicted as a visual hypothesis model called "Hypothesis Model of the Influence of Parameters and Performance on the Breathing Wall", which can be seen in the Figure 7. Even though this hypothetical model has a high significance value, it should be noted that it does not rule out the possibility that there are other parameters and performance that also influence each other. For example, according to Azari (2014), the design and materials of a building envelope have an impact on energy as well as an environmental impact on its life cycle. Appropriate ventilation design can also simultaneously influence comfort, productivity, health and energy use (Jones, 2000). So, further research needs to be carried out to test this hypothesis.

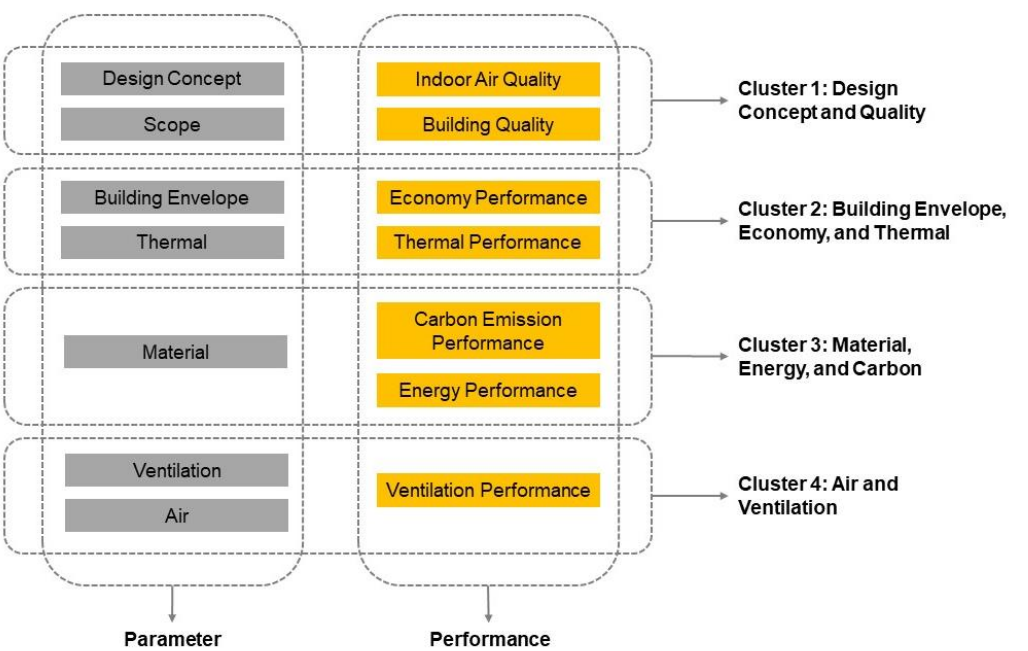

Figure 7. Visual Hypothesis Model of Parameter Influence and Performance on Breathing Wall

CONCLUSION

This study systematically identifies breathing wall parameters as components of the building envelope and examines their correlation with building performance. The content analysis of abstracts reveals that among the breathing wall design parameters, the building category, particularly the material parameters within the material characteristics sub-category, is the most frequently discussed in publications. This finding aligns with the outcomes of the open coding analysis on abstract content, emphasizing the dominance of building envelope parameters, specifically building envelope characteristics and building material characteristics.

Within the breathing wall performance category, thermal performance emerges as the most influential, particularly concerning heat transfer sub-performance, as evidenced by its high frequency of occurrence. Subsequently, indoor air quality performance is also acknowledged as a significant factor.

The study further identifies four primary clusters in the correspondence categories of breathing wall parameters and building performance, namely the Design Concept and Quality cluster, the Building Envelope, Economy, and Thermal cluster, the Materials, Energy, and Carbon cluster, and the Air and Ventilation cluster.

These research findings represent an initial step that can serve as valuable input for the development of a breathing wall model based on various parameters, aimed at achieving the desired building performance. However, it is important to note that the limitations of this research include its reliance on literature review alone, and subsequent empirical testing is essential to determine the effects of each breathing wall variable, ensuring more precise and accurate results.

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THE SIGNIFICANCE OF CONTRACTUAL ELEMENTS IN INFLUENCING BUILDING CONSTRUCTION PROJECT PERFORMANCE: A STAKEHOLDER PERSPECTIVE

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Abstract
Construction projects involve multiple stakeholders and necessitate specific and unique allocations of manpower resources, materials, and work methods tailored to the project's type and scale. Contracts are a vital communication tool among the stakeholders engaged in construction projects. A comprehensive comprehension of the structure and contents of construction contracts is imperative to grasp the distinctiveness of the project's work scope. This study aims to ascertain the significance of construction contracts in attaining project performance aligned with the predetermined targets specified in the contract, as the stakeholders endorsed. Employing qualitative research methods, data collection utilised an online questionnaire distributed to stakeholders of building construction projects. Content analysis, comprising open coding, axial coding, and selective coding stages, was employed to categorise the importance levels of contract components. Research findings indicate that stakeholders overwhelmingly attribute a highly significant role (94% of respondents) to contracts achieving project performance per planned objectives. Additionally, analysis reveals four categorisations of the level of contractual interest in construction projects that impact project performance: technical, legal, administrative, and financial aspects. Contracts are notably intertwined with legal considerations, particularly those about rights and obligations among parties in construction projects (as acknowledged by 51% of respondents). The project owner demonstrates a heightened concern for each category of contract components compared to other stakeholders. Neglecting contracts involving other stakeholders adversely affects the attainment of effective communication among project participants. A dominant sub-category emerges within each category, which is detailed in this paper. The most prominent sub-category is the significance of technical references in contract execution, influencing the contract payment method. This study sheds light on the intricate dynamics of construction contracts, emphasising their pivotal role in ensuring successful project outcomes and effective stakeholder communication.

Keywords: *Contract; Construction Project; Performance; Perspective; Stakeholder*

INTRODUCTION

Building construction projects have complex and unique characteristics. Building construction projects have limited time, large cost requirements, the involvement of human resources with diverse competencies, and requirements regarding equipment and materials (Murdoch, 2000). The uniqueness and complexity of construction projects require a comprehensive understanding of contract structures, which is essential to understanding the unique nature of construction projects. Based on data from the 2015–2020 Bappenas Foreign Grant Loan Implementation Performance Report, problems are related to implementing construction projects in Indonesia. This problem is related to administrative and technical issues. These technical problems are changes in project design, which cause delays in work

implementation times, changes in the scope of work, and changes in the value of work contracts (Laporan Kinerja Pelaksanaan Pinjaman Dan/Atau Hibah Luar Negeri Kementerian PPN/Bappenas, 2023). Problems in construction projects in general also often occur at every stage of the project, such as poor handling of contractor performance management, lack of resources in terms of labour, equipment or materials, as well as delays in payments (Toor & Ogunlana, 2008; Zr, 2009; Yap et al., 2019).

Problems in implementing construction projects impact the implementation of contract documents due to frequent design changes by clients and lack of time for document preparation (O. Dosumu et al., 2017). Previous research on contracts states that the errors that often occur in contract documents are drawings, cost budget plans, and technical specifications (O. S. Dosumu, 2018) Effective contract administration and understanding the appropriate contents of construction contracts can help manage project problems (Uher et al., 2009). A construction work contract, hereinafter referred to as a contract, is an essential instrument in construction services, which is the legal basis for the relationship between parties. Law enforcement against violations of contract implementation can be realised through criminal and civil actions (Widyantoro & Kurniawan, 2020). Therefore, the contract must be fair for both parties (Tampi, 2015), considering the various aspects necessary for project implementation. Diligence in developing a contract strategy is critical to navigating the unique characteristics of construction projects. Choosing a particular contracting method can accelerate the project schedule, enable contractor involvement in design, offer incentives for cost savings, and create alternative project funding opportunities (Gordon, 1994).

This research aims to see the importance of construction contract components in achieving construction project performance per the contract's targets, measured from the stakeholders' perspective. Understanding the importance of these contract components is expected to contribute to the effectiveness of construction project management significantly.

LITERATURE REVIEW

Construction work contracts cover various dimensions essential to the project's success. This includes technical, legal, financial/banking, tax, insurance, socio-economic, and administrative aspects (Yasin, 2009). Previous research identified nine contract conditions that significantly affect project performance: scope changes, design changes, design improvements, supporting documents, labour, project scope definition, project costs, financial reporting and control, and work execution time reporting and control (William & Ashley, 1987). Standard contract forms are essential in construction projects, providing a framework for implementing contract procedures. High-level understanding of contract documents facilitates shared understanding among diverse stakeholders (Rameezdeen & Rajapakse, 2007). Contract design that does not correctly consider risk allocation can harm stakeholder relationships and reduce project performance (Zhang et al., 2016).

Some contract clauses that significantly influence project performance are contract changes, design changes, re-design work, contract supporting documents, work time changes, work scope, contract value, reports, financial supervision, and work implementation schedule (Williams, 2016). Within the scope of architectural science, architectural science covers buildings, from planning, the construction process, and building characteristics to the decorative finishing of buildings (Banhart, 1967). The quality of teamwork influences project

performance improvement, including project management implementation, relationships, communication, and stakeholder decision-making (Bresnen, 1991; Okuntade, 2014). The involvement of an architect as a stakeholder in a construction project can positively contribute to project management. This is because the contract has existed since the planning stage, so the architect's/engineer's role starts from the planning stage to managing contract administration (Clough et al., 2005).

The main stakeholders in a construction project are the project owner, architect-engineer, and contractor (Clough et al., 2005). The project owner is responsible for funding, design, procurement, contract administration, construction implementation, and maintenance. In carrying out their responsibilities, the architect-engineer assists the project owner. The architect-engineer's task is at the design stage, but in the construction implementation, they can play a role in contract administration and become part of the project owner. Construction implementation is the contractor's task, namely building buildings according to the drawings and specifications determined by the project owner. A harmonious understanding between stakeholders regarding contract documents can help manage contract administration and ensure that construction projects run well.

METHODOLOGY

This research adopted a qualitative approach, utilising a survey as an online questionnaire for data collection. Online questionnaires were disseminated to stakeholders as respondents through non-random sampling (Groat & Wang, 2013). The questionnaire included open-ended questions, enabling respondents to articulate their perspectives on evaluating the significance of construction work contracts.

Data analysis followed a content analysis methodology comprising open, axial, and selective coding stages. Open coding was executed to delineate categories. The collected questionnaire data were organised by identifying segments of meaning, which were then focused on by assigning codes and grouped into specified categories. These categories, derived from open coding, extracted information about the phenomenon under investigation, drawing from the meaning segments. The categorisation process may involve the author's assumptions or adherence to existing theories.

Subsequently, axial coding was conducted to establish categories to construct a theoretical model. The main phenomena were identified through axial coding, causal conditions were explored, strategies were determined, and the context, internal conditions, and consequences of these phenomena were depicted. The convergence of categories and theory is termed selective coding and serves as material for discussion. Theory building unfolds through concurrent data collection, analysis, and iterative processes.

Theory formulation progresses from the foundational details of data collection and analysis. The theoretical description encompasses the main categories identified in open coding, the conditions surrounding the core phenomena from axial coding, and propositions describing the relationships of categories in the selective coding model (Creswell & Poth, 2018).

A total of 117 respondents participated in the study, as shown in Figure 1, with an analysis of respondent demographics revealing that 76% of respondents were male and 24% female. Respondents represented various fields of work, including project owners (34%), procurement managers (16%), contractors (16%), supervisory consultants (9%), academics (9%), planning consultants (8%), and management consultants (8%). Educational backgrounds varied, with 56% holding a Bachelor's Degree, 32% possessing a Bachelor's Degree and a Master's Degree, 8% holding a Bachelor's Degree and a Doctoral Degree, and 2% each having a Diploma III or a Diploma IV. Geographically, respondents were distributed across five major islands in Indonesia, namely Java (73%), Sumatra (13%), Papua (5%), Sulawesi (5%), and Kalimantan (4%). The types of projects undertaken by respondents encompassed building construction (37%), civil construction (32%), planning consultancy (9%), housing (7%), interior design work (4%), building maintenance (4%), infrastructure (3%), industrial construction (3%), and administration (2%).

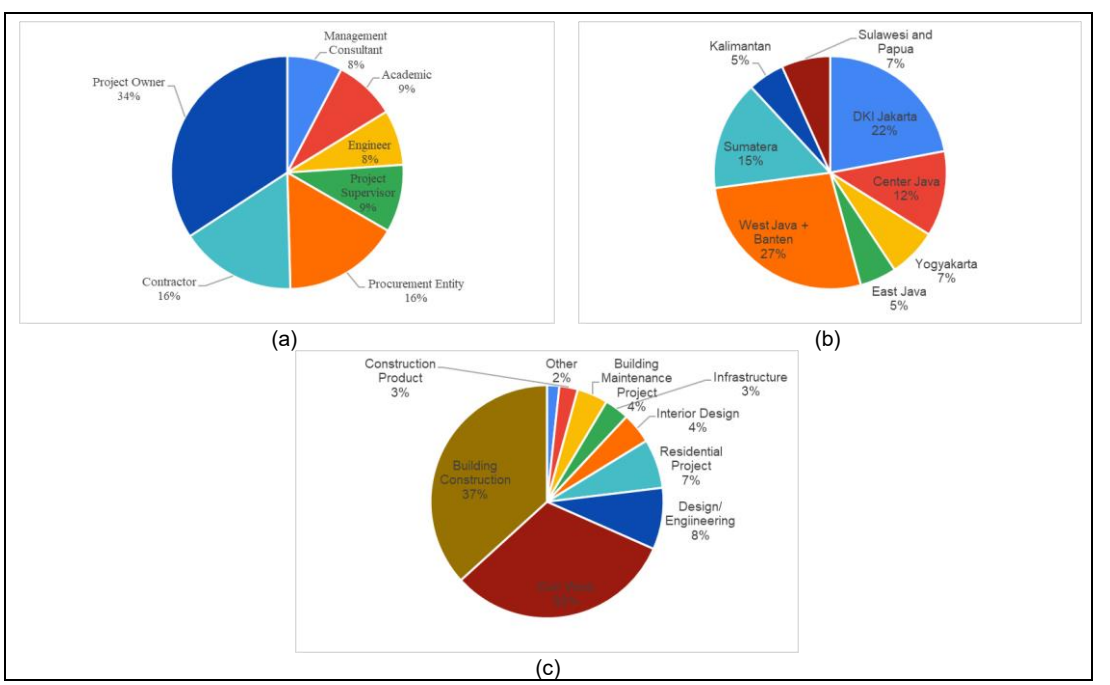

Figure 1. Distribution of Respondents by (a) Field of Work, (b) Domicile, (c) and Project Type

RESULT AND DISCUSSION

Figure 2 illustrates the significance of contract documents in construction projects, as stakeholders perceive. Specifically, 94% of respondents assert that contracts play a "vital" role in construction projects, while 6% consider contracts necessary.

The preliminary data analysis phase involved open coding of responses gathered from participants regarding contracts. Representative examples of open coding from respondents are encapsulated in the following excerpts:

"*Because the work contract is the basis and reference for both parties to carry out construction work, the completer and more detailed it is, the less likely there will be disputes*" (Project Owner).

"*Because the contract contains a cooperation agreement between the employer and the contractor which explains the obligations and rights of each party in the construction implementation process until completion so that the objectives of a project can be achieved*" (Contractor).

"*A contract is an agreement between two parties that binds each other to implement construction work. The contract becomes the guideline and legal basis for each party to fulfil their obligations and obtain their rights. Thus, contract documents are essential when implementing construction work. With a good understanding of the contract documents, it is hoped that no party will suffer losses in construction work. Consequently, the parties should study the articles in the contract document to be signed in detail not to open up opportunities for loss for either party. On the other hand, the chance of contract disputes will be smaller*." (Teaching Staff and Construction Practitioner).

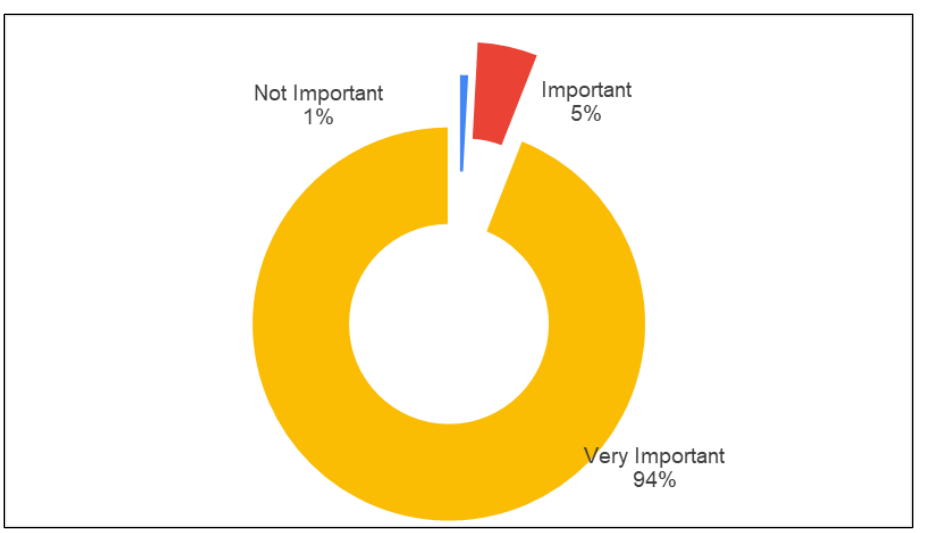

Figure 2. The Importance of Contracts in Construction Projects

Keywords were identified in these quotations, including "statement of agreement," "rights and obligations," "basis and reference," "basis for payment," and "avoiding disputes." Axial coding organised These keywords into codes, categories, and sub-categories. The distribution analysis of the axial coding results revealed percentages for each contract category, as depicted in Table 1.

According to the findings presented in Table 1, stakeholders predominantly associate the contract with the legal category within the project context (54%). This perception is rooted in the understanding that the contract encapsulates an agreement outlining the rights and obligations of the involved parties, constituting 19% of the overall responses. Conversely, within the technical category, the sub-category emphasising the contract's role as a guiding framework for work implementation registers the highest coding frequency at 28%.

Table 1. Distribution Analysis of The Axial Coding Results Revealed Percentages for Each Contract Category

No.	Category	Subcategory	Frequency	Percentage
1	**Administration (A)**		**21**	**14%**
		1. Important documents (A1)	6	4%
		2. Documentation of the relationship between parties (A2)	11	7%
		3. As administrative evidence (A3)	3	2%
		4. As a means of contract control (A4)	1	1%
2	**Legal (L)**		**83**	**54%**
		1. Contains rights and responsibilities (L1)	30	19%
		2. Avoid disputes (L2)	14	9%
		3. Guidelines for engagement and agreements (L3)	25	16%
		4. As a legal basis for the relationship (L4)	14	9%
3	**Financial (F)**		**3**	**2%**
		1. Payment basis (F1)	2	1%
		2. As a financial administration security tool (F2)	1	1%
4	**Technical (T)**		**48**	**31%**
		1. As a performance control tool (T1)	2	1%
		2. As a quality control tool (T2)	1	1%
		3. As a risk mitigation tool (T3)	1	1%
		4. As a work guide (T4)	44	28%

Analysis of Stakeholder Perceptions Regarding the Relationship Between Contractual Aspects in The Legal Category and Project Performance

The predominant category identified among respondents who responded indicating varying levels of importance was the Legal Category. A construction work contract is a pivotal document requiring meticulous drafting and careful consideration of numerous aspects, particularly legal ones (Slamet, 2016). Legal considerations inherent in the contract encompass provisions related to the temporary suspension of work, termination of the agreement or contract, compensation for delays, force majeure, applicable law, contract language, domicile, and the waiver of Article 1266 of the Civil Code (Yasin, 2009). The language employed within the contract emerges as a primary hindrance for contractors in comprehending contract documents while working drawings serve as a complementary element facilitating a better understanding of these documents (Susila, 2019). The Legal Category, with its comprehensive scope, can be further delineated into distinct groupings, giving rise to new categories such as the regulation of rights and obligations, the establishment of a legal foundation or umbrella, and references for problem resolution, as elucidated in the responses provided by several respondents below.

"Set authority and responsibility clearly" (Contractor)

"The contract can also be used as a reference in resolving problems that occur between the two parties" (Project Owner/Head of Division)

"As a guide/legal guarantee for implementers and employers" (Contractor)

These viewpoints emphasise the importance of the Legal Category in delineating apparent authority and responsibility, serving as a reference for issue resolution, and functioning as a guide and legal guarantee for both implementers and project owners within the construction project context, as in Figure 3.

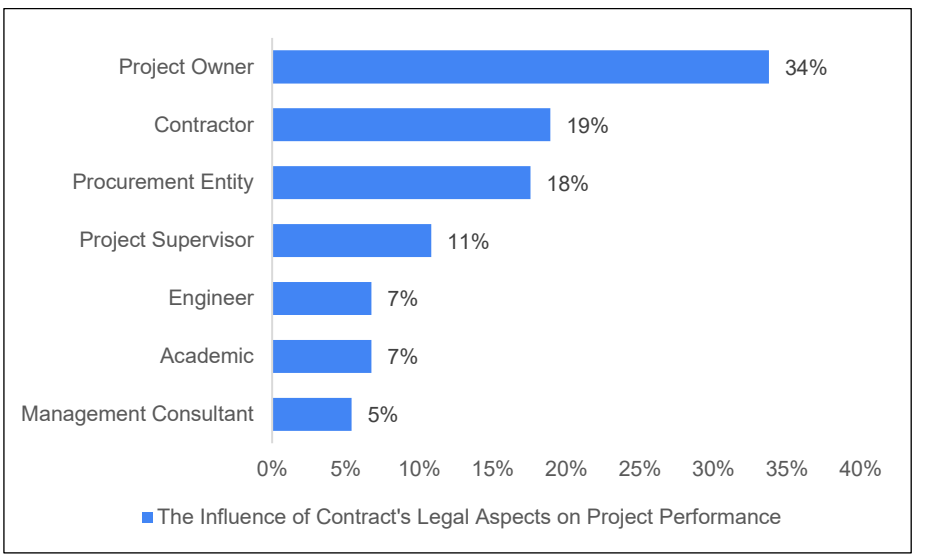

Figure 3. Stakeholder Perceptions of The Influence of Legal Categories on Project Performance

Table 1 delineates that project owners hold the predominant perspective regarding contracts within the legal category, constituting 34% of the opinions expressed. It is noteworthy to acknowledge the existence of two categories of construction work contracts applicable in Indonesia: domestic contracts and foreign contracts. While both adhere to the same format, discrepancies may arise in specific clauses, yet their fundamental function remains consistent. They govern the legal relationship between service providers and users in executing construction work (Lestari & Istri, 2013).

Aligning with the theoretical framework and textual data from respondents, the contract emerges as a crucial point of reference for mitigating disputes between contractual parties. This is contingent upon the equitable regulation of the rights and obligations of both parties within the contract document.

Analysis of Stakeholder Perceptions Regarding the Relationship Between Contractual Aspects in The Technical Category and Project Performance

As articulated by Yasin, the technical aspects of a construction work contract encompass general contract conditions, special contract conditions, technical specifications, contract drawings, scope of work, implementation time, implementation methods, and implementation schedule (Yasin, 2009). The technical category emerges as the second dominant category, comprising 52% of the outcomes derived from data analysis. This category holds significance in influencing the performance of construction projects, as evident in the comments provided by various respondents:

"Work contract documents enable accountable, reliable, and auditable performance control. Contract documents are pivotal in determining contract control efforts, contractor performance assessment efforts, and risk mitigation in the field" (Consultant).

"Good contract control begins with good contract design" (Contractor).

The respondent's textual data reveals keywords such as "performance," "contract control," "risk mitigation," and "contract design." In construction development, factors influencing project success and hindrances during implementation include poor management, inappropriate resource allocation, unsuitable work methods, the impact of the company's financial conditions, and environmental influences (Ismael, 2013).

Claims arising in construction projects must adhere to the provisions stipulated in the construction contract. The predominant factor giving rise to claims is design changes proposed by the project owner (Putri et al., 2013). In this context, the contract document is the primary reference for field implementation, constituting part of the technical category. The technical category plays a contributory role in causing claims. Seven principal factors leading to claims in projects employing international standard contracts encompass user negligence regarding payment, contract failure to rectify quality defects, factors affecting work progress, non-completion of work due to financial considerations of the parties, factors associated with engineers, contract administration, and procedural violation factors (Taurano & Hardjomuljadi, 2013).

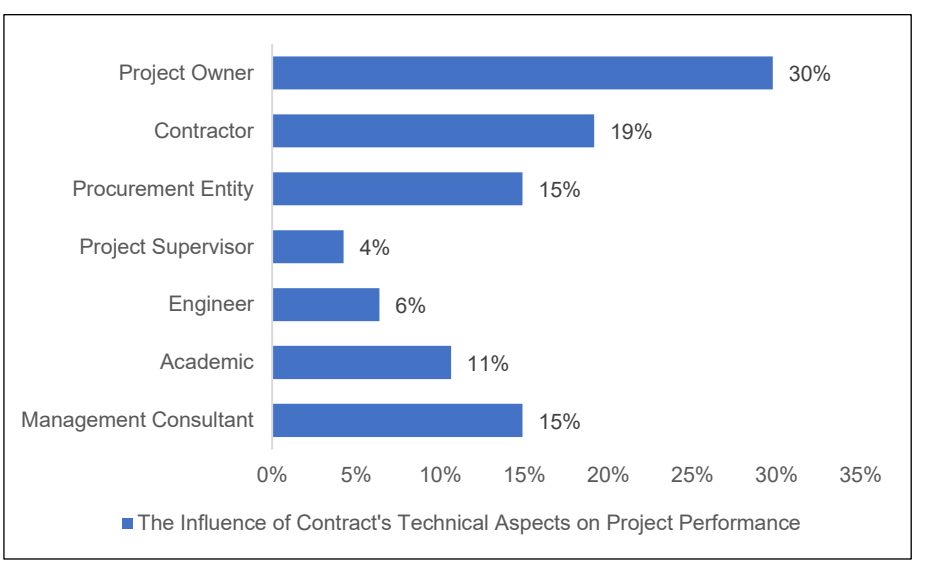

Figure 4. Stakeholder Perceptions of The Influence of Technical Categories on Project Performance

Project owners articulate the prevailing viewpoint on contracts within the technical category, constituting the majority at 30%, as Figure 4 shows, followed by contractors, procurement entities, and management consultants. Compared to the total number of respondents, the frequency data presented herein delineates the alignment between perceptions and the corresponding proportion of respondents.

Notably, it is intriguing that despite a relatively modest representation of respondents, consultant management exhibits a notably elevated level of perception concerning the technical facets of the contract. The discernible emphasis on technical aspects by management consultants, to the exclusion of other facets within the contract, is evident. Nevertheless, from a managerial perspective, as the owner's representative, management consultants play a pivotal role in ensuring quality, a responsibility influenced by various factors within the contract. If a construction management consultant focuses only on the technical aspects of contract management, this can have several significant adverse impacts. Focusing on technical elements can only lead to an imbalance in contract management priorities. Non-technical aspects, such as contract administration, labour relations, and financial elements, must be managed well to achieve overall project success.

Since contract management involves not only technical aspects but also risks, contract terms, and appropriate administration, focusing too strongly on technical aspects can result in a lack of attention to contractual risks and administrative issues, leading to uncertainty and conflict. A contract usually has specific provisions involving non-technical aspects, such as payment schedules, meeting administrative requirements, and progress reports. Non-compliance with these requirements could potentially result in sanctions or legal issues. Therefore, construction management consultants must adopt a balanced approach, paying attention to both technical and non-technical aspects of contract management so that projects can run efficiently and successfully.

Analysis of Stakeholder Perceptions Regarding the Relationship Between Contractual Aspects in The Administration Category and Project Performance

The subsequent category linked with contracts is administration, encompassing statements from the parties, work progress reports, correspondence, and working relations among the contractual parties (Yasin, 2009). Adopting innovative contract methods can potentially bolster profitability for service users and providers (Wijaya et al., 2014). Noteworthy responses from participants regarding contract administration are outlined below.

> *"As an engagement between the parties and the scope of work" (*Academic*).*

> *"The contract binds both parties following the guidelines in the agreement and based on the regulations related to the agreement" (*Academic*).*

Solely, management consultants refrained from responding to administrative aspects, focusing predominantly on technical considerations. Within the administration category of contracts, project owners emerge as the most influential opinion-holders, constituting a majority at 52% as Figure 5 (the above ratio is notably elevated, surpassing the proportion of stakeholders who participated as respondents.). Engagement and mutual agreement are paramount in the collaborative relationship between project owners and contractors. Such agreements and understandings are meticulously documented within a contractual framework, mandated to ensure equitable and just benefits for all parties involved. As project conditions and requirements may undergo modifications during implementation, any such alterations are systematically recorded in change documents, subsequently impacting the overall contract administration.

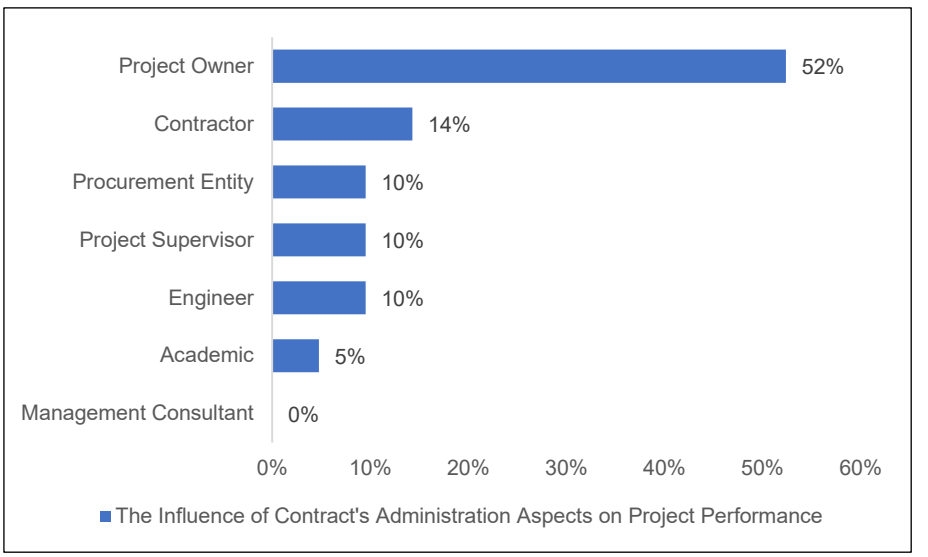

Figure 5. Stakeholder Perceptions of The Influence of Administration Categories on Project Performance

Alterations in contract administration culminate in contractual changes. Notable modifications within construction projects encompass adjustments to the contract value and revisions to the contract completion timeline. Design changes stand out as the primary catalyst for variations in contract value, while adverse weather conditions significantly contribute to alterations in contract completion times (Maulana, 2012).

It is imperative to underscore that contract administration transcends mere administrative duties; it is a pivotal determinant of a construction project's triumph and efficacy. With proficient contract administration, projects are poised for an enhanced probability of attaining their predefined objectives.

Analysis of Stakeholder Perceptions Regarding the Relationship Between Contractual Aspects in The Financial Category and Project Performance

The subsequent category pertinent to contracts is finance. Selected responses from respondents about finance are presented below:

"Financial and technical administration security in determining work items" (Consultant).

"Contract documents also act as implementation and payment guidelines" (Project Owner).

"... for the owner as the basis for payment for the work results" (Project Owner).

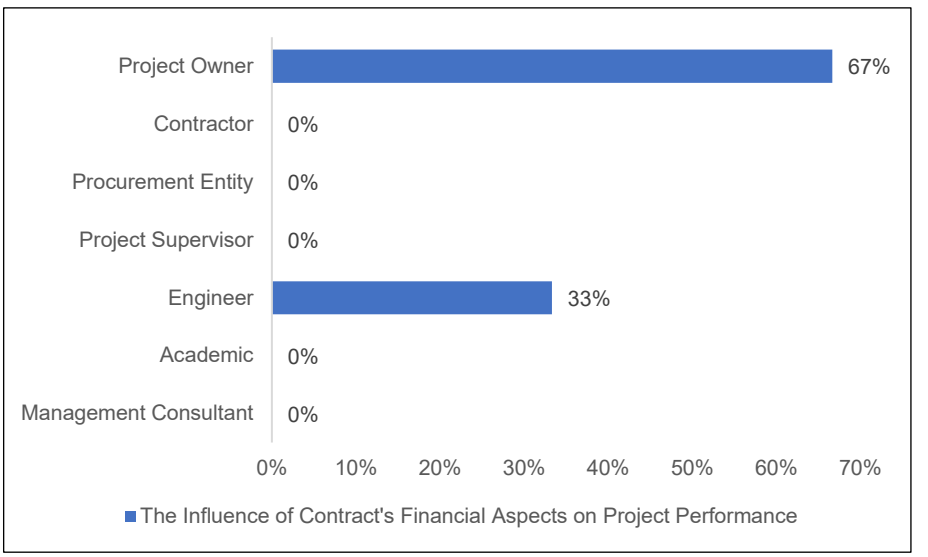

Figure 6. Stakeholder Perceptions of The Influence of Financial Categories on Project Performance

Project owners assert the most predominant viewpoint concerning contracts within the financial category, constituting 67% of the opinions expressed in Figure 6 illustrates that the frequency proportion of project owner perceptions is markedly high, surpassing the corresponding proportion of stakeholders who participated as respondents, particularly in the administrative aspect. Project owners and planning consultants exclusively provide opinions on contracts within this financial category. This observation suggests that the financial category has not garnered significant attention as a priority within construction contracts. It becomes apparent that only project owners and contractors exhibit awareness regarding the crucial significance of financial aspects within contracts.

The exceedingly low level of awareness among the involved parties regarding the impact of financial aspects within contracts on construction project performance may engender various adverse consequences. The following are some possible impacts that could occur:

1. Selection of non-optimal payment methods: without awareness of the financial aspects of the contract, parties involved in the project may make sub-optimal decisions regarding payment methods. This can hurt project finances and give rise to potential dissatisfaction among stakeholders.
2. Late payments: lack of awareness of the link between the financial aspects of the contract and project performance can result in late payments to contractors or related parties. This can hinder cash flow, result in economic problems, and potentially trigger conflict between the parties involved.
3. Lack of accurate budget: without an adequate understanding of the financial aspects of the contract, stakeholders may have difficulty developing an exact budget for the construction project. This may result in an inability to manage financial resources effectively and exceed the established budget.
4. Potential legal disputes: Lack of awareness of the financial aspects of contracts can open up opportunities for legal disputes. The gap in perception between the parties regarding financial rights and obligations in the agreement can cause conflict, ultimately leading to legal action.

Decreased quality of performance: financial aspects of contracts can affect contractors' incentives and motivation. without adequate awareness, contractors may not be motivated to provide the best performance if the payment system or contract structure does not support it. Therefore, a good understanding of the financial aspects of contracts is essential to ensure smooth and successful construction projects and prevent future problems and conflicts.

Correspondence of Stakeholder Perception

Through textual data and correspondence analysis, we have discerned a discernible relationship between the field of work and the classification of contract element categories. The graphical representation of these results, as depicted in Figure 7 through a mosaic plot, illustrates the association between work areas and the classification of contract element categories. The figure distinctly indicates that the categorisation of work areas and contract elements is predominantly influenced by the roles played by stakeholders in the project.

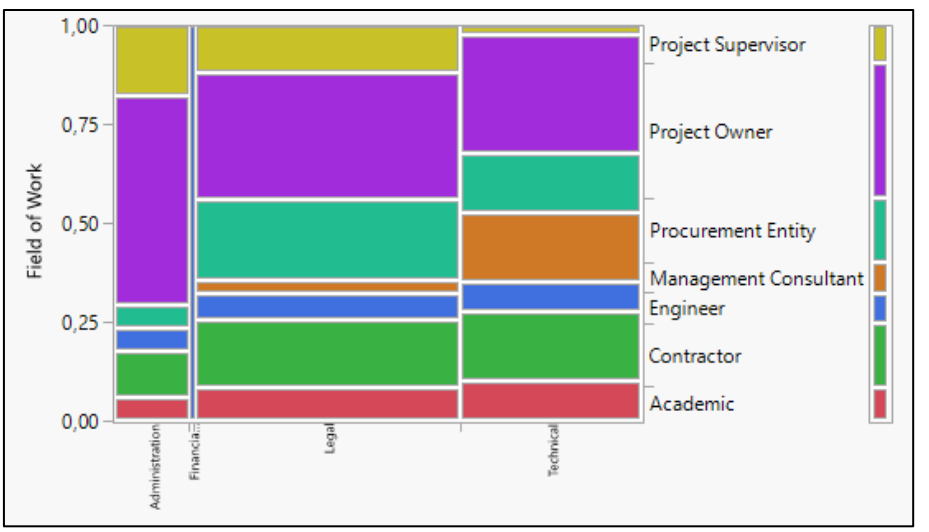

Figure 7. Mosaic Plot of Correspondence Between Fields of Work and Classification of Contract Elements

The statistical measure of the relationship, as denoted by the R-square value of 0.05 ($p = 0.06$), signifies a limited proportion of the variance in the classification of contract elements that the field of work can explain. While this association is statistically marginally significant, with a p-value close to the conventional threshold, the strength of correspondence between the two components is deemed moderate. These findings collectively imply that the role of stakeholders significantly contributes to the determination of the relationship between the field of work and the classification of contract element categories, albeit with moderate statistical significance.

Contracts serve as a communication tool among stakeholders involved in a construction project, necessitating a shared perception and understanding to ensure the delivery of high-quality work. An essential factor contributing to the success of a construction project is the establishment of robust dependability among stakeholders, facilitating effective process control and the implementation of pivotal decisions. Recognising this imperative, fostering

positive relationships and interactions among stakeholders becomes crucial, thereby enhancing the overall efficiency of the work delivery process (Atkin & Skitmore, 2008).

Comprehending stakeholders is critical to project success in project management (Yang et al., 2009). Achieving a proper understanding among stakeholders in construction projects is achievable through effective stakeholder management (Xia et al., 2018), with a common perception of the contract being one of its integral components. Successful stakeholder management in construction projects hinges on information dissemination, understanding stakeholder characteristics, decision-making capabilities, and stakeholder relationship conditions (Hwang & Ng, 2016). A well-executed stakeholder management approach can potentially elevate project quality (Littau et al., 2010). Given the inherent risks in every construction project, the amalgamation of risk management with stakeholder management contributes significantly to improving project quality (Achterkamp & Vos, 2008).

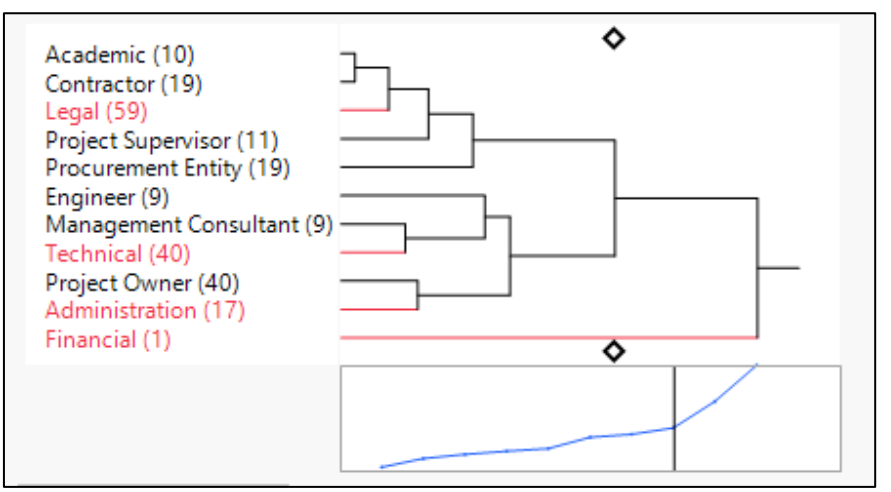

Figure 8. Correspondence Between Work Areas and Contract Elements

As illustrated in Figure 8 above, distinct patterns emerge in the assessment of contracts among various stakeholders in construction projects. Academics, contractors, project supervisors, and procurement entities collectively perceive contracts predominantly as legal instruments. Conversely, engineers and management consultants evaluate contracts primarily as technical tools. Project Owners, in contrast, attribute value to contracts as administrative and financial instruments. The diversity in assessments among these stakeholders underscores the absence of a shared understanding regarding the nature and purpose of contracts in construction projects. This divergence in perspectives suggests a lack of uniform consensus regarding contracts' fundamental role and significance within the construction industry.

Figure 9 illustrates stakeholder perceptions related to subcategories of contract aspects. The project owner is the stakeholder who gives the highest opinion that the contract is good in terms of administration, legal, financial, and technical aspects. This can be influenced by the number of project owners and the most significant research respondents. Still, it can also be caused by the project owner being one of the main stakeholders who has a substantial role in the project's success. The project success criteria are caused by the relationship of the main stakeholders (project owner-contractor-architect/engineer), the role of the project owner, and the performance of the project management organisation (Wang & Huang, 2006). The project

owner and contractor have similar opinions on the sub-category of the contract as it contains rights and responsibilities (L1) and a work guide (T4). In contrast, the sub-category of the contract as guidelines for engagement and agreement (L3) has different opinions. The three main stakeholders (project owner - architect/engineer - contractor) have the same high opinion on the sub-category of the contract as a legal basis for the relationship (L4). This case shows that the three stakeholders consider the contract a vital tool for the legal umbrella of employment relations and technical work guidelines.

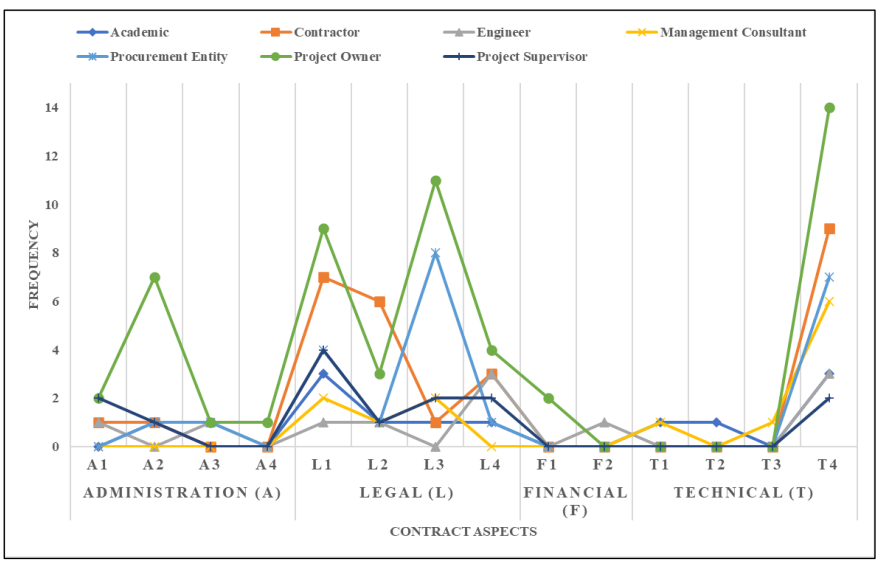

Figure 9. Distribution Related to Stakeholder Perceptions of Sub-Categories of Contract Aspects

Table 2 shows the differences in stakeholder perceptions related to the sub-category of the contract. Based on the P-value parameter, all stakeholders have a P-value >0.05, except for Engineers with a P-value <0.05. In addition, the R-square/β value is deficient for all stakeholder perceptions (the range of Rsquare/β values is between 0 and 1). This shows that most stakeholders have the same perception that contracts are essential in supporting project performance. This perception is the same as seen in Figure 2, in which 94% of stakeholders answered, "very important", and 5% answered "important" for the existence of contracts in construction projects. Based on the significance parameter (P-value per stakeholder), it can be seen that according to the legal and technical aspects of the contract, it has an essential influence in supporting project performance. The project owner assesses that the contract contains rights and responsibilities (L1), avoids disputes (L2), and, as a legal basis (L4), has an impact on project performance from the legal aspect. These three aspects have a negative correlation value (-), which means that issues related to the three aspects impact decreasing project performance. The project owner, academic, and management consultant assess that all technical aspects impact project performance. The project owner assessed that the contract as a performance control tool (T1) and as a work guide (T4) had a negative correlation value (-); various issues in both of these things had an impact on decreasing project performance. Meanwhile, for academics and management consultants, the contract as a quality control tool (T2) and as a risk mitigation tool (T3) had a positive correlation value (+). Both of these things impact increasing project performance if carried out. Project owners and engineers have an essential role in realising the project's success, so supervision management is one of the responsibilities to ensure it (Wang & Huang, 2006; Zanjirchi & Moradi, 2012). The engineer

assessed the contract as a financial administration security tool (F2) that impacted project performance. The correlation value is positive (+). This shows that good project finance can positively affect project performance. Project owners, contractors, and engineers are the three main stakeholders who have a role in managing projects and supervision. These things play a significant role in controlling financial performance in construction projects (Doloi, H., 2013).

Table 2. Regression and Significance Value of The Relationship Between Stakeholders and Contract Aspects

		Academic			Contractor			Engineer			Management Consultant			Procurement Entity			Project Owner			Project Supervisor		
		β		P-value	β		P-value	β		P-value	β		P-value	β		P-value	β		P-value	β		P-value
		0,12			0,08		0,459	0,16		0,016	0,13		0,073	0,07		0,649	0,1		0,309	0,05		0,876
		Std. Error	t	Sig.	Std. Error	t	Sig.	Std. Error	t	Sig.	Std. Error	t	Sig.	Std. Error	t	Sig.	Std. Error	t	Sig.	Std. Error	t	Sig.
Administration (A)	important documents (A1)	0,214	-0,00	1,0000	0,315	0,53	0,5978	0,201	0,83	0,4085	0,221	0,00	1,0000	0,294	0,00	1,0000	0,388	-1,72	0,0876	0,239	1,39	0,1656
	documentation of the relationship between parties (A2)	0,202	0,45	0,6531	0,297	0,31	0,7598	0,189	0,00	1,0000	0,208	0,00	1,0000	0,276	0,33	0,7427	0,365	-1,00	0,3206	0,225	0,40	0,6871
	as administrative evidence (A3)	0,240	-0,00	1,0000	0,352	0,00	1,0000	0,225	1,48	0,1403	0,247	0,00	1,0000	0,328	1,02	0,3115	0,433	-1,54	0,1261	0,267	0,00	1,0000
	as a means of contract control (A4)	0,322	-0,00	1,0000	0,473	0,00	1,0000	0,302	0,00	1,0000	0,331	0,00	1,0000	0,440	0,00	1,0000	0,581	0,00	1,0000	0,359	0,00	1,0000
Legal (L)	contains rights and responsibilities (L1)	0,192	0,52	0,6028	0,282	0,83	0,4093	0,180	0,19	0,8532	0,198	0,34	0,7363	0,263	0,51	0,6124	0,347	-2,02	0,0453*	0,214	0,62	0,5342
	avoid disputes (L2)	0,198	0,36	0,7195	0,292	1,47	0,1442	0,186	0,38	0,7017	0,204	0,35	0,7274	0,272	0,26	0,7931	0,359	-2,19	0,0302*	0,221	0,32	0,7475
	guidelines for engagement and agreements (L3)	0,193	0,21	0,8361	0,284	0,14	0,8881	0,181	0,00	1,0000	0,199	0,40	0,6880	0,264	1,21	0,2278	0,349	-1,61	0,1106	0,215	0,37	0,7107
	as a legal basis (L4)	0,198	0,36	0,7195	0,292	0,73	0,4640	0,186	1,15	0,2516	0,204	0,00	1,0000	0,272	0,26	0,7931	0,359	-1,99	0,0484*	0,221	0,65	0,5199
Financial (F)	payment basis (F1)	0,000			0,000			0,000			0,000			0,000			0,000			0,000		
	as a financial administration security tool (F2)	0,322	-0,00	1,0000	0,473	0,00	1,0000	0,302	3,32	0,0012*	0,331	-0,00	1,0000	0,440	0,00	1,0000	0,581	-1,72	0,0876	0,359	0,00	1,0000
Technical (T)	as a performance control tool (T1)	0,263	1,90	0,0589	0,386	0,00	1,0000	0,246	0,00	1,0000	0,271	1,85	0,0666	0,360	-0,00	1,0000	0,475	-2,11	0,0369*	0,293	0,00	1,0000
	as a quality control tool (T2)	0,322	3,11	0,0023*	0,473	0,00	1,0000	0,302	0,00	1,0000	0,331	0,00	1,0000	0,440	0,00	1,0000	0,581	-1,72	0,0876	0,359	0,00	1,0000
	as a risk mitigation tool (T3)	0,322	-0,00	1,0000	0,473	0,00	1,0000	0,302	0,00	1,0000	0,331	3,02	0,003*	0,440	0,00	1,0000	0,581	-1,72	0,0876	0,359	0,00	1,0000
	as a work guide (T4)	0,190	0,36	0,7200	0,279	0,73	0,4649	0,178	0,38	0,7023	0,196	0,70	0,4868	0,260	0,61	0,5415	0,343	-1,99	0,0489*	0,212	0,21	0,8304

Construction projects are susceptible to variations in orders, which may be instigated by project owners, consultants, or contractors. Alterations about contract documents, such as modifications to the scope of work, drawings, and contractual clauses, can significantly impact the likelihood of disputes, budget overruns, delays, and the overall quality of project outcomes. To mitigate these challenges, one effective strategy involves the diligent control of contracts by stakeholders (Gobana & Thakur, 2017). The management of contracts is imperative for the achievement of optimal project quality. This encompasses carefully selecting contract types to address uncertainties in work delivery (Turner & Simister, 2001) proactively. Furthermore, the success of construction projects is influenced positively by factors such as stakeholder background, characteristics of stakeholder relationships, and the psychological empowerment of stakeholders (Chandra et al., 2011).

CONCLUSION

Based on the findings from this research, the existence of a contract in a construction project is essential. From the grouping results, contracts are divided into 4 (four) aspects: administrative, legal, technical and financial. The legal aspect is the highest aspect of the contract. This is in line with contract terminology, which states that a contract is an agreement between stakeholders. In the contract document, the rights and obligations of the parties are stated. Understanding these rights and responsibilities is prone to differences, so a good understanding of the contract can avoid disputes between parties. Contracts also play a role in technical aspects, the most significant frequency being work guidelines. Contract documents consist of administrative and technical documents. Administrative documents are agreements, while technical documents are drawings, specifications, and payment policies.

Relating to stakeholder perceptions regarding contract categorisation that influences project performance, including legal, technical, administrative and financial aspects. Different perspectives regarding these four aspects exist among stakeholders, with project owners showing the highest level of awareness across all elements compared to other stakeholders. Especially in administration and finance, the frequency of content coding results exceeds 50%. In contrast, contractors show a lower awareness of the importance of contract aspects than project owners, with a frequency of results without coding reaching 20%. The financial category still receives little attention from all stakeholders, as seen from the analysis graph where only two stakeholders, namely the project owner and planning consultant, expressed their opinions. Among all contract categories, the project owner emerged as the dominant influence. This gap shows an uneven distribution of understanding and perception regarding the importance of contracts among stakeholders involved in a construction project. Conditions like this have the potential to cause disputes arising from inadequate communication. Realising that a contract is a communication tool between parties when carrying out a construction project is very important.

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EXPLORING COMMUNITY PERCEPTION AND EVOLVING TRENDS IN THE USE OF WOOD FOR HOUSE CONSTRUCTION

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Abstract
Wood has been used in construction since ancient times. In Indonesia, it remains a primary material in traditional building construction. Efforts to preserve traditional houses involve maintaining their original structure, which includes continued use of wood as the main material. Globally, the trend of using wood in residential construction is rising, especially in countries like Japan, Norway, Finland, and others in Europe and America, where wood is used for both single-family homes and multi-story buildings. However, in Indonesia, wooden houses are becoming rare as more people opt for concrete, steel, and other materials. This study was conducted to gather information on people's perceptions of wooden buildings, particularly wooden houses. The results indicate that wooden houses are highly preferred due to their warm and inviting nature, as well as their strong performance. Additionally, modern wooden houses are favoured both in terms of style and development trends. The goal of this study is to provide insights into public perceptions of wooden houses, especially in the context of the development of wood as a construction material in Indonesia.

Keywords: *Wood Material; Wooden House; Content Analysis; Perception; Wooden House Style*

INTRODUCTION

Wood is a naturally occurring building material that grows and thrives in Indonesia. The country is often referred to as the "lungs of the world" due to its abundant forest resources. According to information from the Ministry of Environment and Forestry of Indonesia, as of 2022, the forested area of Indonesia covers 96.0 million hectares, or 51.2% of the total land area. Of this, 92.0% or 88.3 million hectares are within designated forest areas (Ministry of Environment and Forestry of Indonesia, 2023). Additionally, wood is easily cultivated in Indonesia's tropical climate. This has made wood a staple building material in the country since ancient times, with indigenous communities having long relied on it as the primary material for construction.

Globally, there has been a growing trend in the use of wooden houses and wood-based materials in construction, driven by technological advancements, environmental awareness, and the need for eco-friendly construction solutions (Švajlenka & Kozlovská, 2018). Wooden houses are most popular in countries like the United States, Canada, Scandinavian countries, and Northern Europe (Ovsyannikov et al., 2021). Nations such as Japan, Norway, and Finland have adopted advanced technologies for constructing wooden homes using modular and prefabricated systems to expedite building processes and reduce construction waste. Wood as a construction material is seen as a solution to reduce carbon footprints and combat global warming (Petrović et al., 2023). Compared to other building materials like concrete and steel, wood has a lower carbon footprint and offers more sustainable benefits (Younis & Dodoo,

2022; Zemaitis et al., 2021). As a result, several countries have promoted the use of wood as an environmentally friendly building material and as part of efforts to raise awareness of environmental protection (Tupenaite et al., 2023). Furthermore, advancements in technology have made wooden materials stronger, more durable, and resistant to natural elements such as moisture, insects, and fire through prefabrication (Lehmann, 2020). This has increased the global popularity of wood as a building material.

Wood has been a traditional building material used for centuries in various constructions. Today, there is renewed interest in using wood as a building material due to its renewable nature and its role in reducing carbon footprints (Ottelin et al., 2021). Wood can be used in various aspects of construction, including as a primary structure, framing, interior elements, and facades (Aboulnaga & Elsharkawy, 2022). It is not only used in one or two-story residential buildings but also in the construction of multi-story apartment buildings (Jussila et al., 2023). As a result, wood is increasingly being used not only for interior elements but also as a structural material in mid-rise buildings.

In Indonesia, wooden houses have become less common due to the dominance of modern building materials like concrete, steel, and others (Juliafad et al., 2018). However, wood is still evident in traditional houses, cultural buildings, and certain tourist facilities that utilize the natural aesthetic of wood to create a warm and welcoming atmosphere. The use of concrete and steel in Indonesia became widespread during Dutch colonial rule when much infrastructure was built using these materials. After independence, many government buildings and infrastructure projects continued to use concrete and steel, leading to their widespread adoption, while the use of wood as a building structure declined (Setyowati, 2019).

Despite the decreasing use of wood as a structural material in urban areas, it is still commonly found in traditional houses, cultural buildings, pavilions, gates, and in tourist accommodations such as resorts, where wood is often the primary material. Wood's natural aesthetic provides a warm, friendly, and harmonious atmosphere with the surrounding environment, making it ideal for relaxation facilities (Schreiner et al., 2021). Additionally, the use of wood can reflect the tradition and culture of a location, showcasing local values. The flexibility of wood as a building structure also allows for unique and attractive designs (Psilovikos, 2023).

The wood industry plays a crucial role in supporting the use of wood as a renewable and eco-friendly raw material (Brunner, 2009). The development of the wood industry in Indonesia has been supported by the emergence of processed wood industries, such as Woodlam Indonesia, PT. Kayu Lapis Indonesia, Sampoerna Kayu, among others. This indicates that wood is not entirely abandoned by society and still holds potential, particularly for interior elements (walls, flooring, interior decorations). Another potential lies in the processed wood industry, which produces engineered wood like CLT, Glulam, Plywood, LVL, and Wall panels, potentially increasing public interest in using wood as a building structure. Prefabricated wood can attract attention due to its ability to speed up construction processes and reduce costs. As discussed in research by Tupenaite et al. (2023), wood has become increasingly popular as a building material due to significant advances in technology and engineered wood products like glued laminated timber (glulam), cross-laminated timber (CLT), laminated veneer lumber (LVL), among other options.

Given the relatively low number of wooden houses in Indonesia, it is essential to understand public perspectives on wooden houses. Additionally, there is potential for wood as a building material and a growing trend worldwide. This research aims to gather information on public perceptions of wooden houses, preferences in the development of wooden house designs, as well as the views of students, lecturers, architects, and expert practitioners on the development of wooden house patterns. By understanding these perspectives and preferences, we hope to identify opportunities and challenges in increasing the use of wooden houses in Indonesia and promoting the sustainable development of the wood industry.

Table 1. Perception Related to Wood Based Houses Literature

Variable	Source
Aesthetics	(Petruch & Walcher, 2021), (Younis & Dodoo, 2022)
Cost	(Mergel et al., 2024), (Harju & Lahtinen, 2022)
Strength and safety of wood construction	(Bejo, 2017; Gold & Rubik, 2009; Mühlbachler & Tudor, 2022; Werner et al., 2006), (Hu et al., 2016)
Health	(Gold & Rubik, 2009)
Maintenance	(Viholainen et al., 2020), (Leszczyszyn et al., 2022)
Comfort	(Viholainen et al., 2020), (Karjalainen et al., 2021)
Fire vulnerability	(Gold & Rubik, 2009), (Karjalainen et al., 2021), (Leszczyszyn et al., 2022), (Hu et al., 2016)
Environmentally friendly	(Imada et al., 2024)

Source: (Analysis Results, 2024)

METHOD OF STUDY

This study is considered applied research, as it aims to describe situations, phenomena, issues, or problems through descriptive research. The methodology used is qualitative, intended to explore people's perceptions of buildings made from wood and to understand their views on the development patterns of wooden structures. The study is conducted by gathering data related to people's perceptions of wooden houses.

This study employed data collection through online questionnaires. An online questionnaire was distributed using a non-random sampling method with a convenience sampling technique. This method was chosen because the population size was unknown, and convenience sampling was selected as respondents were those who were "comfortable" or willing to complete the questionnaire (Kumar, 2011). The questionnaire included both open-ended and closed-ended questions. This data collection was conducted over eight days, from March 28 to April 4, 2022, and received responses from 110 participants who stay in Bandung and Jakarta, Indonesia.

The data analysis for this study involved content analysis, distribution analysis, and correspondence analysis. Open-ended responses were analysed through three stages: open coding, axial coding, and selective coding. In the open coding stage, key terms were identified from the responses. The axial coding stage involved categorizing these key terms, while the selective coding stage focused on refining these categories to ensure they were related to the core categories. Finally, the relationship between variables was analysed using correspondence analysis.

RESULTS AND DISCUSSION

In the initial stage of this study, an analysis was conducted using the open coding method, where keywords were identified from the text data provided by respondents. Each respondent's answer yielded one or more keywords. These keywords were then grouped into categories. Table 2 provides examples of the reasons respondents gave for liking wooden houses.

Table 2. Giving Keywords from Reasons to Like Wooden Houses

No	Answer Respondent	Keywords	Sub-Category	Category
22	*"unique [1], expensive [2], luxurious [3]..."*	1. Unique 2. Expensive 3. Luxurious	1. Aesthetic Value 2. Elegant 3. Sophisticated	1. Impression 2. Impression 3. Impression
45	*"Natural [1] and warm [2]"*	1. Natural 2. Warm	1. Natural Properties 2. Comfort	1. Impression 2. Performance

Source: (Analysis Results, 2024)

Reasons for Liking Wooden Houses

The first question in the study's initial stage asked respondents why they like wooden houses. As shown in Table 3, the majority, 76 respondents, cited the appeal of wood as a material. Additionally, 40 respondents mentioned the performance of wood, 27 highlighted its aesthetic qualities, and 10 emphasized the sustainability aspect of wood.

Table 3. Reasons to Like Wooden Houses

Category	Sub-Category	Quotes on Reasons to Love Wooden Houses
Performance (40)	Comfort (23)	Comfortable (R56), warm (R71), Warmer (R31).
	Strength (6)	More earthquake-resistant, they say (R1), safer than concrete in a disaster (R87), earthquake-resistant (R64).
	Ventilation (18)	Keeps the air cool (R2), cooler (R47), wood is a great choice for reducing heat effects (R57).
	Climate Responsiveness (2)	Potentially more responsive to tropical climates (R47), because of the hot weather, wood is a great choice for reducing heat effects (R57).
	Ease (1)	Easily sourced material (R89).
	Wood Properties (1)	Absorbs heat and cold, helping to maintain indoor temperature (R101).
Sustainability (10)	Eco- Friendly (6)	Environmentally friendly (R91), environmentally friendly material aspects (R106), more eco-friendly (R93).
	Natural (3)	Natural material (R15), down to earth (R67).
	Reforestation (1)	Can be replanted (R43).
Aesthetics (27)	Wood Materials (22)	The character wood provides, such as its natural characteristics and aesthetic, is what I like (R9), wood gives a vintage and natural impression (R54), its material and aesthetic colour (R37).
	Design (5)	Unique joinery (R9), doesn't quickly go out of style (R70), the natural look and feel of a house (R73).
Impression (76)	Natural Qualities (34)	Natural (R45), blends harmoniously with its surroundings (R46), natural vibes (R55).
	Sense of Comfort (32)	Makes the home feel warmer or creates a warmer ambiance (R7), visually warm (R2), warm appearance (R27).
	Elegance (6)	This gives the building an elegant expression (R11), valued more highly than a brick house (R21), luxurious (R22).
	Aesthetic Value (27)	Its aesthetic is what I like (R9), looks good (R10), very beautiful (R13).

Source: (Analysis Results, 2024)

The findings indicate that most respondents like wooden houses because of the impression that wood as a material creates. Wood provides a warm and comfortable atmosphere for its inhabitants, while also offering an elegant and aesthetically pleasing appearance. This is supported by research from Nyrud (2009), which highlights the psychological benefits of wood for residents. More recent studies, such as Li et al. (2021), also suggest that wood creates a natural, warm, relaxing, and enjoyable environment.

In addition to the impression wood creates, respondents also value the performance of wooden houses. Wooden houses offer a high level of comfort due to their warm and natural properties. They are also resilient to earthquakes (Adelaide & Piazza, 2015). The excellent thermal insulation provided by wooden houses helps maintain a comfortable indoor temperature, reducing the need for additional heating or cooling systems (Lestari, 2017).

Reasons for Disliking Wooden Houses

The second question in the first stage of the study asked respondents why they dislike wooden houses. As shown in Table 4, the majority (47 respondents) expressed concerns about external threats to the wood material. Additionally, 45 respondents cited maintenance issues, 24 mentioned the material's inherent characteristics, 19 pointed to affordability concerns, 9 felt the performance was insufficient, and 4 raised issues related to construction.

Table 4. Reasons for Disliking Wooden Houses

Category	Sub-Category	Quotes Reasons for Disliking Wood
Maintenance (45)	Complex Maintenance (24)	Hard to maintain (R2), material wood requires proper care (R14), difficult to upkeep (R17).
	Expensive Maintenance (15)	Difficult for treated (R17), Need extra maintenance (R7), Expensive to maintain (R17)
	Maintenance (7)	Potentially high maintenance (R9), upkeep (R44), maintenance (R92).
External Threats (47)	Pest (36)	Concern about termites (R12), prone to termite damage (R35), risk of termites (R36).
	External Environment (11)	Weather-related concerns (R12), not weather-resistant (R22), worry about susceptibility to weather (R23).
	Wood Vulnerability (15)	Risk of complete loss in a fire (R1), prone to decay (R12), wood decays easily (R39).
Natural Characteristics (24)	Material Durability (20)	Lacks durability (R3), fragility (R8), wood easily deteriorates (R16).
	Shabbiness (6)	Prone to moisture (R6), may appear shabby (R49), unpleasant odour when wet (R105).
Affordability (19)	High Costs (17)	Expensive (R4), high cost of wood (R11), costly due to scarce wood (R12).
	Scarcity of Wood (5)	Scarce wood (R12), hard-to-find raw materials (R75), quality materials are difficult to source (R81).
Construction (4)	Difficult Construction (2)	Building process is more challenging (R19), may lack strength if not properly constructed (R73).
	Construction Labor (2)	Requires specialized skills for shaping and installation (R69), depends on the worker's expertise (R95).
Poor Performance (9)	Wood Limitations (6)	Security concerns (R42), poor sound insulation (R32), especially in terms of sound, as wood doesn't insulate well (R68).
	Design Limitations (3)	Limited module sizes (R43), can't easily change colours (R98), limited design options (R110).

Source: (Analysis Results, 2024)

The respondents' reluctance towards wooden houses seems to stem from several factors, including the complex and expensive maintenance required. This sentiment is supported by Leszczyszyn et al. (2022), where most respondents felt that wooden houses demand more frequent upkeep. Wood is vulnerable to external threats such as pests, rot, and termite damage, which can lead to additional maintenance costs. Additionally, concerns about wood's susceptibility to weathering over time raise doubts about the long-term structural reliability of wooden houses.

The high cost of wood compared to other building materials also poses a barrier for some, making affordability a significant concern. Mühlbachler & Tudor (2022) found that while aspects like price and durability were viewed negatively, others—especially health benefits and high quality—were rated more positively. Despite the sustainability advantages of wooden houses, economic considerations and affordability remain key factors influencing people's preferences (Harju & Lahtinen, 2022).

The research also revealed that the construction process for wooden houses is perceived as challenging by some respondents, as it requires specialized skills and knowledge of wood construction that not everyone possesses. Lastly, concerns about the safety of wooden structures, particularly in relation to fire hazards and earthquake vulnerability, lead some to prefer other building materials considered stronger and safer (Gold & Rubik, 2009).

Connection Between Style Preferences and Reasons for Liking Them

The third question in the research's first stage explored respondents' preferences for different wooden house styles and the reasons behind their preferences, using three illustrations of wooden houses. The first illustration depicts a wooden house that represents a specific cultural heritage. This house is designed with traditional wooden structures while reflecting the values, traditions, and local wisdom of a particular community or culture. The second illustration shows a wooden house that adopts a modern approach, maintaining its traditional essence while integrating contemporary style and lifestyle demands. The third illustration features a modern wooden house, where wood is the primary construction material, but the design and features reflect modern architectural styles. Figure 1 presents the preferences for these different wooden house styles as illustrated.

Figure 1. Illustration Wooden House Style Preferences

The correspondence analysis was conducted to understand the relationship between preferences for wooden house styles and the reasons for liking these styles. According to the results presented in Table 5, the Pearson p-value is 0.0062. This value indicates that there is a 0.6% probability that the observed association is due to chance.

Table 5. Correspondence Analysis of Style Preferences and The Reasons for Liking Each Style

N	DF	-LogLike	RSquare (U)
255	8	12,005525	0,0482
Test		**ChiSquare**	**Prob>ChiSq**
Likelihood Ratio		24,011	0,0023*
Pearson		20,537	0,0085*

Source: (Research Data, 2024)

The correspondence analysis was performed using ward hierarchical clustering, with the results shown in Figure 2. The analysis revealed that preferences for wooden house styles and the reasons for these preferences can be grouped into three categories:

1. First Group: Respondents who prefer modern wooden houses due to the efficiency and performance of wood materials.
2. Second Group: Respondents who favour houses that represent cultural heritage because of the impression that wood material gives.
3. Third Group: Respondents who like wooden houses with a modern approach due to the aesthetic qualities of wood.

These groupings illustrate the connection between style preferences and the reasons for liking each style.

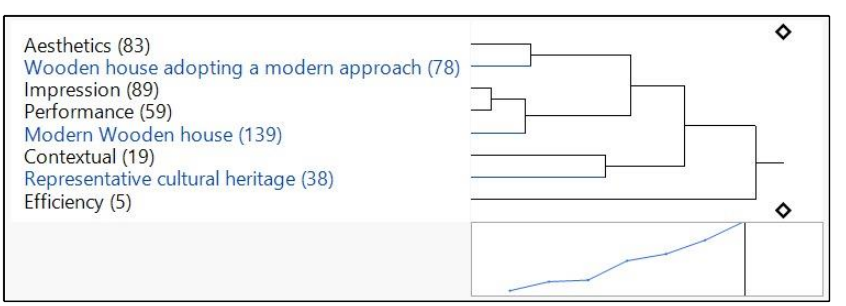

Figure 2. Dendrogram Correspondence Style Preferences and Reasons for Liking That Style

Based on the dendrogram presented, it can be concluded that the majority of respondents prefer modern wooden house styles. The main reasons behind this preference are the efficiency and performance that these designs offer. Modern wooden houses are known for their functional and efficient use of space, often providing environmentally friendly solutions. Additionally, the performance of modern wooden houses is considered strong in terms of durability, weather resistance, and earthquake resilience. This makes modern wooden house styles the preferred choice for many respondents in this study. With these advantages, wooden construction has become a popular option, enabling the development of modern buildings that are environmentally friendly, economical, and durable, while also contributing to environmental sustainability (Švajlenka & Kozlovská, 2021).

Furthermore, the dendrogram also shows that respondents tend to favour wooden houses with a modern approach, especially due to aesthetic considerations. Modern wooden house designs often feature clean, minimalist, and versatile styles, which appeal to many people.

Lastly, the dendrogram reveals that respondents also appreciate wooden houses that represent cultural heritage, largely due to the unique impression that wood as a material conveys. Wooden houses often have a strong appeal because they reflect a rich cultural and traditional heritage through the use of wood in construction.

Table 6. Categories of Reasons for Liking the Wooden House Style

Category	Sub-Category	Quotes Reasons for Liking Wood
Aesthetics (76)	Design (51)	Not monotonous (13), Combining both options (R1), Simple (R3)
	Orderliness (1)	Neater (R38)
	Client Preferences (24)	Personal dream home (R8), more unique (R70), more appealing (R73)
Performance (31)	Ease (1)	Easy (R75)
	Quality (7)	Tested construction strength (R35), more durable (R71), sturdy (R97), easy to maintain (R99)
	Comfort (14)	Appears comfortable (R27), Comfortable (R108), comfort of the space (R32)
	Maintenance (10)	Easier to clean (R6), easy to clean (R7)
Impression (33)	Natural Properties (2)	Natural (R57), Authentic (R20)
	Sense of Comfort (12)	Homey (R41), warm (R19)
	Temporal Impression (20)	More of a vintage/old-fashioned feel (R29), Modern (R42),
Efficiency (5)	Cost (2)	Cheaper (R66), Affordable (R80)
	Spatial (3)	Small (R16), Maximized space utilization (R55), Flexible Location (R89)
Contextual (19)	Has Identity (5)	Contains elements of identity (R22), Cultural characteristics (R56), Reflects the owner's character (R67)
	Local Culture (3)	Maintains local knowledge and culture (R31)
	Contextual Fit (3)	Adaptive to the environment (R45), More suitable for conditions (R77),
	Tropical (4)	Suitable for tropical climates (R83), Considering tropical climate (R103), Adapts to tropical conditions (R98)
	Material Availability (1)	Adapts to material availability (R47)
	Craftsmanship Ability (1)	Craftsmanship capability (R47)
	Climate Responsiveness (2)	responsive to climate (R72), Considers air circulation and shading (R59), Climate-responsive (R79)

Source: (Research Data, 2024)

CONCLUSION

The research concludes that wooden houses are highly favoured, due to the warm and inviting atmosphere they create, as well as their strong building performance. This preference is supported by findings indicating that wood provides a comfortable, warm environment for inhabitants and offers good flexibility, including resilience to earthquakes. The combination of wood's experiential characteristics and its performance makes wooden houses a desirable choice. Thus, wooden houses are considered an appealing option not only for their natural aesthetics but also for their functional benefits.

In other words, consumer perceptions of the benefits of wood in construction can significantly influence their willingness to live in wooden houses (Lähtinen et al., 2014). The study also highlights that public awareness of the importance of environmentally friendly building materials is growing. Positive perceptions of wooden buildings arise because wood is a renewable material with a lower carbon footprint compared to other building materials. Additionally, increased awareness of sustainability in construction has led to a rise in the use of engineered wood as an eco-friendly alternative. Engineered wood has become popular

across various industries, including construction, furniture manufacturing, energy storage, and environmental protection. Enhancements in wood technology aim to improve its quality and performance, making it more effective and efficient for various applications. Consequently, the use of processed wood shows a positive trend in creating more sustainable and eco-friendly solutions across different sectors.

The prospects for developing wood as a building material in Indonesia appear promising, given the country's abundant natural resources, advances in wood engineering technology, and increasing awareness of sustainability. As global concerns about environmental issues rise, using wood as a building material provides a sustainable development solution.

However, despite the interest in wooden houses, the high cost of wood remains a barrier, limiting the number of wooden houses built in Indonesia. Harju & Lahtinen (2022) also note that while sustainability aspects are important, economic considerations often play a more significant role in consumers' purchasing decisions.

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MILLENNIALS AND Z GENERATIONS PREFERENCES FOR TRANSIT-ORIENTED DEVELOPMENT (TOD) BASED HOUSING IN JAKARTA METROPOLITAN AREA

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Abstract
Urbanization in Jakarta drives up land prices and causes higher selling prices and housing rental costs in urban areas. This condition encourages urban sprawl, increased government investment needs to provide infrastructure and transportation activities, and increased travel time and transportation costs. This is an essential issue for millennial & Z generations to work that impacts their productivity. These problems were elaborated to produce initial recommendations named TOD. In the last five years, Indonesia has developed limited vertical housing that adopts the TOD concept around terminals or stations in the Jakarta Metropolitan Area (JMA). The most users of MRT Jakarta are the millennial generation (age 25-40) and Z (age 8-23) as potential users. This study aims to determine the preferences of the millennial and Z generation, especially those living in the JMA area, regarding housing with the TOD housing concept in Jakarta, Indonesia. This research uses exploratory qualitative and grounded theory methods. The data collected through an open-ended online questionnaire was analyzed qualitatively using the content analysis method. The findings show that five aspects are the preferred reasons for the millennial and Z generations to live in TOD housing: accessibility, productivity, efficiency, design, and needs. In addition, there were also five aspects of facilities that must be met in TOD housing: supporting facilities, main facilities, sports facilities, religious facilities, and government facilities. Lastly, six aspects are the preferred reasons for millennial and Z generations not to live in TOD housing: ambiance and design, location, landed house, institutions, public transport, and investment potential.

Keywords: *Content analysis; millennial and z generations preferences; residential environment; TOD-based housing*

INTRODUCTION

Urbanization (urban sprawl), marked by high levels of traffic congestion and high use of private vehicles, has resulted in a worsening quality of urban life, accompanied by poor sanitation and non-integrated land use. The intensification of urban economic activity in Jakarta, which has driven up land prices, has implications for higher selling prices and residential rental costs in urban areas (Winarso & Firman, 2002). As a result, some groups, especially the millennial and Z generations who work in the area, cannot access housing in urban areas and are forced to live far from the city centre (Sondakh & Gunawan, 2019). These conditions lead to urban sprawl, conversion of agricultural land into built-up functions, reduced catchment areas, increased need for government investment to provide infrastructure to support settlement and transportation activities, as well as increased travel time and costs for people's transportation to work, which has an impact on productivity.

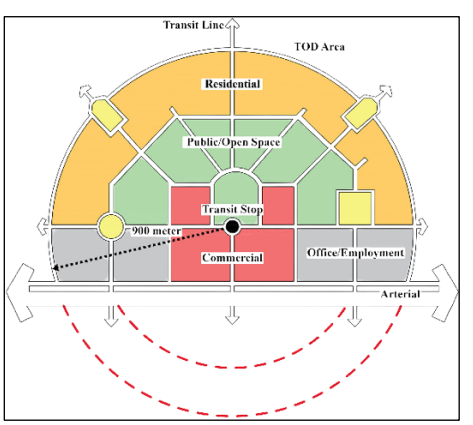
The above phenomenon is a housing concern issue. One of the recommendations to ensure the availability of decent, accessible, and affordable housing in urban areas is the concept of Transit-Oriented-Development (TOD). Residential development integrated with transportation nodes is part of the efforts that will be carried out to realize the mandate of

Rencana Pembangunan Jangka Menengah Nasional (RPJMN) 2020-2024 within the framework of urban infrastructure development in the aspects of transportation development and access to housing and settlements that are adequate, safe and affordable. In the last 5 (five) years, Indonesia has limitedly developed vertical housing that adopts the TOD concept around terminals or train/ MRT stations in the JMA. In the long term, this concept has the potential to be implemented within the framework of implementing the RPJMN (Kementerian Pekerjaan Umum dan Perumahan Rakyat, 2019). TOD is an opportunity that needs to be utilized to optimize housing provision for millennials (ages 24-35 years) and Z generations (ages 23 and under) at strategic urban points.

The purpose of this research is to find out the preferences of the millennial and Z generations, especially those living in the JMA area, regarding the TOD housing concept in Jakarta. This research will produce several findings indicating that several aspects are the main reasons for the millennial and Z generations' interest in living in TOD housing. Besides, it also produces aspects of the facilities that must be met in TOD housing. The preference aspect of the millennial and Z generations who are not interested in living in TOD housing can be used as a note in designing TOD housing in the future.

Theoretical Review

There are many opinions on defining TOD, so the definition of TOD itself cannot be explained generally. This is because each city and region have its characteristics, starting from physical, economic, social, and demographic differences. So, it is necessary to review various TOD definitions to see multiple perspectives on the concept and implementation of TOD. The concept of TOD is a mixed-use community within an average 2,000-foot walking distance of a transit stop and core commercial area. TOD mixes residential, retail, office, open space, and public uses in a walkable environment, making it convenient for residents and employees to travel by transit, bicycle, foot, or car (Calthorpe, 1993).



Source: Calthorpe (1993)

Figure 1. The Concept of TOD

TOD is 400 to 800 meters from a public transport node, emphasizing intermodal integration. TOD enhances value by integrating mass transit networks, reducing motorized vehicle usage, and promoting mixed, dense development with medium to high space utilization (Peraturan Menteri ATR/BPN, 2017). TOD is an integrated urban space that unites

people, activities, buildings, and public areas, fostering easy walking and cycling connections and efficient transit services throughout the city. From various existing literature studies, it can be concluded that TOD is a mixed-use community situated 400 to 800 meters from the transit stop and commercial core, integrating multiple amenities to facilitate convenient travel by transit, bicycle, foot, or car. TOD aims to enhance value by integrating mass transit networks, reducing motorized vehicle usage, and encouraging mixed, dense development with medium to high space utilization (ITDP, 2017).

Material and Methods

This research is conducted qualitatively and using an exploratory method. The study employs the grounded theory approach, a qualitative research method capable of generating general explanations of a phenomenon, process, action, or interaction shaped by the respondents. The research team refrains from employing preconceptions or hypotheses at the beginning of the study. Instead, the research team attempted to explore the factors that make up the phenomenon through respondent data.

Data Collecting Method

Data collection was conducted by distributing questionnaires online through non-random sampling methods. The online questionnaire consisted of 5 (five) questions regarding respondent identity, including name/initials, age, occupation, income, and domicile, as well as open-ended questions regarding respondents' free opinions regarding their thoughts, expectations, and preferences related to TOD housing.

The online questionnaire was freely shared through social media with location restrictions to Jakarta, Bogor, Depok, Tangerang, Bekasi (JMA), and ages ranging from 23 to 35 years. The data collection process took place over three weeks, from February 22 to March 15, 2023, with 164 respondents. The breakdown of respondents includes 32 individuals aged 23 years and below, 71 individuals aged 24-27 years, 50 individuals aged 28-31 years, and 11 individuals aged 32-35 years. Among them, 32 respondents had incomes below Rp 4,500,000, 70 respondents had incomes between Rp 4,500,000 and Rp 9,000,000, 40 respondents had incomes between Rp 9,000,000 and Rp 13,500,000, and 22 respondents had incomes exceeding Rp 13,500,000. Respondents' occupations varied: entrepreneurs, educators, healthcare professionals, students, civil servants, private sector employees/state-owned enterprises/regional-owned enterprises, and those without employment. The respondents' domiciles ranged from Tangerang, Jakarta, Depok, Bogor, to Bekasi. Out of the respondents, 132 expressed interests in living in TOD housing, while 32 respondents were not interested in living in TOD housing.

Data Analysis Method

Data from the questionnaire will be analysed using the content analysis method with three stages: open coding, axial coding, and selective coding (Creswell, 2018). The first stage, open coding, involves identifying keywords from respondents' answers. The result of the open coding stage is a frequency distribution. The second stage, axial coding, categorizes keywords into more general terms based on their semantic closeness or nature. The frequency of each category is presented in diagram form through distribution analysis. The final stage, selective

coding, involves constructing a hypothesis model based on the relationships between categories obtained from the axial coding stage.

Result

In this study, the generated analysis includes correspondence of age and occupancy status, age and buying system, motivation aspect, aspect facilities, and motivation aspect not to live in TOD housing.

Correspondence of Age and Occupancy Status

The initial stage involves the analysis of the frequency distribution of age and TOD housing status, which is either buying or renting. There are 92 people with the choice of buying for TOD housing status and 40 people with the option of renting for TOD housing status, as shown in Table 1.

Table 1. Frequency Distribution Analysis of Age and TOD Housing Status

TOD Housing Status Preference	Age				Total
	Under 23 Years Old	24-27 Years Old	28-31 Years Old	32-35 Years Old	
Buy	12	45	30	5	92
Rent	15	16	7	2	40
Total	27	61	37	7	132

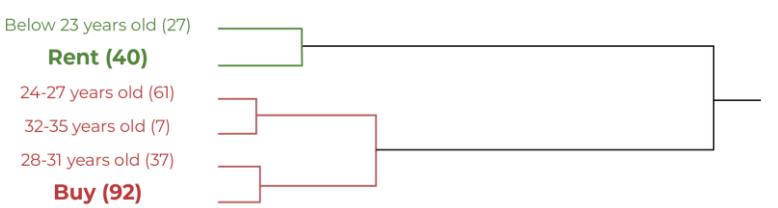


Figure 2. Cluster Diagram of Age and TOD Housing Status

To see the relationship between the age factor and TOD housing status, a correspondence analysis produces a cluster diagram seen in Figure 2. Based on the results, this correspondence analysis produces a significant relationship with a P-value of 0.0122 and a Likelihood Ratio of 0.0157. Groups under age 23 tend to choose rent status for TOD housing. Groups aged 24-27 years, 28-31 years, and 32-35 years choose buy status for TOD housing.

Correspondence of Age and Buying System

The initial stage involves the analysis of the frequency distribution of age and TOD housing buying system factors. There are 45 people with the choice of KPR 6-15 years, 10 people with the choice of KPR 16-25 years, 31 people with the choice of staging cash 1-5 years, and six people with the option of hard cash under one year.

A correspondence analysis produces a cluster diagram to see the relationship between the age factor and the TOD housing buying system, as seen in Figure 3. Based on the analysis results, this correspondence analysis produces a reasonably significant relationship (weakly significant) with a P-value of 0.0772 and a Likelihood Ratio of 0.0587. Groups of people 23

years old and under tend to choose KPR for 16-25 years. Groups of people 24-27 years old, 28-31 years old, and 32-35 years old tend to choose KPR for 6-15 years and cash in stages 1-5 years. Hard cash options under one year are the last for ages 24-27, 28-31, and 32-35.

Table 2. Frequency Distribution Analysis of Age and TOD Housing Buying System

TOD Housing Buying System Preferences	Age				Total
	Under 23 Years Old	24-27 Years Old	28-31 Years Old	32-35 Years Old	
KPR 6-15 years	1	25	17	2	45
KPR 16-25 years	4	4	2	0	10
Staging cash for 1-5 years	6	12	10	3	31
Hard cash <1 year	1	4	1	0	6
Total	12	45	30	5	92

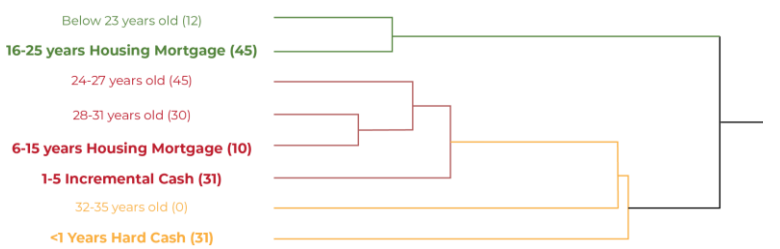


Figure 3. Cluster Diagram of Age and TOD Housing Buying System

Motivation Aspect Living in TOD Housing

The initial content analysis stage involves open coding of respondents' answers regarding motivation or reasons for being interested in living in TOD housing. An example of open coding from respondent answers is illustrated in the following quotes:

> *"Because it facilitates mobility, especially with the odd-even rule in Jakarta." (Female, healthcare professional, age 28-31 years)*

> *"Easy to mobilize, TOD is also known for its compact design concept, making it easy to find daily necessities. Additionally, TOD is located in the city center, allowing easy access to urban facilities if you live there." (Male, private sector/State-Owned Enterprises/Regional-Owned Enterprises employee, age 23 and below)*

Based on these quotes, several keywords were identified, including "mobility convenience," "compact design concept," "easy to find daily necessities," and "city centre location," which were then grouped into sub-categories and categories (axial coding). Through the analysis of textual data, 12 categories related to the reasons for being interested in living in TOD housing, as shown in Table 3.

The categories that were obtained were analysed for frequency using distribution analysis. The distribution analysis results indicate that millennials and Z generations' primary motivations for being interested in TOD housing are accessibility, convenience, public transportation, comfort, location, productivity, cost efficiency, time efficiency, attractiveness, design, facilities, lifestyle, and needs. The most dominant category that emerged is convenience, accounting for 83 (27.221%), followed by accessibility with 75 (24.59%) and public transportation with 32 (10.49%). Attractiveness and lifestyle factors had the most

minor responses, totalling only 4 (1.31%). The generated categories will be further analysed using cluster analysis in Figure 4 to formulate hypotheses.

Table 3. *Axial Coding* Result of Motivation Aspect Living in TOD Housing

Category	F	Subcategory
Accessibility	75	Transportation accessibility, high accessibility, easier accessibility, accessibility, ease of travel, station accessibility, integrated, easy connection, close transportation access, easy access to work, easy mobilization
Public Transportation	32	Availability of public transportation, minimizing use of private transportation, reach of public transportation, no interest in using private transportation, access to public transit, integration with public transit, close transportation access, no interest in using private transportation
Attractiveness	2	Identity, attractiveness
Design	6	Design concept, privatization, having private space, compact concept, new concept, land efficiency
Cost Efficiency	16	Cost efficiency, cost saving
Time Efficiency	17	Time efficiency, save time
Facility	11	Facilities, availability of facilities, need for facilities, fulfillment of various needs, complete facilities, ease of meeting needs, urban facilities, suitable housing, fulfillment of multiple demands, housing, available facilities.
Attractiveness	2	Eco-friendly lifestyle lifestyle
Convenience	83	Convenience, practical, tired of traveling, easy mobility
Location	27	Position close to the station, affordable position, proximity to workplace, proximity to activities, reach of public transportation, access, strategic area.
Comfort	17	Comfort, no traffic jams, avoid traffic jams, reduce pollution, quality of life, no noise, no traffic jams, high traffic jams.
Productivity	17	Energy saving, productivity

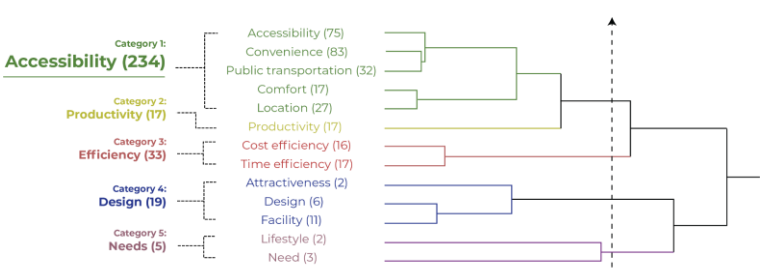


Figure 4. Cluster Diagram of Motivation Aspects Living in TOD Housing

The results of category clustering in the cluster diagram in Figure 4 consist of 5 category groups: accessibility, productivity, efficiency, design, and needs.

Aspect Facilities in TOD Housing

The initial content analysis stage involves open coding of respondents' answers regarding the expected facilities in TOD housing. An example of open coding from respondent answers can be seen in the following quotes:

> *"Bridges or pathways directly to the station, convenience store, modern market, food court, and coffee shop, spacious parking, children's playground, sports park" (Female, private sector/State-Owned Enterprises/Regional-Owned Enterprises employee, age 24-27 years)*

"Leisure and fitness (park, sports centre), F&B, entertainment" (Male, private sector/State-Owned Enterprises/Regional-Owned Enterprises employee, age 24-27 years)

Based on these quotes, several keywords were identified, such as "bridge," "convenience store," "sports park," "sports centre," and "entertainment," which were then grouped into sub-categories and categories (axial coding). Through the analysis of textual data, 18 categories related to expected facilities in TOD housing were identified and can be seen in Table 4.

Tabel 4. Hasil *Axial Coding* Fasilitas Hunian TOD

Category	F	Sub-category
ATM	1	ATM
Residential	17	Affordable housing, houses with yards, floating cluster residences, dwellings, noise-free residences, privacy-preserving residences, residences with private rooms, homes with family rooms
Parking Facilities	9	Spacious parking, parking lots, electric vehicle charging stations, free parking
Offices	5	Office, office district
Open Space	21	Gardens, small gardens, green open spaces, playgrounds, children's playgrounds, child-friendly spaces, sports parks, open spaces, children's parks
Cycling Facilities	3	Bike stations, bicycles, bike lanes
Transportation Facilities	46	Integrated roads, feeder stops, public transportation, roads to stations, shuttle vehicles, roads to stations, stations
Entertainment Facilities	6	Family entertainment facilities, entertainment facilities, recreation areas
Religious Facilities	2	Worship Facilities
Pedestrian Path	30	Adequate pedestrian paths, separated access, good accessibility, adequate pedestrian paths, pedestrian overpasses, pedestrian-friendly facilities, sky bridges, direct access to train stations, comfortable pedestrian paths, pedestrian paths, road crossings, travelators, escalators, elevators, seating areas, integrated pedestrian paths, comfortable pedestrian paths, easily accessible pedestrian paths, direct lifts to platforms, direct access between residences and stations, wide pedestrian paths, direct paths to stations, pedestrian bridges
Security Facilities	9	Security system, one-card system
Health Facilities	17	Health facilities, hospitals, pharmacies, medical facilities, clinics, fitness centers
Commercial Facilities	60	Supermarkets, minimarkets, traditional markets, commercial facilities, both traditional and modern markets, food shopping facilities, laundry facilities, clothing shopping facilities, restaurants/eateries, daily shopping facilities, shopping centers, convenience stores, cafes, food courts, co-working spaces, food shopping facilities, commercial facilities
Sport Facilities	11	Sports facilities, swimming pools, fitness centers
Government Facilities	1	Single-window government administrative office
Education Facilities	10	Educational facilities, schools, libraries
Social Facilities	3	Public social facilities

The categories that were obtained were analysed for frequency using distribution analysis. The results of the distribution analysis indicate that the facilities needed by millennial and Z generations for TOD housing include ATMs, housing, facility criteria, parking, offices, open spaces, cycling facilities, transportation facilities, entertainment facilities, worship facilities, pedestrian pathways, security facilities, healthcare facilities, commercial facilities, sports facilities, government service facilities, educational facilities, and social facilities. The most dominant category that emerged was commercial facilities at 60 (23.90%), followed by transportation facilities and pedestrian pathways at 46 (18.32%) and 30 (11.95%),

respectively. The ATM factor as a banking facility and government service facility has the slightest response, totalling only 2 (0.79%). The generated categories will be further analysed using cluster analysis in Figure 5 to formulate hypotheses.

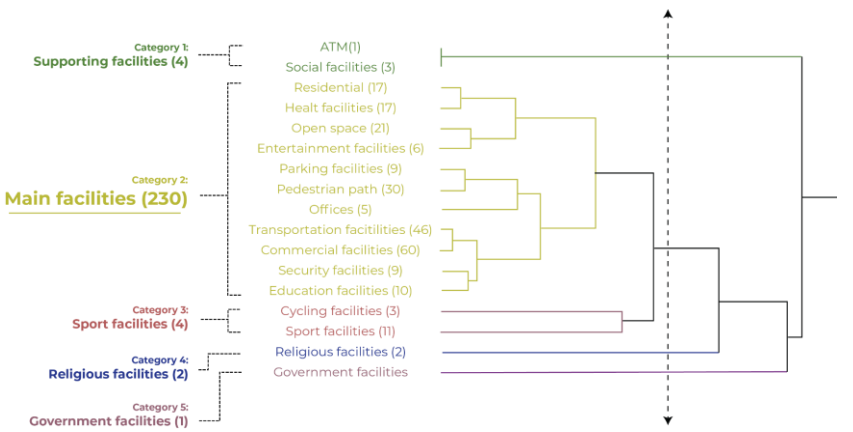


Figure 5. Cluster Diagram of Aspects Facilities in TOD Housing

The results of category clustering in the cluster diagram in Figure 5 consist of 5 category groups: supporting facilities, main facilities, sports facilities, religious facilities, and government facilities.

Motivation Aspect Not to Live in TOD Housing

The initial content analysis stage involves open coding of respondents' answers regarding motivation not to live in TOD housing. An example of open coding from respondent answers can be seen in the following quotes:

> *"Noisy, prone to traffic jams, and the air is not clean" (Female, private sector/State-Owned Enterprises/Regional-Owned Enterprises employee, age 24-27 years)*

> *"The current public transportation infrastructure has a much longer travel time than the private vehicle (motorcycle) that I use daily. This includes the limited flexibility of public transportation" (Male, private sector/State-Owned Enterprises/Regional-Owned Enterprises employee, age 32-35 years)*

Based on these quotes, several keywords were identified, such as "crowded," "traffic congestion," "air pollution," and "longer travel time of public transportation," which were then grouped into sub-categories and categories (axial coding). Through the analysis of textual data, eight categories related to reasons for not being interested in living in TOD housing were identified and can be seen in Table 5.

The acquisition of categories has frequencies analysed using distribution analysis. The results of the distribution analysis indicate that the most significant reasons why millennial and Z generations are uninterested in living in TOD housing are due to unattractive design, unappealing atmosphere, proximity to the station, higher prices, more attractive landed houses, suboptimal institutions, less competitive public transportation, and less investment potential. The most dominant category that emerged is an unappealing atmosphere at 24

(38.70%), followed by unattractive design at 17 (27.41%), and more attractive landed houses at 8 (12.90%). The factors of higher prices and less investment potential had the most minor responses, totalling only 2 (3.22%). The generated categories will be further analysed using cluster analysis in Figure 6 to formulate hypotheses.

Table 5. *Axial Coding* Result of Motivation Aspect Not to Live in TOD Housing

Category	F	Subcategory
Unattractive design	17	Lack of open space, suboptimal design, less interest in design, more inclined towards landed houses, disliking vertical housing, preferring the design of landed houses.
Higher price	1	Higher prices.
Less optimal institution	4	Suboptimal development, non-priority development, unclear development, lengthy construction.
Too close to the station	4	The location is too close to the station.
Less potential for investment	1	It is not owned and is less attractive as a long-term asset.
More interested in landed house	8	More interested in landed houses, finds landed housing more appealing.
Unattractive design	24	Crowdedness, noise, density, less peaceful atmosphere, traffic jams, air pollution, lack of privacy, lack of tranquillity, feeling unsafe, uncomfortable atmosphere, untidiness.
Less eminent public transportation	3	Longer travel time on public transportation, less flexible public transport, less competitive public transit, and preference for private vehicles.

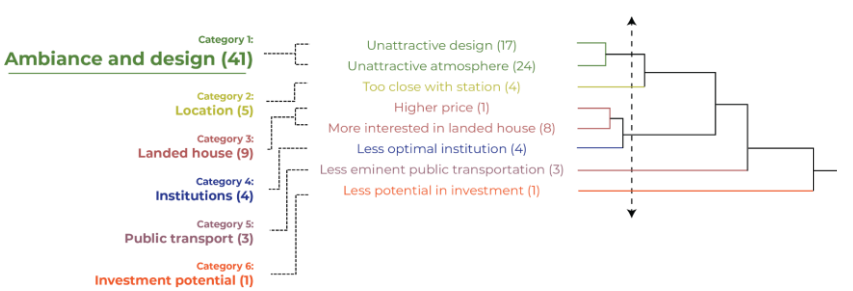


Figure 6. Cluster Diagram of Motivation Aspect Not to Live in TOD Housing

The results of category clustering in the cluster diagram in Figure 6 consist of 6 category groups: ambiance and design, location, landed houses, institutions, public transportation, and investment potential.

DISCUSSION

Based on the analysis of three factors: the motivational aspect of living in TOD housing, the aspect of facilities in TOD housing, and the motivational aspect of not living in TOD housing, a "TOD-Based Housing Criteria" was established. The hypothesis for “TOD-Based Housing Criteria” can be seen in Figure 7.

The motivation aspect of living in TOD housing consists of 5 category groups: accessibility, productivity, efficiency, design, and needs. Accessibility includes public transportation access, road infrastructure, travel distance, connectivity between city areas, transportation sustainability, and safety (Ewing & Cevero, 2010). It aims for the ease and availability of transportation facilities for city residents to reach their destination easily [9]. Productivity linked to residence or dwelling refers to the impact of a person's living

environment on their productivity and performance in various activities such as work, learning, and other daily activities (Peponis et al., 2007). Efficiency in TOD housing design that optimizes financial resources and time involved in various activities (Litman, 2019) includes reduced operational costs, efficient use of energy, reduced travel time, and efficient infrastructure management (Hamilton & Hamilton, 2003). The design or planning of residences and urban areas can positively impact all aspects of urban life, representing an approach to design that considers social, economic, environmental, and health aspects (Gehl, 2013). Lifestyle and needs can have a significant influence on preferences for urban living. Lifestyle encompasses individuals' choices and habits in various aspects of life, such as social activities, hobbies, daily routines, and cherished values.

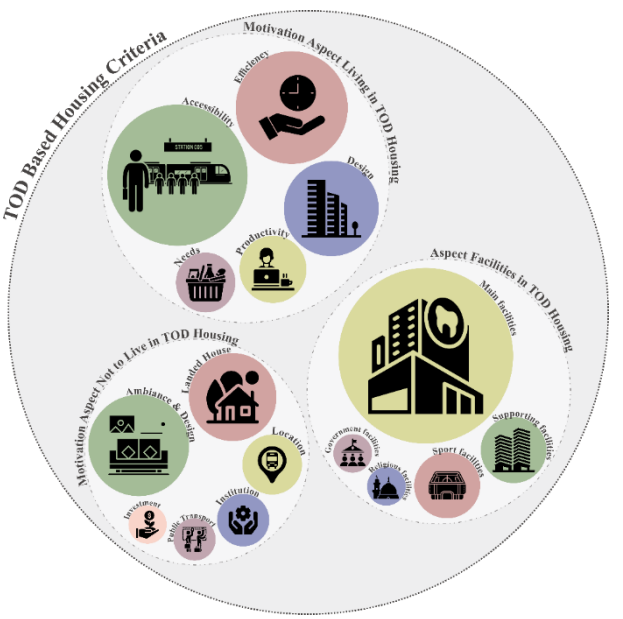


Figure 7. Hypothesis Model – TOD Based Housing Criteria

Aspect facilities in TOD housing consist of 5 category groups: supporting facilities, main facilities, sports facilities, religious facilities, and government facilities. Housing facilities refer to the amenities and infrastructure available within or around a living environment to meet the needs and comfort of its occupants (Madureira, 2013). These facilities encompass all the infrastructure, services, and utilities within or around the residential area to cater to the residents' needs (Beriatos & Argentini, 2015). In TOD housing, some functions of these facilities include facilitating social interactions and strengthening bonds among residents. The benefits include improved quality of life by providing easy and convenient access to various services and facilities, enhanced health and safety through disease protection and promotion of a healthy lifestyle, and increased property value by attracting potential buyers seeking a comfortable and secure environment (Evans, 2017).

The motivation aspect of not living in TOD housing consists of 6 categories: ambiance and design, location, landed houses, institutions, public transportation, and investment potential. Unattractive building design can contribute to an unpleasant atmosphere in the surrounding environment due to unfavourable aesthetics or visual perceptions, physical discomfort accompanied by a lack of ergonomics, and limited social interaction caused by a

scarcity of inviting public spaces (Zeisel, 2006). Buildings located too close to a station may experience noise and vibrations. Additionally, residences or structures near stations may expose occupants to air pollution (Babisch, 2002) and privacy disturbances (Belojevic, Jakovljevic, & Stojanov, 2008). Single-family homes generally offer higher privacy than condominiums in Transit Oriented Development (TOD). Residents have direct outdoor access and private yards and do not need to share facilities with others, as is common in condominiums (Chow & Liu, 2017). Public transportation in Indonesia faces challenges due to limited and poorly integrated infrastructure, insufficient public transportation quantity and quality resulting in low service levels, and public reluctance to use public transportation (Yudhistira, 2017). Vertical or TOD housing may not be attractive to investors seeking immediate returns, as higher property appreciation values may occur with single-family homes with larger plots and higher market values (Othman, Ahmad, & Shaffril, 2014).

CONCLUSION

Preferences of millennial and Z generations for TOD housing in the JMA can be observed based on the age group division with housing status, housing purchase system, and preferred TOD housing criteria. It is concluded that the Generation Z group (age 23 and below) tends to prefer renting a house. In contrast, the millennial group (age 24-35) is likelier to buy a home for stability and long-term certainty. Millennials' chosen housing purchase system tends to lean towards cash in stages 1-5 years or hard cash options. The desired TOD housing criteria can be identified through three factors: motivation aspects, aspect facilities, and motivation aspect not to live in TOD housing. The most dominant category for motivation aspect interested in living in TOD housing is accessibility; the most dominant category for not being interested in living in TOD housing is design and ambiance, while the most expected facilities in TOD housing are main facilities such as commercial amenities, transportation, pedestrian pathways, and open spaces. The motivational aspect of living in TOD housing can be used as criteria for architects, urban designers, or urban planners in designing TOD housing. Aspect facilities in TOD housing can be used as a checklist of facilities that must be provided in TOD housing. Lastly, the motivation aspect of not living in TOD housing can be used as a criterion to avoid designing TOD housing.

This research used a grounded theory approach, ensuring high originality in the findings. However, the generalization of findings is limited due to the non-random sampling method used for millennial and Z generations in JMA. Additionally, data collection was performed using online questionnaires, which might yield slightly different results than direct distribution. Further research possibilities include examining the influence of age on preferences for TOD housing types, the impact of age on preferences for down payment and affordable instalments in purchasing TOD housing, and the influence of age on preferences for transportation from TOD housing to the station. A better understanding of the motivation aspect, aspect facilities, and the motivation aspect not to live in TOD housing can enable designers and planners to implement TOD housing-based design towards a sustainable community and meet the preferences of millennial and Z generations to live in TOD housing.

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EXPLORING HOUSING QUALITY PERCEPTION ON PUBLIC RENTAL HOUSING THROUGH ONLINE USER REVIEW: CASE STUDY – WEST JAVA TRANSIT APARTMENT

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Abstract
The high population growth in Indonesia has led to rapid urbanization. Low-income people often face difficulties in fulfilling their housing needs in these urban contexts. To address this issue, the government has implemented several programs, such as public housing or flat housing, also known as Transit Apartments in West Java. Under the Transit Apartment Program, the West Java Government provides transitional housing for young families and industrial workers who do not have their own houses and are categorized as low-income communities. This research aims to obtain feedback and strategy for the improvement of Transit Apartment operational as an alternative to simple vertical rental housing for industrial workers in peri-urban of Greater Bandung. The situation of this provision needs to be evaluated in order to develop better strategies to meet the occupants' needs. One way to evaluate is through user opinion polls. When online reviews have developed through the internet media, opinions from users can be obtained and can be utilized. This research uses open-source data from Google Review to evaluate the Transit Apartment in West Java Province. Using online user review data, this study explored the perceptions of occupants about the quality of Transit Apartments in West Java Province. The data from online reviews were analyzed using the content analysis method. The results indicate that residents are highly satisfied with the quality of transit apartments due to the elements of tangibility, assurance, and reliability. On the other hand, residents feel very dissatisfied with the elements of responsiveness and empathy. This research identifies the quality of transit apartments in West Java from a service quality perspective and provides recommendations for the government to improve transit apartment services.

Keywords: *Transit Apartment; West Java; Housing Quality; Housing Satisfaction; Online Reviews*

INTRODUCTION

Transit apartments are a program that aligns with the Sustainable Development Goals (SDGs), which aim to achieve liveable and sustainable housing. One way to evaluate the success of this program is by subjectively assessing the residential quality of transit apartments. This subjective assessment can be conducted by identifying the factors that contribute to housing quality and the level of satisfaction of occupants with their living conditions (Poll, 1997). Residential satisfaction is perceived differently by each individual and is influenced by their social, economic, and geographical circumstances (Chapman & Lombard, 2006; Thomsen & Eikemo, 2010). Therefore, evaluating satisfaction with the quality of residential environments is subjective.

However, current government planning and development pays little attention to the subjective side of society. Assessments from society are often ignored because the government, as the policy maker, has higher authority. Therefore, this study was conducted to reveal public perception, in this case transit apartment residents, of housing quality in West Java Transit Apartment.

This research is qualitative research with a grounded theory approach (Creswell, 2019). In this study, researchers developed hypotheses (provisional theories) that explain occupancy satisfaction with quality in the population under study. The resulting hypothesis is a relationship mapping of identified housing quality factors that influence resident satisfaction. The knowledge revealed will be useful for government and transit apartment managers as a reference for developing transit apartments' quality and construction that can increase occupant satisfaction.

METHODS

The Case Study

This research focuses on Transit Apartments located in West Java, Indonesia. The case study examines four Transit Apartment locations, namely Ujung Berung (Bandung City), Batujajar (West Bandung Regency), Rancaekek (Bandung Regency), and Solokan Jeruk (Bandung Regency), to identify the quality of housing in Transit Apartments. The selection of study locations was based on the availability of online review data from Google Maps users (Google Reviews), including both positive and negative reviews.

Data Collection

The development of big data has enabled people to access vast amounts of internet-connected data easily and quickly. One such type of big data that is now easily accessible is online user reviews. Online reviews are sourced from consumer experiences because they have used the product or service. Online reviews can be subjective and biased, depending on an individual's experience with the product or service, which may differ from other customers. Online reviews contain a variety of textual information.

Research on housing quality using online reviews is still rare, especially in the context of public rental housing in Indonesia. To obtain online review data from Google Maps, researchers used a Google extension application called DataMiner. DataMiner can easily and practically extract data. Additionally, DataMiner provides data extraction that can be exported to various formats, such as Microsoft Excel.

This research used non-random sampling, specifically users who provided reviews on Google Maps only. Meanwhile, users who did not leave a review on Google Maps did not have the opportunity to contribute to the study. Data collection was conducted in February 2023. The data sample used was 453. From the data collection, a total of 231 user reviews from four different transit apartments were further analysed.

Table 1. Grouping Keywords into Categories and Classifying Them in Service Quality Elements

No	Categories	f (%)	Service Quality Elements (Parasuraman, dkk., 1988)	f (%)
1	Comfortability	17.0	Reliability	31.3
2	Rental costs	9.1		
3	Low-income housing	2.4		
4	Disaster	1.6		
5	Target group	1.4		
6	Water	1.4		
7	Electricity	0.6		
8	Place to rest	0.2		
9	Public transport	0.2		
1	Cleanliness	9.7	Tangibility	27.1
2	Facilities	6.5		
3	Tidiness	3.4		
4	Wideness	3.0		
5	Natural environment atmosphere	2.6		
6	Parking	1.6		
7	Beautifulness	1.0		
8	Residential unit equipment	0.6		
9	Road condition	0.6		
10	Water system	0.6		
11	Photo area	0.6		
12	Crowdedness	0.4		
13	Maintenance	0.2		
14	Architectural style	0.2		
1	Conformity to preferences	13.7	Assurance	26.3
2	Security	7.1		
3	Recommendation	0.8		
4	Peacefulness	0.4		
5	CCTV	0.2		
1	Management	1.4	Responsiveness	4.2
2	Regulation	1.0		
3	Queue list	0.8		
4	Requirements	0.2		
1	Security guard	1.8	Empathy	3.4
2	Friendliness	0.8		
1	Location	2.6	Location and Accessibility	7.8
2	Tranquillity	2.0		
3	Close to the protocol road	0.8		
4	Coolness	0.6		
5	Close to industry area	0.4		
6	Close to family	0.2		
	Total	495		384

Data Analysis

The qualitative analysis of the collected data was conducted using content analysis, correspondence analysis, and cluster analysis. The content analysis process consists of three stages: open coding, axial coding, and selective coding. Open coding was used to identify keywords from each sentence (text data) without missing anything. The results of this stage

are the frequency distribution of each category. Axial coding was used to identify the relationship between the categories of satisfaction with the object study and the level of satisfaction (rating), which was carried out using correspondence analysis. The results of the correspondence analysis are in the form of a dendrogram that describes the relationship between categories. These categories are then classified into elements of service quality theory. Selective coding was used to formulate a hypothesis about the factors that influence the quality of the residential environment and the level of satisfaction with residents of Transit Apartments. The results of this analysis are in the form of a hypothesis diagram containing the factors of residential quality that influence satisfaction with living in the West Java Transit Apartment.

RESULT

Text data obtained from online reviews is semantically read and parsed (words, sentences, or paragraphs) and then coded (keywords). From the keyword grouping results, 112 keyword variations were obtained. The identified keywords were then regrouped into groups of overarching categories (axial coding). This study has 52 sub-categories. The 52 sub-categories are further grouped into 5 elements in service quality theory and one new element (Table 1). The new element was specifically taken into consideration by the people in West Java in choosing to live in West Java Transit Apartments.

During the open-coding stage, five elements of service quality were identified, along with a new element: reliability, tangibility, assurance, responsiveness, empathy, and location and accessibility. Reliability (f=31.3%) and tangibility (f=27.1%) were found to be the most frequently discussed elements among transit apartment users in terms of satisfaction assessments (Table 1). In contrast, empathy (f=3.4%) was the least frequently discussed element. This can be interpreted as meaning that reliability is most often discussed by residents regarding satisfaction assessments.

Reliability

Reliability was found to be the most frequently discussed element among transit apartment users in terms of satisfaction assessments, with a frequency of 31.3% (f=31.3%). The reliability element consists of eight categories, with the comfort category having the highest frequency value (17%) after rental costs (9.1%) and disasters (1.6%). The comfort category refers to the comfort experienced by residents in their residential units, buildings, and the transit apartment environment. In contrast, the categories of places to rest (0.2%) and public transportation (0.2%) had the lowest frequency of reliability elements.

Tangibility

Fourteen categories were identified under the tangible element, with a frequency of 27.1%. The category of cleanliness (9.7%) had the highest frequency value, followed by facilities (6.5%) and tidiness (3.4%). Cleanliness refers to the cleanliness of residential units and their surroundings. Meanwhile, maintenance (0.2%) and architectural style (0.2%) had the lowest frequency of tangible elements. This suggests that cleanliness is the most important aspect of satisfaction assessment for residents under the tangible element.

Assurance

The assurance element was found to have a frequency of 26.3%, with conformity with preferences (13.7%) being the most frequently discussed category, followed by security (7.1%). Transit apartment conditions that are in line with residents' preferences and are safe can foster feelings of confidence and trust among residents. Conformity to preferences has a strong influence on the assurance element, while the CCTV category has little influence due to its low frequency.

Responsiveness

The responsiveness element (4.2%) pertains to the willingness and ability to assist transit apartment residents and provide prompt and high-quality service. The responsiveness element consists of four categories, with the management category having the highest frequency value (1.4%). In contrast, the requirements category had a very low-frequency value, indicating that it had little influence on the responsiveness element.

Empathy

The empathy element (3.4%) is comprised of two categories: security guard (1.8%) and friendliness (0.8%). The security guard category reflects the attitude of security guards towards residents who are perceived as unfavourable. Meanwhile, the friendliness category pertains to the social environment of transit apartments, where residents are friendly. It can be inferred that the security guard category has a significant impact on the empathy element.

Location and Accessibility

The location and accessibility elements were identified as the key findings of this research, comprising six categories. The frequency distribution revealed that location had the greatest impact on the location and accessibility elements, followed by the categories of tranquillity and close to protocol roads. Although it had the lowest frequency value, the category of being close to family was found to be one of the factors that influenced residents' satisfaction ratings.

The frequency distribution results provide insights into the factors that influence the level of occupant satisfaction and dissatisfaction, based on the category grouping of keywords, categories, and service quality elements. The data is converted into numerical data (0-1), with responses that mention a keyword and category from each review being coded as 1 (one), and statements that are not mentioned by the reviewer being coded as 0 (zero). The numerical data is then used to perform correspondence analysis.

DISCUSSION

Following the open-coding stage, axial-coding was conducted, followed by correspondence analysis to examine the relationship between categories, as indicated by the proximity between the level of satisfaction (rating given) and the factors that influence it. The rating given by reviewers was on a scale of 1 (one) to 5 (five), with a score of 1 (one) indicating complete dissatisfaction and a score of 5 (five) indicating complete satisfaction.

The results of this analysis revealed a significant correspondence between the level of satisfaction (rating given) and the factors that influence it (p value <0.0001) (Figure 1).

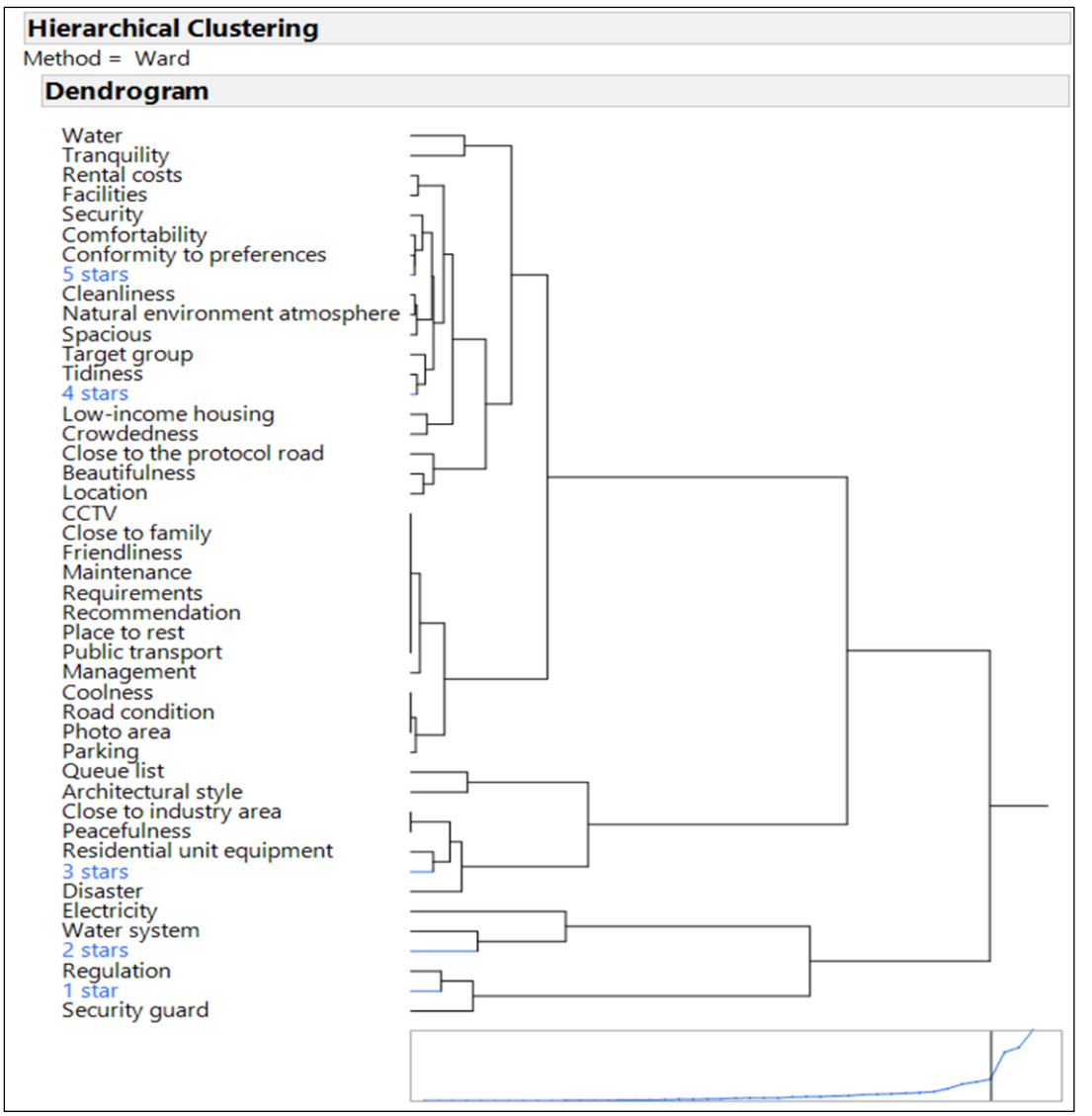

Figure 1. Correspondence Analysis Results of Satisfaction Levels and Influencing Quality Factors (p value= <0.0001)

The Rating 'Very Satisfied' is Represented by 5 Stars

According to the results of the correspondence analysis, residents gave the West Java Transit Apartment a rating of 5 stars, indicating high satisfaction with its comfortability, security, conformity with preferences, cleanliness, natural environment atmosphere, and spacious. In service quality theory, comfortability can be classified under reliability. Building reliability refers to the condition of a building that meets the requirements for safety, health, comfort, and convenience in accordance with specified functional requirements (Rizal, 2016). A comfortable building environment influences the level of occupant satisfaction with the

quality of the transit apartment building. Comfort in a residential environment is one indicator that influences occupant satisfaction (Amérigo & Aragonés, 1997). The physical characteristics of a residence, such as comfort, quality of the building, building plan, and size of the house, can have a significant influence on a person's residential satisfaction (Ibem & Aduwo, 2013; Türkoğlu, 1997; Widya et al., 2019). This research shows that occupant comfort in buildings has a high frequency.

According to service quality theory, conformity with preferences and security are included in the assurance element, as the quality of a transit apartment can instill confidence in its residents. Housing satisfaction can be achieved when there is a match between an individual's expectations/perceptions and the actual housing conditions (Amérigo & Aragonés, 1997). Individual satisfaction with a residence increases when there is a match between individual preferences and the actual condition of the residence (Khozaei et al., 2012). The conformity of residential preferences in transit apartments has a positive influence on the value of residential satisfaction. The frequency figures for aspects of residential conformity with preferences are quite high in the results of the analysis, indicating that there is a match between preferences and actual conditions in transit apartment housing. Residents who feel that the transit apartment suits their preferences will describe living conditions in the transit apartment as good, nice, and pleasant.

Security is also a factor that contributes to high levels of satisfaction among transit apartment residents. Residents feel that the conditions in transit apartments are safe, which enhances their satisfaction. Safety is one of the factors that individuals consider when choosing a place to live (Rahmadaniyati et al., 2016). An advanced security system can influence a person's decision to choose a place to live (Fisher et al., 2009). The safer a residential area, the more likely consumers are to stay in the residence (Mulyano et al., 2020). This sense of satisfaction with security increases residents' trust in transit apartments.

Cleanliness, natural environment atmosphere, and spacious are considered tangible elements of transit apartments. These elements are visible and can be perceived by the residents. Transit apartment residents are aware of the importance of maintaining cleanliness, which results in clean and tidy transit apartments. The waste bank program, where residents can exchange their waste for shopping coupons, also contributes to a clean transit apartment building environment. A clean environment free from pollution, rubbish, and noise can improve subjective well-being (Zhan et al., 2018). The natural environmental atmosphere found in transit apartments can provide a high sense of satisfaction. This refers to the presence of parks and green open spaces that are numerous and well-maintained, according to the residents. The presence of plants both outside and inside the residential area can increase occupant satisfaction with their residence(Akbari et al., 2021).

Building features such as the size of the house, number of rooms, number of floors, size, and location of the kitchen, technical installations, and the quality of the residential unit have a strong influence on residential satisfaction (Ariffin et al., 2010). The results of the analysis indicate that residents are satisfied with the building design factors because the building is spacious both in terms of residential units and the overall size of the building. The spacious of the building creates a sense of relief for the occupants which has an impact on their satisfaction with living.

The Rating 'Satisfied' is Represented by 4 Stars

Residents gave the West Java Transit Apartment a rating of 4 stars, indicating high satisfaction with its tidiness and suitability for the target group. Tidiness is included in the tangible elements, which can be directly perceived by residents. Environmental characteristics such as tranquillity, greenery, cleanliness, and safety are key factors that influence residential satisfaction (Huang & Du, 2015). Furthermore, residents assessed that there is a match between the characteristics of transit apartments and the community groups of industrial workers and young and single families. This is in line with the goals and targets of transit apartment residents. Self-congruity with housing influences the decision to live in a residence (Sirgy et al., 2005).

The Conditions of 'Very Satisfied' and 'Satisfied' are Rated at 4 and 5 Stars

Based on the results of the correspondence analysis, it is evident that there are several categories that residents who feel very satisfied (5 stars) and satisfied (4 stars) often mention. These categories include facilities, crowdedness, beautifulness, maintenance, road condition, photo spots, parking, rental costs, water, low-income housing, places to rest, public transportation, requirements, management, CCTV, recommendations, friendliness, tranquillity, close to protocol roads, location, close to family, and coolness. In service quality theory, the categories of facilities, crowdedness, beautifulness, maintenance, road conditions, photo spots and parking are included in the tangible elements (tangibility). Public facilities play a crucial role in producing quality housing that will also affect the residents' satisfaction with living (Mohit et al., 2010). Transit apartments are considered to have adequate public facilities such as parks, sports fields, children's play areas and mosques.

According to the paragraph, the presence of a spacious and well-equipped parking area with a canopy is a significant factor in creating a sense of satisfaction among transit apartment residents. The availability of parking space is one of the crucial determinants of where to live, particularly in the context of multi-storey housing (Hanif et al., 2015). The natural ambiance and numerous open spaces in transit apartments are frequently utilized as photogenic locations by transit apartment residents. The construction of transit apartments leads to the creation of a vibrant and bustling environment around them.

The categories of rental costs, water, MBR housing, places to rest, and public transportation can be classified under reliability elements. Housing affordability refers to the relationship between housing and the ability of individuals or groups to access that housing (Stone, 2006). From an economic perspective, housing affordability is related to the decisions each household makes regarding spending on residential and non-residential needs (Suhaida et al., 2011). When the expenditure for housing needs incurred by each household is no more than 30% of the total household expenditure, then the residence can be categorized as affordable housing (Newman & Holupka, 2014). In this research, the majority of residents stated that they were satisfied because the rental costs for transit apartments were affordable. This is in line with the aim of the transit apartment program, which is to provide temporary housing to low-income people before they have their own housing.

The availability of clean water is a utility factor that affects the satisfaction of occupants. Transit apartment managers have provided clean water facilities through PDAM and wells.

Furthermore, requirements and management are included in the element of responsiveness. In this case, transit apartments can provide good services. Residents feel that the requirements given to be able to live in a transit apartment are easy and the management provides good service. This influences a good assessment of transit apartments.

The recommendation and CCTV categories can be classified under the assurance element because of the ability of transit apartments to generate a sense of trust and confidence in their residents. The presence of CCTV that is integrated for 24 hours provides a sense of calm and security. Residents who have a sense of trust and confidence in transit apartments will provide recommendations to prospective residents.

Transit apartment residents also feel that the residential environment is friendly. This friendliness can be classified into the aspect of empathy. The feeling of caring between individuals in this transit apartment environment is a form of empathy.

Tranquillity, close to protocol roads, location, close to family, and coolness can be classified under the elements of location and accessibility. Transit apartments are built near protocol roads to ensure that residents find them easily accessible. Accessibility factors such as access to public transportation, major roads, and toll roads are among the determining factors when choosing a place to live (Mulyano et al., 2020). Location, which influences a person's satisfaction with their residence, usually refers to ease of accessibility to central business areas, workplaces, communities, places of worship, and public facilities such as schools, health centres, shopping centres, and transportation centres (Gibson, 2007; Potter & Cantarero, 2006; Teck-Hong, 2012; Thanaraju et al., 2019). Accessibility is a determining factor that influences a person's preference for a place (Ardeshiri et al., 2018). Residential-related projects must be well planned, designed, and implemented, especially in terms of accessibility, proximity to workplaces, schools, health facilities, shops, and other community centres (Leh et al., 2016). In addition to this, residents also feel that the transit apartment is located in an area near their family. This shows that the people of West Java, especially residents of transit apartments, pay attention to the aspect of closeness to family members. The location close to parents, older siblings, and other family members also influences decisions about where to live (Mulder, 2007).

Environmental conditions around the location, such as pollution and environmental maintenance, also influence a person's satisfaction with their residential location (Chapman & Lombard, 2006; Cook, 1988; Gibson, 2007; Hipp, 2010). In this research, the surrounding environmental conditions provide a positive value for satisfaction.

The Rating 'Neutral' is Represented by 3 Stars

A queue list, architecture style, residential unit equipment, close to industrial areas, peacefulness, and disaster make residents feel neutral. The queue list is one of the aspects of responsiveness, which is related to the speed of service provision. Some respondents expressed dissatisfaction with the long queue list to live in a transit apartment, which resulted in a longer waiting time. The tangible element of a transit apartment has a neutral value, which is related to the building style and completeness of the residential unit. Residents feel that the residential units of this transit apartment are complete and can meet their needs and perceptions. Modern building styles have a positive impact on residential satisfaction. However, these two categories do not have a major impact on residents' assessments of transit apartments.

The disaster category can be classified as a reliability element. Flooding is the cause that has the greatest value for residents' dissatisfaction with transit apartments. Conditions that are free from flooding are a factor that residents pay more attention to when choosing housing (Rahardjo et al., 2015). The social environment in transit apartments is perceived as undivided by residents, and this aspect can be classified under the assurance element. Specifically, the peace category can be grouped under this element.

The location of the transit apartment near an industrial area is beneficial for the target population of transit apartments, especially the industrial workers. A residential location in proximity to the workplace is known to increase a person's satisfaction with their residence (Mulligan et al., 2004). Residents are content with their residence if it is located approximately 5 km from their workplace (Teck-Hong, 2012). However, these factors do not have a significant impact on residents' satisfaction with transit apartments, as residents have rated it neutrally by giving 3 stars.

The Rating 'Dissatisfied' is Represented by 2 Stars

The quality of the transit apartment is a source of dissatisfaction among residents, primarily due to the electricity and water systems in the building. The electricity is one of the aspects of reliability and water systems is one of the aspects of tangibility. The availability of infrastructure, such as utility networks in buildings, is an important physical element that influences preferences when selecting a place of residence (Ardeshiri et al., 2018). The electricity system in this transit apartment uses a token system, which simplifies payment and management of electricity for residents. However, residents are dissatisfied with the electricity category due to frequent power outages in transit apartments. Additionally, the poor water system is due to leaks in several residential units.

The Rating 'Very Dissatisfied' is Represented by 1 Star

The residents of the transit apartment have expressed their dissatisfaction with the regulations and security guards, as evidenced by their rating of 1 star. The regulations in the transit apartment are perceived as inadequate, as residents are not allowed to bring guests into the transit apartment, and the regulations are considered strict. This suggests that responsiveness in transit apartments is low. Additionally, residents are dissatisfied with the security guards, who are perceived as impolite and lacking empathy.

The previous analysis and discussion revealed that three elements in service quality theory, namely assurance (conformity to preferences and safety), tangibility (cleanliness, natural environmental atmosphere, and spacious), and reliability (comfort), have a significant impact on the satisfaction of transit apartment residents. However, two elements in service quality theory, namely responsiveness (regulations) and empathy (security guards), have a significant impact on the dissatisfaction of transit apartment residents.

The categories within the five elements of service quality and the element of location and accessibility must be able to work together to create a high-quality transit apartment residence that satisfies its residents.

CONCLUSION

The research obtained a hypothetical model structure that maps the housing quality factors influencing the satisfaction of apartment residents, grouped based on service quality and location and accessibility elements. The hypothesis model maps 52 transit apartment quality categories in relation to satisfaction ratings. The analysis revealed that residents were highly satisfied with the tangible elements, assurance elements, and reliability elements. The tangibility element is related to cleanliness, natural environmental atmosphere, and spacious. The assurance element is related to conformity with preferences and security. The reliability element is related to comfortability. Conversely, residents expressed high dissatisfaction with the responsiveness and empathy elements. The responsiveness element is related to regulations, while the empathy element is related to security guards.

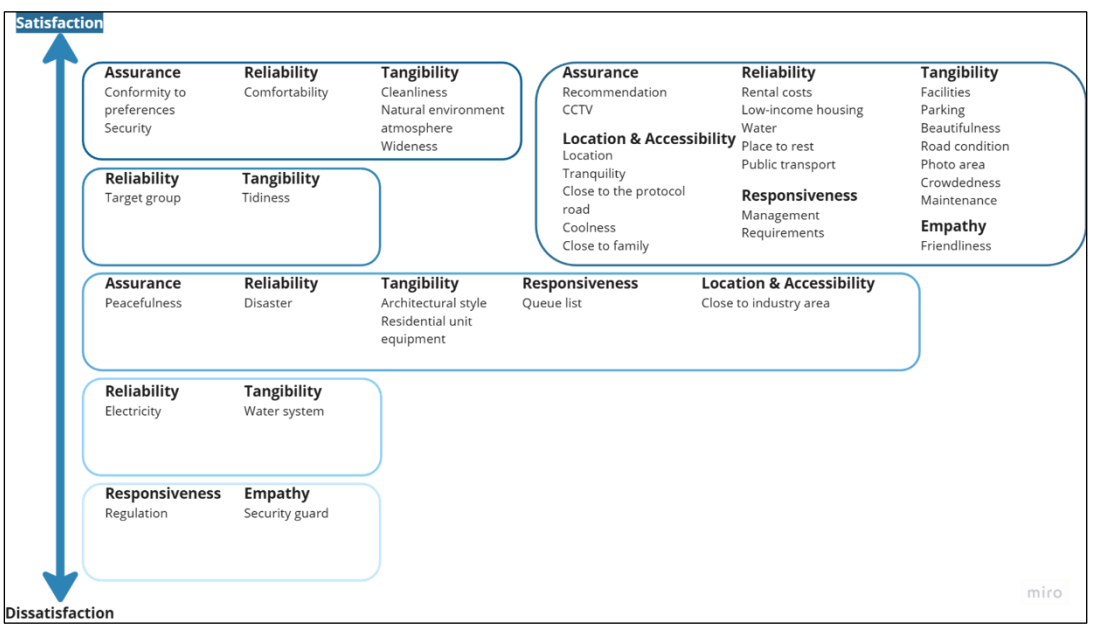

Figure 2. A Hypothesis Model of the Relationship Between Quality Factors and Satisfaction

To improve resident satisfaction and residential quality in transit apartments, transit apartment management and the West Java regional government can prioritize improvements in the responsiveness element related to regulations and the empathy element related to security guards. This can be achieved by making transit apartment regulations more adequate and tailored to residents' characteristics while still paying attention to family aspects. Additionally, managers must pay more attention to security guards' attitudes to ensure they are polite and not arbitrary.

This research is original because it uses a qualitative approach with grounded theory research procedures. Future research should be conducted to increase the reliability of these findings.

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SYNTACTIC MEASUREMENT OF FORMAL HOUSING BUILT BY DEVELOPER IN BANDUNG CITY

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Abstract
Housing built by developers offers a variety of choices for consumers. There are multi-types of residential units offered in one residential area. Various housing site models have emerged according to the creativity of developers in designing them. The effectiveness of proposals for multi-type housing site plans needs to be evaluated, especially in their ability to ensure the integration and equal connectivity of each housing unit type. Research on this topic is still limited; therefore, this study aims to analyse spatial integration through mapping accessibility of different unit types. The study focuses on locations in Bumi Adipura Housing, Jingga Residence Housing, and Green Caraka Residence Housing in Bandung City. This study emphasizes the syntactic analysis of the study locations using space syntax. Space Syntax is one of the methods used to identify the spatial configuration of housing patterns in the built environment. Site plan data were obtained through the open-source Cadmapper. With the assistance of DepthMapX software, the data were analysed using axial maps, revealing connectivity and integrity values. This study focuses on two aspects: integration and morphology. The results of this research can provide recommendations for the design and planning of multi-type housing patterns that support social integration and high connectivity opportunities.

Keywords: *Multi-Type Housing; Integration; Connectivity; Space Syntax*

INTRODUCTION

The attractiveness of the city of Bandung as a place to live is still powerful. The substantial population growth in the city, both naturally and as a result of urbanization, causes the demand for housing. In Bandung's Regional Spatial Plan (RTRW), the government is seeking solutions by directing development towards the East Bandung region to establish it as a secondary urban centre. There is a trend of increasing housing development in East Bandung, where developers compete to build and market formal housing.

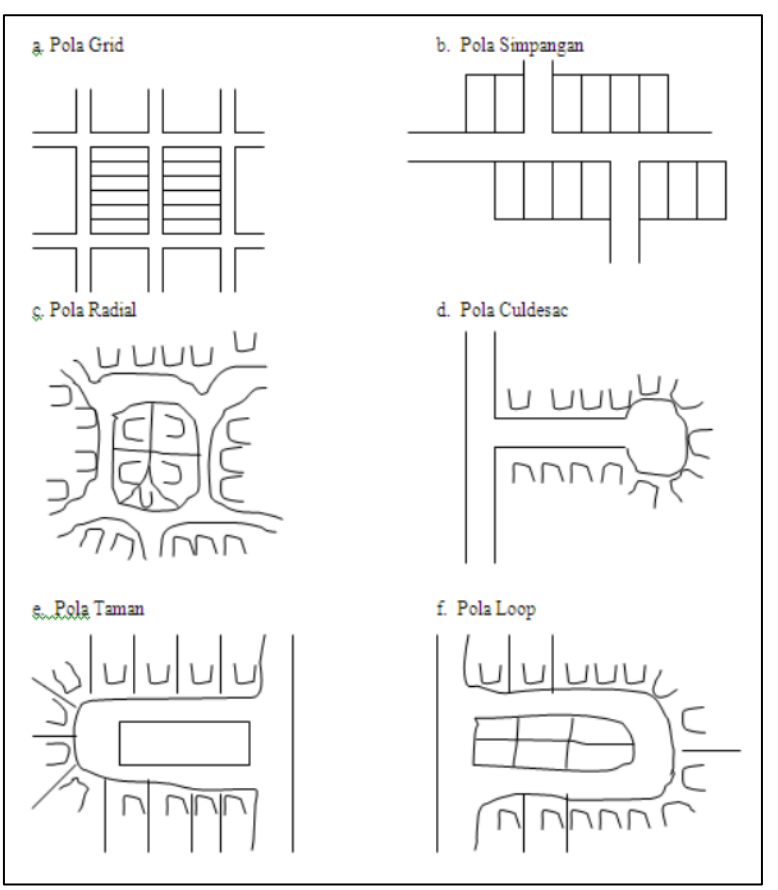
On the other hand, the housing demands of the community vary according to social and economic backgrounds. Developers try to provide various types of houses within a single area. Starting from simple types, medium types, and luxury types, these are tailored to meet the preferences of the target occupants. Developers carefully plan the land to accommodate multi-type houses. The effectiveness of diverse site plans or master plans for multi-type housing developments needs to be evaluated, especially in the context of their ability to ensure that each type of residential unit is integrated and or connected equally (De Chiara & Callender, 1983; Southworth & Ben-Joseph, 2003).

The diversity of site forms can be influenced by spatial configuration and housing layout patterns. Space consists of two main components: pattern/layout and configuration. In simple terms, spatial configuration is the interconnection between spaces that form the organization or structure of space and the circulation of movement activities and human interactions. De

Chiara J (1983) stated that road network patterns can influence the space for residents to move in and carry out activities. Southworth and Ben-Joseph (2003) broadly explain three housing patterns: grid pattern, fragmented grid pattern, and cul-de-sac pattern. Meanwhile, De Chiara and Callender (1983) mention six road patterns. There are grid patterns, intersection patterns, radial patterns, cul-de-sac patterns, park patterns, and loop patterns.

Source: Southworth and Ben-Joseph (2003)

Figure 1. Street Pattern (a) Grid Pattern; (b) Fragmented Grid; (c) cul-de-sac



Source: Indrayani (2012)

Figure 2. Josepth De Chaire's Street Pattern Based

Furthermore, Oliveira (2016) asserts that residential spatial arrangements in the cul-de-sacs and loops with doors facing away from the main road encourage segregation compared to grid and linear types. In line with this, Jacobs (1916), and Duany & Plater-Zyberk (2017)

explain that loops tend to be more segregative than grid or linear types. Jacobs (1916) stated that designing roads with many intersections makes cities appear more lively and interactive and can be used to monitor each other.

A syntactic analysis of a sample of study locations can be used primarily to identify the configurational properties of the spatial typology of the neighbourhood (Min, 1993). The research team of Bill Hiller and Julienne Hanson at University College London in the late 1970s and early 1980s developed a method used to read urban spaces called space syntax. Hillier states that space syntax is a set of techniques for analysing the spatial configuration of all types, especially where spatial configuration is a crucial aspect of human affairs, such as buildings and cities. Önder and Gigi (2010) add that the space syntax method can help interpret urban systems about syntactic systems such as symmetry-asymmetry, integration-segregation, distribution, determination of control values, integration features, and morphology. Furthermore, space syntax is used to see connectivity or interrelationships between spaces and the spatial integration of road networks in settlements. Good connectivity and integration of space syntax can mean that an area is an area that has good accessibility and is easy to reach the most.

Based on background, this study aims to analyse spatial integration through accessibility mapping of different unit types and housing patterns. The analysis results from the space syntax method then yield differences in spatial interactions and depth based on road network patterns. The results of this analysis are described by the axial line space syntax analysis using Depthmaps-X software. Connectivity and integration values are utilized to analyse the effective housing patterns for diverse house types.

The Content of The Extended Abstract

Method

In this study, data was collected through secondary data. Secondary data was obtained from document review and literature review. The secondary data used is a site plan from the study location taken from the open-source CadMapper. To determine the study location, a purposive sampling method was used in this study, where the selected location is considered one of the residential areas offering various housing types within a single area located in East Bandung. In the purposive sampling technique, also called judgment sampling, the location sample was deliberately determined by researchers by considering more representative results (Etikan et al., 2016).

The data analysis method in this study uses a quantitative approach with space syntax analysis. Spatial analysis using DepthmapX software begins with digitizing the site plan which is then processed using space syntax analysis to determine the connectivity value and integrity value. These two indicators were obtained from axial line analysis map analysis. Furthermore, from each study location the minimum, average, and maximum values of connectivity and integration are displayed using the fewest line maps.

Connectivity measurements are carried out to find the level of interaction of each space with nearby spaces. High integration values are indicated by "warm" line colours, namely red or yellow, while low integration values are depicted by "cool" line colours, namely green or

blue. High integration values signify that the street is not too deep, well-known, busier, and most frequently used. Theoretically, it holds the highest economic value. Streets with high integration scores also indicate a more integrative rather than segregative character character (Hillier, 1996; Hillier & Vaughan, 2007).

Discussion

The study location is housing in the East Bandung area and provides various types of housing in one area. Bumi Adipura Housing, Jingga Residence, and Green Caraka Residence were selected by considering different sub-district locations and different housing patterns. So that we can see the differences and integration of each study location.

Connectivity analysis is a static local measurement analysis, taking into all direct connections that each street has to other streets in its vicinity. Connectivity is applied to describe the number of connections each road has to nearby roads. Connectivity is also used to see the interaction of adjacent spaces. The following are the results of connectivity analysis using axial map analysis.

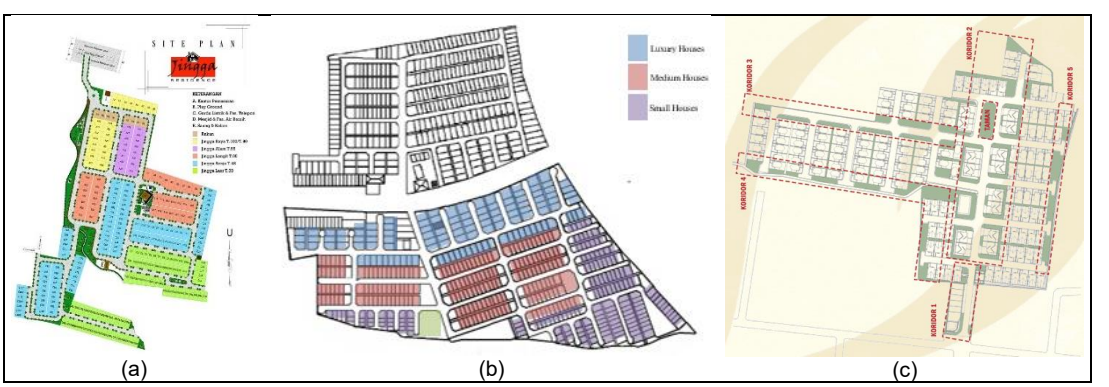


Figure 3. (a) Bumi Adipura Siteplan; (b) Jingga Residence Siteplan; (c) Green Caraka Residence Siteplan

In Bumi Adipura Housing, interactions between spaces were quite good. It can be seen that there are four road segments highlighted in red. The area of simple house types and medium house types have red or yellow colour gradations, and the connectivity value is high. The highest connectivity value is located in the simple type of house area with a grid pattern. This means that access is accessible and interaction between rooms is high. However, the connectivity value is low in houses with culdesac road patterns in luxury housing types of areas. Connectivity in Jingga Residence is dominated by red and yellow. High connectivity values are found in spaces encompassing house types 100, 80, 60, 55, and 48, as well as 36. This indicates that spatial interactions with different house types are very good. House types 48 and 36, situated in the green-shaded gradient, have low connectivity values because they are located behind the area, resulting in lower spatial interactions. In Green Caraka Residence, there are two axial lines with high connectivity values. The highest connectivity value is observed in the linear pattern. A contrasting colour is evident where the linear pattern intersects with the grid pattern. This signifies that the orientation of houses also influences spatial interactions.

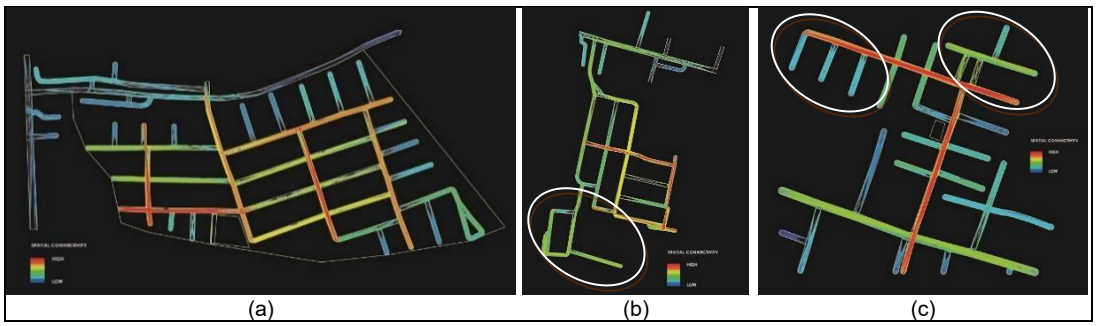


Figure 1. Connectivity Axial Maps Analysis (a) Bumi Adipura; (b) Jingga Residence; (c) Green Caraka Residence

Integration analysis is a spatial configuration analysis that assesses the ease of reaching specific spaces. Spaces that are easily accessible have higher accessibility integration values, while spaces that are difficult to reach have lower accessibility integration values. In theory, this integration analysis can estimate the level of road accessibility to all other roads in the urban system by considering the total number of changes in urban entity directions (Hiller & Hanson, 2003).

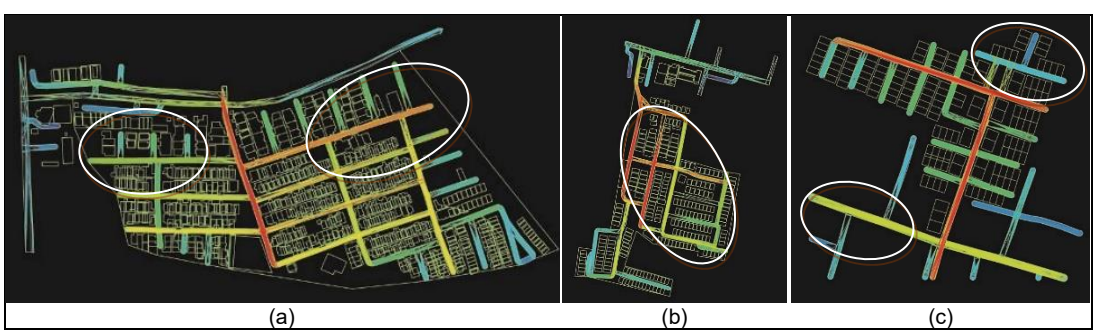


Figure 4. Integration Axial Maps Analysis (a) Bumi Adipura; (b) Jingga Residence; (c) Green Caraka Residence

It can be seen that in the Bumi Adipura housing complex, the colour gradations are dominated by red and yellow. This implies that most house types are well-integrated, except in the area with a cul-de-sac road pattern. The highest value is found on the main road, which is 2,381 and is connected to 6 roads. This road connects the medium house type and the medium house type. Meanwhile, the integration between medium and simple housing types is predominantly in the yellow gradation. The integration analysis of Jingga Residence indicates that most configurations have been integrated. However, two configurations are blue. These configurations are part of houses with types 36 and 48. This point shows a low integration value, which means the space configuration is too deep to be achieved. Placing type 100, type 80, type 60, type 55, and type 40 houses in a grid facing each other produces a space configuration with red gradations. Green Caraka Residence has a contrasting colour gradient from red to green and blue. The highest integration value is found on the main road of the complex. The green gradation is caused by a dead-end road. The lowest integration value is indicated by the blue colour gradient, where the area has to navigate through a park pattern.

Table 1 shows the minimum, average, and maximum values from the connectivity and integration analysis. In connectivity analysis. The minimum, average, and maximum values are derived from the analysis using the fewest line maps. The minimum represents the streets connected to only one other street. The housing development with the highest average connectivity value is Jingga Residence. Although it has a maximum value lower than Bumi Adipura Housing, the dynamic grid pattern facilitates high spatial interactions. Different types of houses are arranged closely to each other. Green Caraka Residence has a smaller average value compared to others due to many dead-end streets; furthermore, the park pattern influences road connectivity afterward.

In the integration analysis, it is evident that Bumi Putra Housing with a combination of grid and cul-de-sac patterns has the highest average value. Despite the cul-de-sac pattern having a lower value, spatial arrangement is maximized in the grid pattern. The grid layout aids spatial interactions and minimizes spatial depth, enabling the integration of all house types. Green Caraka Residence, with a combination of grid and park patterns, shows an average integration value of 1.091. Meanwhile, Jingga Residence with a grid pattern has the smallest figure, measuring 1.355. When considering the regional pattern, Jingga Residence has an elongated area with a large grid, contributing to its lower average integration value.

Table 1. Comparison of Connectivity and Integration Analysis

No	Location	Pattern	Connectivity Analysis			Integration Analysis		
			Min	Average	Max	Min	Average	Max
1	Bumi Adipura	Culdesac, Grid	1	2,97	10	0,66	1,26	2,38
2	Jingga	Grid	1	3,33	6	0,49	0,86	1,35
3	Green Caraka	Grid, Garden	1	2,78	6	0,47	1,09	1,79

Reference: Study Result

CONCLUSION

Space Syntax can be used to analyse the spatial integration of housing patterns and morphology. Using axial line analysis, the connectivity and spatial integration values are determined. Based on the results of Space Syntax analysis, the Grid housing pattern has higher connectivity values compared to cul-de-sac and park patterns. However, an excessively long grid pattern can result in low integration values. Many intersections contribute to high integration values and small segregation values. The placement of diverse housing types does not affect the design of road network patterns effectively having high integration values for each different house type road.

This study concludes that site design, including building layouts in residential environments, has affected promoting social interactions among residents. Therefore, the site plans should not be viewed by designers merely as a tool for organizing building structures. Based on the findings of this study, researchers believe that the design of the built environment has the power to facilitate social relationships through site plan manipulation. It is not the quantity of open spaces or social facilities, but rather the arrangement of spatial patterns that helps determine the use of these spaces.

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MAPPING PERCEIVED ADEQUATE HOUSING AFFORDABILITY ISSUES OF LOW-INCOME HOUSEHOLDS: CASE STUDY OF BANDUNG METROPOLITAN AREA

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Abstract
Housing affordability is still prevalently a crucial matter to be addressed thoroughly in the urban housing development discourse with its' entailed issues. Besides the general issue such as mismatch between the household's ability to achieve adequate and suitable housing, another pivotal problem that must be addressed comprehensively is regarding the housing affordability definition and the measurement approach. the current definition and measurement considered could not comprehensively cover the actual housing situation of the households, as solely focuses on the economy. To establish a thorough housing affordability definition and measurement approach it is argued that we must understand better the complexity of its related dimension. it is propositioned that housing affordability should be perceived beyond economics, as it could be argued supposedly defined subjectively and contextually, depending on the household characteristics. this research purpose is to extensively identify the perceived housing affordability and the entailed factors in the different contexts of low-income households to explore the subjective aspects of housing affordability. The study was conducted with a qualitative approach, and case study research design, exploring with an in-depth explanation of how low-income households perceived housing affordability, through investigating the households' situation and depicting the problem experienced, including the trade-offs to address the affordability problem in the context of Bandung Metropolitan Area. The results showed that throughout the housing type. The economic factor as in the housing price compared to the household capabilities, was perceived by the respondents as being the most important. It is followed by the consideration of the housing location, which helps reduce the transport expenses and the ease of access to several facilities, also the households mostly experience trade-offs in compromising housing physical quality to attain a suitable house compared to their capabilities. It could be concluded. The perceived factors and the depiction of trade-offs will provide insights to include more multi-dimensional factors related to housing affordability, which could comprehensively cover the housing situation. The consideration of these more complex criteria will also lead to a more contextual housing policy related to sustainable affordable housing.

Keywords: *Housing; affordability; factors; low-income; subjective; contextual; trade-offs; Bandung*

INTRODUCTION

Housing affordability is a crucial issue that must be addressed thoroughly to achieve the 'housing for all' ideal. Within urban areas, inclusive housing development must be oriented in providing access to decent and adequate housing that is able to accommodate extensive range of households' affordability, especially for low-income households The ubiquitous housing affordability issues are generally understood as the occurrence of a mismatch between a household's ability and the available housing stocks, mostly related to finances. The situation also worsens as the housing affordability gap perpetually increases due to particular factors related to the supply and demand side (Anacker, 2019; Collins, 2013; Galster & Lee, 2021; Malpezzi & Mayo, 1997; Shlay, 2013). This situation mostly affects the low-income households, as most of the available housing stocks perceived to be unaffordable.

Hence, low-income households must undertake several trade-offs related to housing and non-housing aspects, in addressing the housing unaffordability issue (Anacker, 2019; Haffner & Hulse, 2021; Stone, 2022).

Another pivotal problem that must be addressed comprehensively is regarding the housing affordability definition and the measurement approach. The definition and measurement of housing affordability is still utilized diversely (Galster & Lee, 2021; Stephen Ezennia & Hoskara, 2019). The most prevalently used measurement approach, also well-known as the conventional approach, is the ratio and residual approach (Stephen Ezennia & Hoskara, 2019). The ratio approach is widely-utilized due to its' practicality. It provides a threshold of households' income to housing cost ratio in percentage, that reflects the maximum level in which the housing-related cost is perceived affordable for certain households' financial capability. The commonly used threshold ratio is at 30%, mainly utilized by banks as mortgage providers also by real estate developers to assess the target market. On the other hand, the residual approach measures housing affordability in more comprehensive manner, as it includes the non-housing households' expenditure in the measurement. This approach acknowledges the differences in the households' way of maintaining the balance of housing cost, non-housing cost, and income. With this approach, housing is perceived as affordable if the households can maintain certain amount of residual income while meeting the housing and non-housing necessities.

Even though those mainstream housing affordability measurements have been globally used, both still have weaknesses and have not been depicting the actual housing affordability comprehensively (Stephen Ezennia & Hoskara, 2019; Zamrodah, 2016). The ratio method with its' rule-of-thumb percentage approach considered not scientific-based and prone to overgeneralization, as it could not picture the diversity of individual or households' situations (Hulchanski, 1995). The Residual approach is better, as it considers the variety of households' conditions, but is perceived to solely focus on the economic aspects (Stephen Ezennia & Hoskara, 2019). Both of the measurement approaches considered are not yet able to reflect the condition of the actual housing affordability and the issues that come within. It cannot comprehensively depict the trade-off condition especially in low-income households, since they are, through ratio or even the residual approach, measured able to achieve housing affordability despite the inadequate housing and low non-housing consumption quality (Hancock, 1993; Meen, 2018).

Thus, housing affordability should include more extensive factors, as the related discourse has geared towards including multi-dimensional and complex aspects (Haffner & Hulse, 2021). To establish a thorough housing affordability definition and measurement approach it is argued that we must understand better the complexity of its related dimension. it is propositioned that housing affordability should be perceived beyond economics or the objective factor only. It could be argued that housing affordability supposedly defined subjectively and contextually, depending on the household characteristics.

Reflecting on the implementation of housing affordability definition and measurement in the context of Indonesia. The housing policy in Indonesia has not been defining housing affordability even though the terminology is utilized prevalently. Referring to the one of Indonesia fundamental statute, *Undang-Undang* (Act) Number 1 Year 2011 on Housing and Settlement, adequate and affordable housing mention several times, and the provision of it

considered as government responsibilities. It could also conclude that adequate and affordable housing is a public right. Hence, the statute, or even any other regulations, are not explicating the housing affordability in specific and detailed manner. The information regarding the adequate and affordability issues is also partially available. Based on the *Badan Pusat Statistik* (Statistic Bureau Indonesia), currently, the only available data regarding these issues, is about the adequate housing. The number of Indonesia households that could not access adequate and affordable housing reached 39,34% in 2022 and decreasing to 34,74% in 2024. Although, the access to adequate housing is improving, it does not depict the housing affordability condition. It could be assumed that several households could experience several burdens, or other trade-offs despite the perceived ability to access the adequate house, due to the housing affordability issues. Based on these situations, even though the housing affordability issue is already considered, it is perceived still cursory. The housing affordability has not been described clearly, showing the unreliability and followed by the urgently need of further valid data that comprehensively depict the characteristics of the housing affordability problem, experienced by the households in Indonesia. If the housing affordability comprehensive definition and measurement persistently overlooked, the fulfilment of housing need will not be thorough, and will further exacerbate the right to the adequate and affordable housing (King, 2000, 2003; Pattillo, 2013).

Mapping Perceived Housing Affordability Variety on Diverse Context of Low-Income Households Tenure Status

To address the issue of housing affordability, particularly in the fuzzy definition and measurement, this research aims to identify and depict extensively the issues related to housing affordability in the different contexts of low-income households. The research mainly focusses on exploring the subjective aspects of housing affordability in the urban areas of Indonesia. The domain of subjective aspects recognized will potentially illustrate the actual condition of households' housing affordability experience, including the burden and the strategies undertook by the households. The subjective aspects approach within housing affordability is considered scarcely used, due to its fluctuation, complexities, and the difficulty to generalize the results (Stephen Ezennia & Hoskara, 2019). Hence, the subjective aspects are capable of providing the value of choices that can be very distinct in every household, depicting the actual issues of affordability. By exploring the subjective aspects within housing affordability, the research will contribute to extending the discourse to a more comprehensive degree, in which it is prevalently dominated by positivistic approach that overlook the variety in the households' experiences towards housing affordability (Clapham, 2002, 2005, 2017).

The research data was collected through in-depth semi-structured interviews with convenient sampling from the households on several housing types in order to illustrate the diversity of housing affordability conditions:

- Rental sectors 1 - room rental (*kos*), households renting unit in a form of a room as a part of a building (housing)
- Rental sectors 2 - unit rental (kontrak), households renting an entire house
- Rental sectors 3 - social housing (rusunawa), households renting a unit in a social housing

- Rental sectors 4 – subsidized housing rental, households renting a subsidized housing rental (rented by the low-income homeowners)
- Owner-occupied housing sector – subsidized housing (first-time buyers), households owning a house with a subsidized mortgage program

The urban area that was chosen for the data collection is Bandung Metropolitan Area, as it could illustrate the variety of affordability problems extensively through the variety of low-income housing tenure status. The criteria for the respondents also determined as an income below Rp 8.000.000 (based on low-income criteria of Ministry of Public Works and Public Housing, Peraturan Menteri Pekerjaan Umum dan Perumahan Rakyat Nomor 1 Tahun 2021). Therefore, the study objective is also to illustrate the interaction between the perceived variables related to housing affordability and the households' strategies to achieve the preferred housing condition in each type of housing tenure through establishing pattern analysis with open and axial coding (Creswell & Creswell, 2017).

Research Findings

Based on the data analysis from the interview the research establishes several key points to further identify the perceived housing affordability factors.

Household/Respondent Characteristic

The characteristics of the respondents are quite diverse. It includes the family with single-earners, and dual-earners, which comprises a small family of 2, and normal nuclear family of up to 3 to 4 family members, and a large household with 5 members. Most of the respondents work in the informal sector with an uncertain income.

Perceived Housing Affordability

The data from the interview showed that all of the respondents considered their choice of housing to be economically attainable. The choice of housing is also mainly decided based on the household's budget constraint. Hence, if measured with the ratio and residual approach, several respondents could be perceived as experiencing housing affordability stress as the housing cost-to-income ratio is above 30%. Moreover, several respondents also are not able to save money, which means no residual income. This occurrence is due to the unexpected expense also the fluctuation of income.

Housing Choice Motives

The main motive of the household housing choice is the housing cost relative to the household's financial capability. Most of the respondents in the rental sector noted that the rental housing price that they could afford was still far lower than the owner-occupied housing. Several households in the rental unit aspire to buy subsidized housing and already started the effort by striving to save some money from the residual income. However, there is an example of a respondent who can afford owner occupied house but chooses not, to increase non-housing consumption.

Table 1. Identified Housing Affordability-Related Factors and Trade-Offs

Type	Perceived Housing Affordability, Housing Choices Motives and Households' Distinct Situation	Trade-Offs
Room Rental 1	house is economically attainable, considering the relatively limited household income with no residual income (single-parents), proximity to work and facilities	low-quality of natural light and air circulation, too dense and contiguous dwelling area only accessible for motorbikes, stagnant housing goals plan no improvement
Room Rental 2	house is economically attainable and allows the households to save money to improve family prosperity also aspire to attain owner-occupied housing, proximity to work and facilities	low-quality of natural light and air circulation, too dense and contiguous dwelling area only accessible for motorbikes, stagnant housing goals plan no improvement
Unit Rental 1	house is still economically attainable considering the limited income and uncertain household expenses, no savings mostly prioritized for family necessities, proximity to work and facilities no plan to move to another housing type or location	inadequate area (bedroom) for family members, low-quality of natural light and air circulation, too dense and contiguous dwelling area only accessible for motorbike, stagnant housing goals plan no improvement
Unit Rental 2	house is still economically attainable considering the limited income, attain an additional income from selling daily goods within the dwelling area, allow to save money and plan to own housing, proximity to work and facilities no plan to move to other housing type or location	low-quality of natural light and air circulation, too dense and contiguous dwelling area only accessible for motorbike
Rental Subsidized Housing Unit 1	house is still economically attainable considering the limited income due to uncertain employment situation (informal) and uncertain household expenses, no savings mostly prioritized for family necessities, proximity to work	low housing physical condition needs repair but could not afford, limited facilities available nearby, including public transport, must compromise with necessities (under consumption of non-housing)
Social Housing 1	house is still economically attainable, considering the limited income and uncertain household expenses, no savings mostly prioritized for family necessities helped by the low monthly rental fee, proximity to work and facilities no plan to move to other housing type or location, close to relatives and neighbour from the former neighbourhood (resettled from Kampung Kota)	inadequate area (bedroom) for a family member
Social Housing 2	house is still economically attainable, able to consistently save some money helped by the low monthly rental fee, proximity to work and facilities, close to relatives and neighbours from the former neighbourhood (resettled from Kampung Kota), plan to buy subsidized owner-occupied housing	inadequate area (bedroom) for a family member
Subsidized Housing 1	housing mortgage still considered attainable, able to have residual income for saving, being independent, and possess assets that could be inherited	inadequate area (bedroom) for family members, low housing and surrounding area physical condition needs repair and improvement, limited facilities available nearby, including public transport, a location far from urban central and working place must compromise with necessities (under consumption of non-housing) recreation
Subsidized Housing 1	housing mortgage is still considered attainable, being independent and possessing assets that could be inherited, proximity to work, and not being crowded has different atmosphere than urban central	inadequate area (bedroom) for family members, low housing and surrounding area physical condition needs repair and improvement, limited facilities available nearby, including public transport,

Other than the housing price to household budget constraints several other motives influence the households' choice of housing. All of the respondents in the rental sectors informed that the main reason for choosing the rental housing besides the household budget constraint is regarding the location. It includes the housing location close to the workplace of the household members also the facilities. Most of the rental housing is located strategically in the urban area thus situated within close distance of several urban facilities. Hence the household who rent subsidized housing also chose the housing as it is still located near the workplace, even though the housing is located in the urban periphery. The main motive of the respondent in the subsidized housing was to own an asset that could be an inheritance. These aspects fundamentally differentiate the rental unit and owner-occupied housing, hence the disadvantage of the unstrategic location must be compromised. But this consequence of the unstrategic location also becomes an advantage for several respondents as the housing location provides a distinct atmosphere that is quieter and more suitable for rest compared to the housing in the urban area.

Trade-Offs Condition

Based on the data (Table 1), we could also identify several trade-offs that emerge because of the housing choice and the perceived affordability of the respondent. The trade-off experienced by most of the respondents is the inadequate number of bedrooms. Most of the housing only provides 1 to 2 bedrooms per unit, this housing typology typically could not fulfil the needs of families with more than 2 children or a large/extended family. Moreover, regarding the physical condition of the house, most of the house especially the subsidized housing has low quality and are prone to be frequently repaired, resulting in unexpected housing expenses. On the other hand, the rental unit which is mostly located in the densely populated area (Kampung Kota) has low natural light and air circulation quality.

There are several other trade-offs related to the location of the housing that occurs to the respondents. The rental units located in Kampung Kota have substandard accessibility. It mostly could only be accessed by motorcycle, on the contrary, the subsidized housing which has decent access is situated far from facilities, including public transport. This situation also leads the low-income homeowner to adapt to the condition by changing their lifestyle, as in lowering the consumption of non-housing necessities such as for recreation, or any other activities that usually can be done conveniently in the urban centre.

DISCUSSION

According to the findings, the factors related to housing affordability are perceived by the variety of households identified. Throughout the type of housing tenure, there are several similarities and differences. The economic-related factor as in the housing price compared to the households' capabilities to attain the current housing, perceived by the respondents is the most important aspect. It is followed by the consideration of the housing location, which helps reduce the transport expenses and the ease of access to several facilities, this factor covers both quantitative and qualitative value. The difference could be seen in the subsidized housing household types, as the additional factor is to be able to attain assets and be independent. On the other hand, by achieving this perceived attainable housing, several trade-offs emerge related to a variety of aspects. It is mostly related to the physical aspects of the housing and the environment which might affect the households negatively. For instance, additional

expenses to repair and improve the house, members' health degradation, and the decrease in living quality.

The findings show that housing affordability should include factors beyond economics. It includes the fundamentally related spatial aspects related to the location accessibility quality (Cai & Lu, 2015; Haffner & Hulse, 2021). The spatial condition of the housing could influence the household expense as well, as it relates to transportation, public facilities, access to employment, and other opportunities. The physical condition or the adequacy of the house affects housing affordability in economic terms as well, as the more maintenance the house needs, the more expense will be needed as well.

It could be argued that the economic factors based on the households' perceived housing affordability factors are still apparent, hence the other factors beyond economics must also be put into consideration. As the findings illustrate, the measured affordability, both ratio and residual approach, could not represent the actual burden experienced by the households. Several households whom considered has housing affordability below 30% ratio apparently are not able to save any amount of residual income, and struggle to fulfil family necessities. moreover, they must compromise on lowering their lifestyle and aspiration regarding the housing mobility. Most of the respondent, especially in the rental sector, prefer homeownership but did not expect to achieve it, and stay in the rental unit. Illustrated by this occurrence, it could be understood that housing affordability significantly affect the housing preferences, aspiration, and expectation, that they must compromised (Preece et al., 2020).

CONCLUSION

Within the housing study and discourse, housing affordability is still prevalently a crucial issue that has not been addressed thoroughly. It is related to the wide yet diversely utilized definition and measurement approach. it is considered that the common understanding of housing affordability only focuses on the economic side and overlooks other aspects that could depict the household's actual situation related to the housing needs that must be fulfilled. The factors beyond economics could be identified by the perceived important factors related to housing affordability, and the trade-offs experienced by the households. Hence, the apparent perceived factors are still mostly related to economics followed by other housing consumption and other qualitative aspects. the identified factor corresponds to the previous study which explained that several dimensions must be added to the housing affordability measurement regarding housing appropriateness, including the spatial or accessibility aspects, adequacy of housing, and decent amenities. Thus, the current measurement, ratio, and residual approach, as well as the other method, is still usable as the methods still cover several subjective aspects. However, the method should be used in the proper context.

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EVALUATION OF RUTILAHU PROGRAM FOR SUSTAINABILITY OF LIVABLE HOUSES IN SUKAWENING VILLAGE, BANDUNG DISTRICT, INDONESIA

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Abstract
The need for housing to be quite high in Indonesia, on the other hand, low-income people are also quite high. These situations cause the backlog problems. The Ministry of Public Works and Public Housing issued a Rutilahu Program for unhabitable houses. This program aims to improve the quality of housing for the poor. The research location was Sukawening Village in Bandung District, West Java Province. The objectives of this study: a) to identify the results of changes to houses after receiving Rutilahu Program; b) to determine the level of occupant satisfaction with their homes. The research method was a combination of qualitative and quantitative. Qualitative method to describe the implementation process of Rutilahu program. Quantitative method to analyze respondent characteristics, area of houses repaired, and occupant satisfaction. Data collection was carried out through interviews with 20 respondents and surveys in 2020. The result, the houses became livable and more spacious, the quality of materials were more permanent, the style of the houses were modern, and the people were very satisfied with their houses. These results were very important for the sustainability of livable housing in Sukawening Village. For sustainability, occupants need to be educated on how to care for the housing and the sorrounding environment.

Keywords: *Livable house; Rutilahu; Sukawening Village; Sustainability*

INTRODUCTION

Indonesia is the fourth country in the world for the largest population (268 million people in 2019), average population growth of 1.5% per year. The need for housing to be quite high in Indonesia, on the other hand, low-income people are also quite high (9% in 2019) (Hutapea, 2019). The ability of the government and developers to provide housing is limited. These situations cause the backlog problems, the gap condition between the number of houses built and those needed by the community (Bramantyo, 2012). Ministry of Public Works and Public Housing issued a Rutilahu Program or Self-help Housing Assistance for unhabitable houses. This program aims to restore social functioning and improve the quality of housing for the poor by improving housing conditions. The program is implemented in every province throughout Indonesia (Minister of Social Affairs, 2017). Low-income families received around 17.5 million rupiah (US $ 1.250) for their home improvements in 2020 (Yudatama, 2020).

The research location was Sukawening Village, Ciwidey sub-district, Bandung District, West Java Province. The area of Sukawening Village is 700,19 Ha, at an altitude of 1200 to 1500 meters above sea level, the temperature ranges from 18 to 20^0C. This location is located about 45 km from Bandung city (Figure 1). Some of the population's livelihood is as farmers. The population is around 10,306 people and 38% of their education is elementary school. Low education of the head of the family will have an impact on family income. However, education level influences the socio-economic level of the family (Anita &

Sudradjat, 2015). Therefore, some families live in uninhabitable houses, they cannot afford to repair their damaged houses. There were several unhabitable houses, such as the walls of the house were damaged, construction of the bamboo roofs, the floor had not been tiled, and most of the bathroom was outside the house (Figure 2).

Figure 1. Sukawening Village as Research Location

Source: (Resident Documentation)

Figure 2. The Houses are Uninhabitable

In 2019, several uninhabitable houses in Sukawening village received assistance from the Rutilahu Program. Rutilahu is an abbreviation for Rumah Tidak Layak Huni (Uninhabitable Houses), a government program that provides financial assistance to low income families to repair their uninhabitable houses. The government provided funds of 17.5 million rupiah per house in 2019–2020. The families could increase the cost of repairing their houses independently, such as helping to build a new house and adding funds from their savings. The funds from the Rutilahu Program were used to build the new houses by destroying the old ones. The government (village officials) assisted in the program implementation process, such as selecting a house, explaining it to the community, monitoring the house design and the house building process.

So, the research question what the significant impact of this program on is improving the houses of law income people. Evaluation is an objective and systematic examination of the effects of public programs on the targets to be achieved (Ram & Needham, 2016). However, physical changes to the house will affect the occupant' daily activities and the level of satisfaction of residents with their homes (Nguluma, 2003).

The objectives of this study: a) to identify the results of changes to houses after receiving financial assistance from the Rutilahu Program; b) to determine the level of occupant satisfaction with their homes. The method used in this research was a combined method, a combination of qualitative and quantitative methods (Creswell & Clark, 2007). Qualitative

method to describe the Rutilahu program, the implementation process from start to finish the housing improvement. Quantitative method to analyse measured data such as respondent characteristics, area of houses repaired and types of repairs, and occupant satisfaction.

Data collection was carried out in 2020. Data was conducted through interviews with 20 respondents and field surveys (Figure 3). The variables in the study consisted of: a) variables for respondent characteristics: age, number of family, income, occupation, ethnicity; b) variables for physical changes: room design, building materials, utility; c) respondent satisfaction with Likert scale (5-point scale).

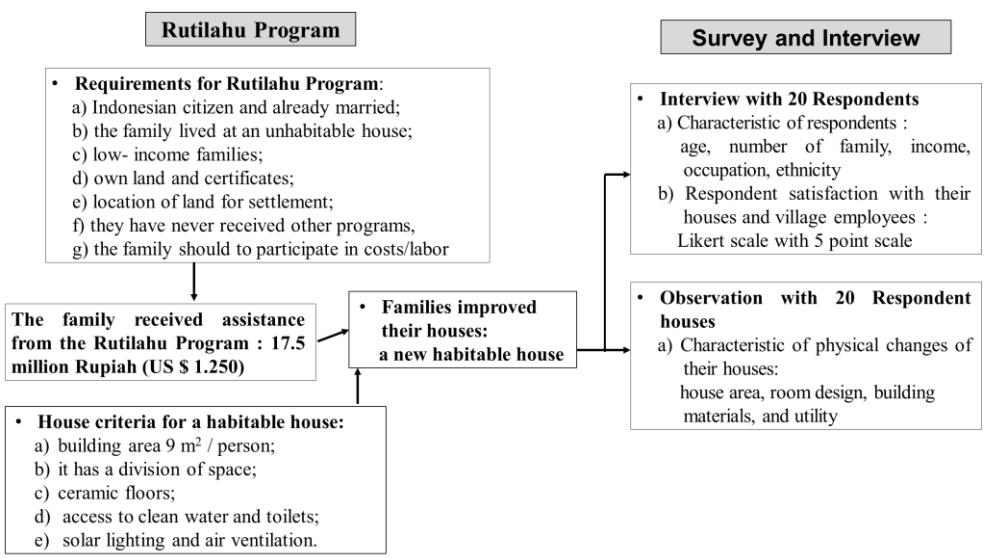

Figure 3. Research Methodology Chart

The Content of the Extended Abstract

The Process of Rutilahu Program

Rutilahu Program has requirements for families who can receive the financial assistance (Ministry of Public Works and Public Housing, 2016), as follows: a) Indonesian citizen and already married; b) the family does not own a house or occupies the only house in an unhabitable condition; c) low- income families with an income of at least 30% of the district minimum wage; d) own land and certificate; e) location of land for settlement; f) they have never received home repair assistance from other programs; g) the family should to participate in costs and / or labour during the implementation of rehabilitation.

A livable house is a house that meets the building safety requirements, the minimum adequacy of the building area and the health of its occupants (Ministry of Public Works and Public Housing, 2017). If described, the habitable house must meet the following criteria: a) building area 9 m^2 / person; b) it has a division of space; c) ceramic floors; d) it has access to clean water and toilets; and e) it has solar lighting and air ventilation.

The Rutilahu program took about a year in the implementation process from start to finish. The Department of Housing and Settlements at the Provincial Level of West Java notifies this program. The government disseminated information about Rutilahu Program to village officials and building consultants, then conducted workshop for them in early 2019. Furthermore, they disseminated this program to the community in Sukawening Village. Village staffs and consultants collected data on uninhabitable houses in Sukawening, then the data was sent to the Bandung Regency Housing and Settlement Department and forwarded the data to the West Java Province Housing and Settlement Department. Announcement of families who received assistance of Rutilahu Program in mid-2019. Furthermore, the process of providing funds, drawing house designs, and carrying out the construction of livable houses had been carried out until the end of 2019. The selected families must comply with the criteria, and the house designed must also comply with the criteria of the Rutilahu Program.

House Characteristic

In general, 20 respondents have lived in Sukawening Village for quite a long time, 45% of respondents have lived for more than 30 years, they were indigenous local people. They are Sundanese ethnicity (100%), Muslim (100%), and their education is low (70%). The socio-cultural level, the characteristics of the husband were the same as their wives. They work in the informal sector with monthly income below 1.5 million rupiah (45%) and 1.5 million to 2 million rupiah (55%). They were categorized as low-income people.

The condition of the houses before receiving Rutilahu Program were damaged such as the walls of the bamboo booth were damaged, plank floor and the construction of the bamboo roof were damaged, too. The houses lack of daylighting and fresh air. Meanwhile, a livable house is a house that meets the building safety requirements, the minimum adequacy of the building area ($9m^2$/person), access to clean water and toilets, it has solar lighting and air ventilation. Therefore, the funds from the Rutilahu Program were used to build the new houses by destroying the old ones. House conditions before and after program can be seen in Table 1.

Table 1. House Conditions Before and After Rutilahu Program

No	Variable of House Elements	Old Houses (Before Rutilahu Program)		New Houses (After Rutilahu Program)	
		Area/Material	Total	Area/Material	Total
1	House Area	< 30 m^2 30-49 m^2 50-70 m^2 > 70 m^2	45% 45% 5% 5%	< 30 m^2 30-49 m^2 50-70 m^2 > 70 m^2	30% 55% 5% 10%
2	Floor	Flank floor	100%	Ceramic floor Stucco floor	50% 50%
3	Wall	Woven bamboo walls	100%	Brick walls plastered	100%
4	Plafond	Woven bamboo	100%	GRC board	100%
5	Roof	Bamboo construction with roof tile	100%	Timber construction with roof tile	100%
6	Electricity Capacity	450 watt	100%	450 watt 900-1200 watt	40% 60%
7	Bathroom Location	Outside the house Inside the house	30% 70%	Outside the house Inside the house	5% 95%
8	Source of Clean Water	Dug well Communal water sources	75% 25%	Dug well Communal water sources	75% 25%

Condition of houses built with the help of the Rutilahu Program are as follows: 55% more spacious house (> 30m^2), 100% permanent floor with ceramic and stucco floor, 100% plafon with GRC board, 100% permanent roof with timber construction and roof tile, 95% of bathrooms are in the house and 60% of homes with increased electrical power capacity (900-1200 watt). The program helped to turn their houses into the permanent building, improved the quality of utilities, and majority of houses comply with the requirements for the safety and healthy houses. Besides having structural strength, brick walls with concrete column construction were also seen as more robust and modern. Ceramic floors were chosen because they gave the impression of being cleaner and the floors were easy to clean. Windows and doors were also replaced with new wood materials with ventilation patterns placed above the windows and doors (Figure 4). The architectural style of the building is characterized by modern tropical architecture.

Home design emphasizes more on efficiency and functionality of space and materials because funds to build a house are limited. However, some houses have not been completed because there are insufficient funds. Therefore, some of the walls have not been painted, and the floors have not been ceramic tile.

Figure 4. House Design After Receiving The Rutilahu Program

The layout of the space in the house separates the public zone (living room) from the private zone (bedroom), and the service zone is always placed in the back (kitchen and bathroom) (Figure 5). The bedrooms consist of one main bedroom with one to two children's bedrooms. The living room is the centre of the house and functions as a space for socialization between family members. All houses have a front terrace as a transition space before entering the house.

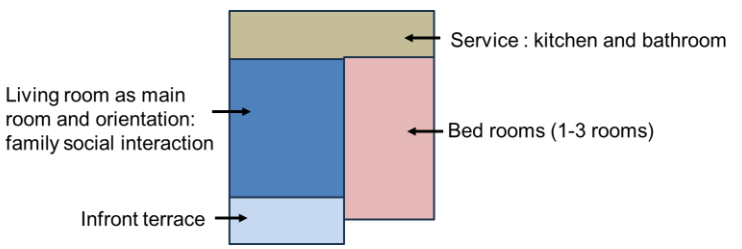

Figure 5. The Pattern of Most House Plans

Level of Occupant Satisfactions

Satisfaction can be defined as a state in which a person's expectations are met. Satisfaction creates stability in the neighbourhood, because satisfaction is a significant predictor of immobility (Speare, 1974). Dissatisfied people may have a tendency to move out (Sabet & Miryahedi, 2017). Negative opinions are formed when the housing does not fit the household's demands, the size of the dwelling as the most important determinant of housing satisfaction (Dekker, De Vos, Musterd, & Van Kempen, 2011). The level of satisfaction used a Likert scale from very dissatisfied, dissatisfied, ordinary, satisfied to very satisfied. This data was taken through semi-open interviews with occupants.

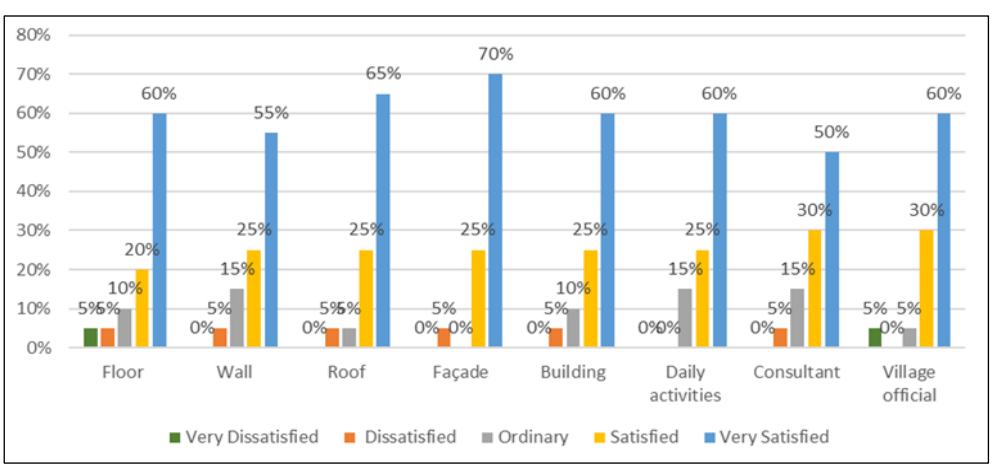

Figure 6. Level of Respondent Satisfactions with Their Homes

New house plans with more modern designs and permanent materials made most respondents (occupants) very satisfied with their homes (Figure 6). Occupant satisfaction levels were as follows: 60% of them were very satisfied with the improvements to their entire homes, 55%–65% of them were very satisfied with the floor, wall, and roof repair, 70% of them were very satisfied with design of front façade, and 60% of them were very satisfied with daily activities in their homes. They were also very satisfied with the performance of

village official (60%) and building consultants (50%) who helped them to handle this program. The Rutilahu program was very helpful for low-income people to regain their happiness in life through repairing their homes.

DISCUSSION

A village requires several factors to survive and sustainable, such as the existence of residents and the welfare of the population. Residents will stay if they feel comfortable living and safety in the village (Anita, 2015). Therefore, houses must be repaired so that they become livable houses. A livable house will provide a comfortable space for residents to carry out daily activities in their houses. If they feel comfortable living in their houses, they will feel happier and they will survive living in Sukawening Village. The Rutilahu program is very useful for sustainability of Sukawening Village. They are satisfied with their houses, daily activities in their houses, and the process of building a house through the Rutilahu Program. The high level of respondent satisfaction with the results of the Rutilahu Program shows that this program has been quite successful in being implemented in Sukawening village. This could be an example or role model for implementing the program in other surrounding villages.

The weakness of this program is limited funds. Not all residents have enough savings to increase the cost of building improvement, so their houses are not finished. In addition to increasing funding for the program, the government should also help build roads and other public facilities around Sukawening Village for the sustainability of this village. The existence of public facilities can help increase employment opportunities to increase residents' income.

CONCLUSION

The Rutilahu Program is very helpful for low-income people who live in unfit for habitation to regain their happiness in life through repairing their homes. A livable house is a basic necessity for human needs because everyone needs a house that is comfortable and able to provide maximum protection for himself and his family. The benefits of a livable house are that the house looks more beautiful, wider and livable. The quality of the materials is more permanent, the style of the houses is modern, and the people are very satisfied with their houses. Occupants can carry out their daily activities properly, the houses are more comfortable and healthier, and guests are happy to visit. For the sustainability of the house, occupants need to be educated on how to care for the housing and the surrounding environment.

This program could be carried out well and according to schedule in Sukawening Village by involving families, community self-reliance bodies, government officials from village to provincial levels, consultants, and the community. This program was implemented quite successfully because the houses directly provided benefits to the community and village officials carried out their duties well. Therefore, the occupants were very satisfied with their homes and also very satisfied with the performance of the village officials who help them implement this program.

The weakness of the program was limited cost of building, so some houses were not finished. For sustainability this program, the government needs to increase aids fund because the price of building materials will increase in the future. However, the Rutilahu Program is very useful for sustainability of Sukawening Village.

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PROMOTING SUSTAINABLE HOMEOWNERSHIP FOR LOW–INCOME HOUSEHOLDS IN BANDUNG: AN INTEGRATED APPROACH WITH RENTAL HOUSING AND SAVINGS SCHEMES

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Abstract
Housing affordability remains a critical challenge for low-income households in developing cities like Bandung, Indonesia. To lessen the problem, the West Java Housing and Settlement Office has launched the integrated program of GEMPITA. This research studies the extent of the possibility of the program in addressing the sustainability of affordable homeownership. This study employs a qualitative method. By this approach, it uses mainly in-depth interviews with program operators to collect data and information. The research also gathers them from documents related to program to assess the program's impact on its key objectives of increasing access to sustainable homeownership and improving affordability and financial stability of low-income people. Through this comprehensive analysis, this research seeks to make valuable contributions to the field of affordable housing for low-income populations. The findings revealed that the program can assist low-income households in preparing their finances to meet the down payment requirements for suitable housing. However, the program still faces challenges of sustainability due to internal and external factors. Internally, the challenge is not only the saving amount for down payment but also the monthly instalment amounts. Externally, the urbanization has pull out new subsided housing development to suburban which entail additional expenses of transportation costs.

Keywords: *GEMPITA; Transit Apartment; Low-Income Communities; Affordability*

INTRODUCTION

Housing affordability is critical for low-income households in Greater Bandung, Indonesia. Urbanisation in this region has significantly increased housing demand. It leads to difficulties for low-income people accessing affordable housing (Jones, 2017). The difficulty comes from the impact of housing and transportation costs in the area (Dewita et al., 2018). The preference for housing locations' proximity to facilities also increases household budgets (Mulliner et al., 2013). Those show the complexity of the housing problem for low-income people (Rameli et al., 2017).

Affordability is not a specific housing problem in Bandung. It has occurred in many countries (Liu & Ong, 2021). For example, loan limitations for low-income people in Nigeria led the government to provide financial housing assistance (Nubor, 2017; Ghani, 2021). Also, in South Africa, low government capacity has hindered the distribution of low-income housing (Tyhotyholo et al., 2022). In addition, it has been a severe issue among Malaysia's low-income households (Hing & Singaravelloo, 2018). Meanwhile, the West Java government has started to explore solutions in the Bandung area through vertical public housing (Nurdini & Hadianto, 2018).

Public rental housing increases the purchasing power of low-income people and enhances their income elasticity (Shao et al., 2022). It indeed plays a crucial role in addressing the problems of low-income households. However, its effectiveness depends on various factors, including a favourable socio-economic environment and a practical institutional and regulatory framework (Li et al., 2014). It is essential to consider its affordability, as public rental housing in remote locations can harm low-income households (Zhou et al., 2018). This issue requires a strategy to bridge the gap between housing finance needs and housing prices (Suryanto et al., 2019).

Integrating rental housing with a savings scheme could be the strategic approach to achieving affordability goals (Shlay, 2006). This idea is due to the limited growth in the earnings of low-income households and the increasing income inequalities (Dong, 2017). The program addresses the barriers low-income households face in purchasing homes, mainly due to a lack of wealth for a down payment and limited incomes to afford monthly mortgage payments (Hembre et al., 2020). Additionally, integrating savings schemes has enabled participants to achieve homeownership with substantially lower credit scores, lower incomes, and lower revolving debt, aligning with the program goals (Ehlenz & Taylor, 2018).

In 2018, the West Java Housing Office launched the GEMPITA program. It is a new initiative to address the housing affordability issue that integrates a savings scheme for the tenants of transit apartments to help them afford a decent house in the Bandung area. This apartment is a temporary residence for low-income people to be able to prepare a down payment for buying a decent house with loans through banks that collaborate with the program. The program expects low-income tenants to be able to afford their own houses within five to ten years. However, there is no guarantee of this program's effectiveness given the dynamics of the financial level of the renters and urbanisation in the area.

The combination of those two aspects impacts the housing affordability of low-income people. Urbanisation introduces a range of challenges that disproportionately impact low-income households. They encompass high living costs, which can strain already limited budgets (Ye et al., 2017; Jenkins et al., 2019). The challenges also include income inequality, which can worsen the affordability issue (Uwayezu & Vries, 2020; Zhang, 2015), and disparities in access, which can further marginalise these households (Schouten, 2020; Amer et al., 2021). Given the complexity of the challenges, the research will examine how the GEMPITA program can effectively promote sustainable homeownership for low-income households. This question is crucial as it will address housing challenges (Zhou, 2018), consider factors of homeownership, and prioritise affordability (Fahmi et al., 2015), as well as the accessibility of low-income households (Rameli et al., 2017). By those, it can estimate the program's effectiveness in achieving its goal of sustainability.

LITERATURE REVIEW

Sustainable Homeownership

The issues of sustainable homeownership for low-income households revolve around economic, social, and related-policy interaction. Housing affordability is a core problem because of the families' financial problems. However, it is more than just about housing costs; it is also the ability to meet other basic living expenses (Stone, 2006). By definition,

affordability is the housing cost that should be, at most, a fixed proportion of income and leave enough to meet other basic living expenses (Czischke & Bortel, 2018).

In developing countries, housing costs have increased tremendously compared to household income. The situation poses a critical problem for low-income households to own a home (Amer et al., 2021). Therefore, it urges government agencies to ensure the provision of affordable housing (Bilal et al., 2019). Reforms have stimulated the housing market, but more targeted programs are needed to improve housing supply, quality, and affordability (Sengupta & Tipple, 2007).

The following aspect is access to capital. For low-income groups, this access refers to a limited ability to obtain and utilise financial services and products. Those include access to working capital, formal financial accounts, savings, credit, and insurance at affordable, fair and transparent costs (Ozili, 2021; Ozili, 2021; Oladimeji & Adegbite, 2019). This inclusion is critical in providing opportunities for low-income people to build savings, make investments, and access credit, thus contributing to their economic empowerment (Ugwuanyi & Okore, 2022; Bigirimana & Hong-yi, 2017). Studies have also identified that poor households with limited access to financial institutions face entry barriers that restrict their access to rewarding income sources (Kajela & Dara, 2019).

The third aspect is financial literacy. For low-income households, it can hinder the ability to make informed decisions about homeownership and manage their finances effectively. The lack can significantly affect an individual's ability to make sound financial decisions (Monticone, 2010). In addition, it can affect the ability of low-income households to save and access credit (Ngcobo, 2021).

The last is inadequate affordable housing. The situation limits options for low-income families, especially in desirable locations with access to essential infrastructures and facilities. Liu and Ong (2021) highlight that high land prices and construction and compliance costs contribute to the need for more affordable housing in Malaysia. Aurand (2013) also shows that urban sprawl does not necessarily increase the affordable housing supply but instead shows the complexity of the problem. Therefore, Razak et al. (2020) suggest implementing public housing schemes that could address the impacts of inadequate affordable housing.

Integrated Housing Program

Integrated housing programs, particularly those combining rental options and savings schemes for low-income individuals, have shown promising outcomes in improving housing stability. Tsemberis & Eisenberg (2000) highlight the effectiveness of the Pathways-supported housing program in effectively housing those who are homeless and living on the streets.

Additionally, Brunette et al. (2004) demonstrated better housing outcomes for clients participating in long-term integrated programs than short-term programs. This finding suggests that the duration and comprehensiveness of programs play a vital role in improving low-income housing outcomes. Furthermore, the study by Tsai et al. (2009) underscores the potential of integrated programs. It identifies areas for further research in housing services, indicating the ongoing interest and potential for advancements in this field. However, there are also some challenges to that strategy.

The challenge to improving housing outcomes is multifaceted. Rigorous studies are essential to establish effective strategies to reduce disparities and advance equity across the lifespan (Slopen et al., 2018). The challenges include homeowners' inability to afford improvements, limitations to staff resources, and client income constraints, which may hinder housing improvements (Chisholm et al., 2019). Other challenges are effective coordination, eligibility criteria, and equitable access. They underscore the importance of well-coordination in addressing the issues of housing programs for low-income households.

Temporary Apartment

Temporary apartments have the potential to be a pathway to sustainable, affordable homeownership for low-income households. They can provide a stepping stone for low-income to transition from renting to owning homes (Thomas, 2018). Additionally, temporary communities may evolve into long-term solutions fostering greater well-being (Rihova et al., 2014; Thomas, 2018). Furthermore, shared homeownership policies offer a housing option, potentially contributing to homeownership for this group (Cheung & Wong, 2019).

However, it is essential to note that more is needed to promote further affordable homeownership (Yusof et al., 2019). Additionally, its effects on income and wealth must be carefully examined (Mehdipanah et al., 2021). While it may provide immediate relief, its impact on long-term housing stability and wealth outcomes requires thorough evaluation.

GEMPITA Savings Scheme

GEMPITA is an acronym for the Transit Apartment Residents Saving Program. West Java Governor Regulation Number 27 of 2019 regulates it. The regulation states that GEMPITA is a mandatory saving activity for residents of *transit apartments* to prepare down payment costs for housing ownership. The scheme has two objectives: (1) to help obtain liveable, affordable, and sustainable homes and (2) to help prepare the occupants' finances to achieve independent ownership of the dwelling.

In West Java, the program is to provide housing in the form of apartments for the community with a residential period of 5 years and a maximum of 10 years to meet the needs of sustainable and affordable housing. The government collaborates with the local government, housing associations, and developers to achieve the goals. The government also facilitates it with the banks for financial assistance. The scheme starts from the second month of occupancy of the *transit apartment*, considering that the residents are LICs and need to pay a deposit fee at the beginning of the *transit apartment*. Its monthly deposit is 10% of the total salary of residents. The government handed over the responsibility for the program's implementation to the housing technical unit.

GEMPITA can be a relevant solution to tackle the formidable challenge of enabling low-income communities to attain homeownership. The rigorous rules and regulations of GEMPITA can cultivate discipline among residents of *transit apartments* in managing finances to afford decent housing. Moreover, the monthly commitment to fulfil GEMPITA instalments can motivate *transit apartment* residents to strive for increased income, thereby optimizing their engagement with GEMPITA.

METHODS

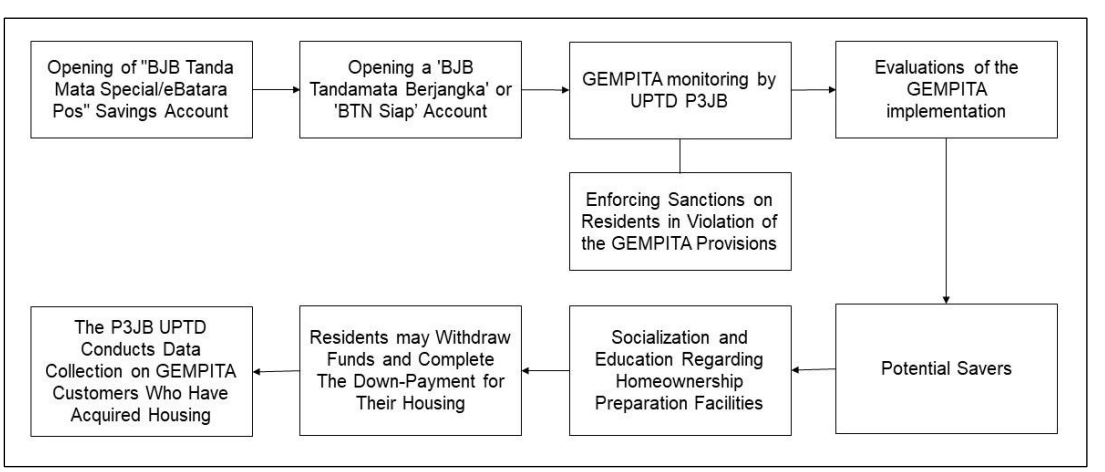
This study employs a qualitative research approach. It will provide a comprehensive understanding of such integration's challenges, opportunities, and potential outcomes, contributing valuable insights to inform policy and program development in the housing sector (Thaden et al., 2013; Lankester et al., 2019; Cheung & Wong, 2019; Tan, 2008; Rameli et al., 2017). The interviews, focus groups, and observations allow us to deeply understand low-income households' motivations, aspirations, and challenges regarding homeownership. This method can be crucial for effectively tailoring programs as it can help uncover the nuances and dynamic interplay among the factors.

In this method, there are 2 (two) types of used data: primary and secondary (Kumar, 2011). This research collected primary data and information through in-depth interviews and FGD (Focus Group Discussion) with the Technical Implementation Unit of the West Java Housing Management and Services area. It gathers data on data and information related to the policy and goals, target population, the implementation process, and the success and challenges of the GEMPITA scheme. It also collected data on subsidized housing prices in the program and savings simulation.

Meanwhile, secondary data are in various forms. They include literature related to housing affordability and the habitable cycle, as well as archives and documents in the form of local regulations and reports of the Office of Housing and Settlements of West Java province. Through the descriptive method, the research analyses and interprets the data to find such facts related to the sustainability of affordable housing according to the real condition of low-income people (Groat & Wang, 2013).

RESULT AND DISCUSSION

Implementation of the Saving Movement for Residents for *Transit Apartment* in West Java

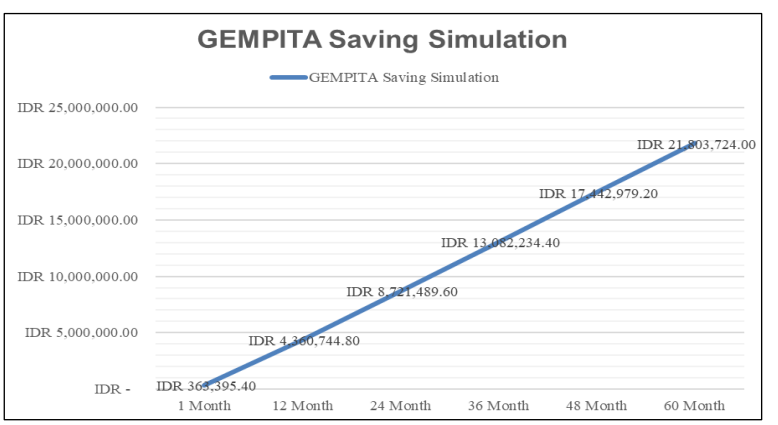


(Source: GEMPITA Handbook, West Java Province Housing and Settlement Service, 2022)

Figure 1. GEMPITA Implementation Scheme

There are eight stages in the implementation of GEMPITA (Figure 1). Firstly, to commence their tenure in the transit apartment, residents are initiated to open a 'BJB Tandamata Khusus' or 'BTN eBatara Pos' savings account. Subsequently, they open a 'BJB Tandamata Berjangka' or 'BTN Siap' account to participate in GEMPITA. Every month, residents make deposits into the GEMPITA savings. The P3JB UPTD will conduct monthly observations and evaluations of the GEMPITA implementation, and residents violating GEMPITA regulations will face sanctions. Residents categorised as potential savers (those with savings exceeding IDR 5,000,000.00) will receive socialisation and education regarding homeownership preparation facilities. Upon accumulating sufficient savings for the home purchase down payment, residents may withdraw funds and complete the payment for their housing. The housing options are diverse and not limited to recommended housing products.

Potential residents can purchase various houses, from self-funded and commercial houses to subsidised ones like Land/FLPP and BP2BT houses. Once residents successfully make the down payment, the P3JB UPTD conducts data collection on GEMPITA customers who have acquired housing. By regulation Number 27 of 2019, the West Java Governor states the monthly GEMPITA deposit amount to be 10% of the residents' total income.



Source: (Authors' Analysis, 2023)

Figure 2. GEMPITA Saving Simulation

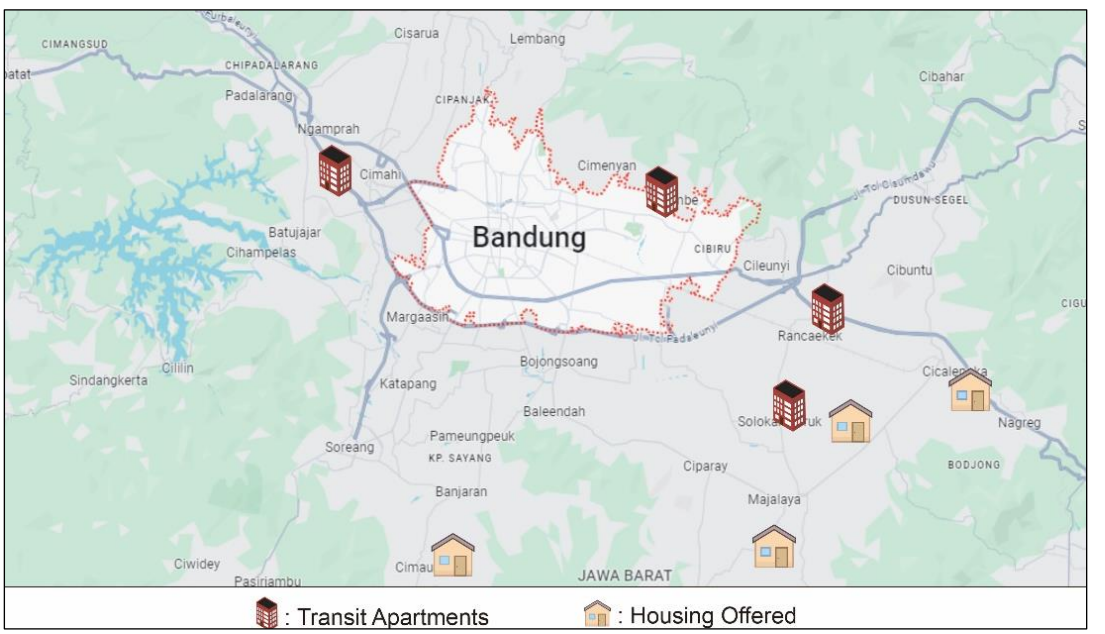
Based on the average minimum wage in the Greater Bandung area in 2023, a household's monthly income is IDR 3,633,954. The temporary residents must deposit 10% of their income monthly, IDR 363,395.40. The required down payment for purchasing a house is 1% of the house price. Article 25 of the Public Works and Housing Ministerial Regulation Number 20 of 2019 outlines it. The average housing price in Java (excluding Jakarta, Bogor, Depok, Tangerang, and Bekasi), determined by the Ministerial Decree of Public Works and Housing No. 242 Year 2020, is IDR 150,500,000.00. Residents' savings can meet this minimum down payment amount when projected over 4 (four) months (Figure 2).

Affordability in Residential Ownership Through The Savings Movement for *Transit Apartment* in West Java

As previously discussed, individuals participating in the GEMPITA scheme would withdraw their savings as a down payment for their housing. The GEMPITA management and the bank recommend subsidised housing in the Greater Bandung area. Low-income

households can obtain houses through the KPR method, with a minimum type of 21 and a maximum type of 36. However, these subsidised houses are primarily in suburban areas far from Bandung's urban centre.

Most subsidised houses offered to residents are outside Bandung and far from transit apartments (Figure 3). Meanwhile, apartment residents are workers from industries around the transit apartment, except for Ujung Berung transit apartment residents. This apartment's target is mainly civil servants.



Source: (Authors' Analysis, 2023)

Figure 3. Location of Apartment Transit and Houses Offered

The distance between the transit apartment and the subsidized housing varies from 7.8 km to 56 km, and travel takes 30 minutes to 2 hours (Table 1).

Table 1. Distance Between *Transit Apartments* and Subsidized Housing

	Pasadana Paseh	Graha Arthaloka	Cikawao Persada	Tamaland
Apartment Ujung Berung	29.4 km	31.4 km	30.6 km	27.7 km
Apartment Solokan Jeruk	7.3 km	31.1 km	9.9 km	14.8 km
Apartment Batujajar	56.3 km	29.8 km	47.5 km	47.5 km
Apartment Rancaekek	10.8 km	52.4 km	19.4 km	12.5 km

Source: (Google Earth, 2024)

Meanwhile, the price of the houses provided is between IDR 130,000,000 and IDR 150,500,000, which is the standard price of a current mortgage house (Table 2).

In addition to the monthly house instalments, people must consider transportation costs as the offered house may be far from their workplace in Bandung or a temporary apartment. This expense increase can make saving more difficult and even disrupt their monthly payments.

Table 2. Subsidized Housing Offered by BTN

Location	Residential	Price
Bandung Regency	Pasadana Paseh	IDR 130.000.000
Bandung Regency	Graha Arthaloka	IDR 150.000.000
Bandung Regency	Cikawao Persada	IDR 150.000.000
Bandung Regency	Tamaland	IDR 150.500.000

(Source: BTN, 2023)

The Regional Minimum Wage (RMW) varies across different cities and regencies in this area. Due to the dispersion of subsidised housing and workplaces among GEMPITA users in Bandung City, Bandung Regency, West Bandung Regency, and Cimahi City, it requires an average value of the Regional Minimum Wages (RMW). Table 3 provides the calculation.

Table 3. Average Regional Minimum Wage (RMW) in Greater Bandung Area* (2003-2023)

	Bandung City	Bandung Regency	West Bandung Regency	Cimahi City	Average
2003	538.000	537.500	0**	537.500	403.250
2004	588.407	562.428	0**	562.500	428.334
2005	642.590	601.000	0**	601.000	461.148
2006	746.500	710.000	0**	715.000	542.875
2007	860.565	820.280	820.280	840.655	835.445
2008	939.000	895.980	895.980	910.894	910.464
2009	1.044.630	1.000.950	1.011.064	1.019.000	1.018.911
2010	1.118.000	1.060.500	1.105.225	1.107.304	1.097.757
2011	1.271.625	1.123.800	1.175.959	1.172.485	1.185.967
2012	1.538.703	1.223.800	1.236.991	1.224.442	1.305.984
2013	1.811.375	1.565.008	1.646.475	1.388.300	1.602.790
2014	2.000.000	1.735.473	1.738.476	1.735.473	1.802.356
2015	2.356.000	2.041.000	2.045.000	2.041.000	2.120.750
2016	2.626.940	2.275.715	2.280.175	2.275.715	2.364.636
2017	2.853.663	2.463.461	2.468.289	2.463.461	2.562.219
2018	3.091.346	2.678.029	2.683.277	2.678.028	2.782.670
2019	3.339.580	2.893.074	2.898.744	2.893.075	3.006.118
2020	3.623.778	3.139.275	3.145.427	3.139.275	3.261.939
2021	3.742.276	3.241.929	3.248.283	3.241.929	3.368.604
2022	3.774.860	3.241.929	3.248.283	3.272.669	3.384.435
2023	4.048.462	3.492.465	3.480.795	3.514.093	3.633.954

*in IDR

**West Bandung Regency was Formed by Expanding Bandung Regency, as per UU RI No. 12 of 2007.

(Source: West Java Governor's Annual Regulations)

Over the past 20 years, the Regional Minimum Wages (RMW) have increased by 230%, with an average annual increase of 11.5%. In 2003, subsidised housing in West Java cost IDR 36,000,000, 83 times higher than the local RMW. However, in 2023, the cost of subsidised housing was IDR 150,500,000, which was only 41 times higher. Despite the decreasing ratio between the minimum wage and subsidised housing instalment yearly, subsidised housing remains unaffordable for low-income communities (LICs). This situation is due to annual inflation, increasing the costs of other household needs the community must meet. Figure 5 compares the average Regional Minimum Wage (RMW) and subsidised house prices in the Greater Bandung Area from 2003 to 2023.

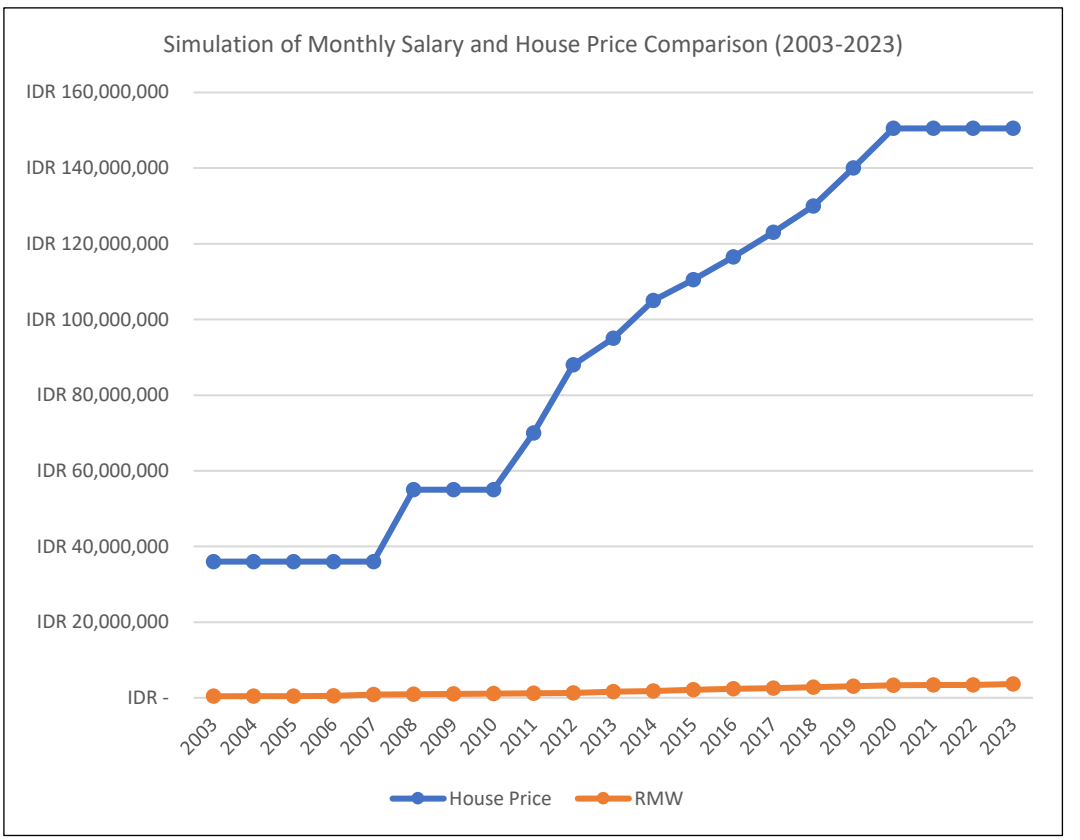


Figure 5. Simulation of Monthly Salary and House Price Comparison (2003-2023)

According to Stone (2006), the ideal expenditure for a housing loan is a maximum of 30% of monthly income. Based on the provisions of existing regulation, the selling price of subsided housing varies based on the zoning set. This price will be the basis amount of the application for the Housing Mortgage (KPR) from the Bank of BTN, which is the national bank providing mortgage services. According to the provisions, the maximum salary/basic income requirements to be eligible for a subsidised housing mortgage (KPR) around Bandung falls into the Zone 1 category, which covers Sumatra, Riau Islands, Bangka Belitung, and Java except for the Jabodetabek area (Table 4).

Table 4. Comparison of Maximum Basic Income and Ideal Expenditure

Type of Residence	Income/Month	Ideal Monthly Expenditure for Housing*
Rumah Sejahtera Tapak (Landed Houses)	IDR 6.000.000	IDR 1.800.000
Rumah Sejahtera Susun (Flats)	IDR 7.000.000	IDR 2.100.000

*Based on Stone's statement (2006), the ideal expenditure for ideal housing is 30% of the income.
Source: (Author's Analysis, 2023)

For GEMPITA participants, obtaining housing through subsidized KPR can be done through two KPR providers: (1) Bank BTN through the BTN BP2BT KPR program; and (2) Bank BJB through the FLPP program. The details are visible in Table 5.

Table 5. Scheme Conditions for KPR Programs of Bank BTN and BJB

Program Type	Down Payment Percentage	Interest Rate	Loan Term
KPR BTN BP2BT	Starting from 1%	Interest Rate: 9.5% fixed for the first 5 years or 10% fixed for the first 10 years	Up to 20 years
BJB KPR Sejahtera FLPP	Starting from 1%	Fixed Interest Rate: 5% throughout the entire term	Up to 20 years

Source: (Authors' Analysis, 2023)

In its promotion, it is highlighted that the minimum down payment (DP) is 1% of the total property price, amounting to IDR1,505,000. When combined with one-time administrative and legal fees, the total rises to IDR14,735,006.25. However, it is essential to note that this amount can only be applicable under specific conditions or policies and is not part of the GEMPITA scheme.

For regular KPR applications, the actual minimum DP is 5% of the total property price, totaling IDR7,525,000. When added to administrative and legal fees, the overall cost becomes IDR19,885,278. Connecting this with the GEMPITA savings simulation, participants can only complete the total payment (KPR's DP, administrative, and legal fees) for homeownership after saving for 4-5 years. The GEMPITA scheme has primarily focused on discussing the DP, overlooking other initial costs associated with home purchase agreements. Table 6 provides a comprehensive overview of the conventional KPR simulation for subsidized housing through Bank BTN with a 5% down payment.

The simulation for the KPR was executed via the online platform of the bank providing the KPR, which is in association with the GEMPITA Program, and it was conducted for the maximum duration permissible. The result from the simulation indicates that, under the conventional BTN KPR program, when a down payment constituting 5% of the property's value is made, the ensuing monthly instalment is set at IDR 1,352,028 (Table 6). Conversely, when the down payment constitutes 1% of the overall property value, the monthly instalment levied amounts to IDR 1,800,356.25. This instalment encompasses all administrative expenses and the management of the property's legal status. If participants opt for the BJB KPR Sejahtera FLPP program and make a down payment equivalent to 5% of the property's cost, the monthly instalments are levied at the amount of IDR 943,572. The amount for this instalment does not encompass the administrative prerequisites and legal charges.

The results derived from the calculations indicate that the initial payment, which encompasses the down payment and legality charges, required from the KPR participants amounts to IDR 19,885,278. Upon comparison with the GEMPITA savings, it is evident that residents of transit apartments are required to accumulate savings for a minimum duration of approximately 5 years in order to attain the amount necessary for the first payment (Table 7). With a note that the resident is saving in an orderly manner and not receiving any exemptions from saving.

Meanwhile, the average RMW for Bandung City, Bandung Regency, West Bandung Regency, and Cimahi City is known to be IDR 3,633,954. Following the theory of affordability, the expenditure on residential instalments should be at most 30% (Newman & Holupka, 2014). Consequently, the upper limit of the residential instalment burden for individuals in this region should be confined to IDR 1,090,186. Based on the details

mentioned above, the affordability of housing in the regions of Bandung City, Bandung Regency, West Bandung Regency, and Cimahi City is not feasible. This is attributed to the fact that: 1) The initial payment required from residents encompasses not merely the down payment, but also the administrative expenses and the management of the residence's legal status; 2) The instalment amount is greater than the ideal residential instalment ratio (30% of total expenses); 3) Houses that receive subsidies are typically situated in suburban locales, which are considerably distant from the heart of urban areas. This is proven by the testimonials of GEMPITA participants who already have housing and have been published by UPTD P3JB. These dwellings are dispersed across regions such as the Cicalengka District, Batujajar District, and even extend to Sumedang Regency. Given this geographical spread, residents may incur supplementary transportation expenses if their source of income is in the central urban area.

Table 6. Conventional KPR Simulation for Subsidized Housing Through Bank BTN with a 5% Down Payment

Loan Details	
Property Price	IDR150.500.000
Interest Rate (per year)	9.5%
Floating Interest Rate (per year)	13.5%
Fixed Rate Loan	240 months (20 years)
Loan Term	240 months (20 years)
Down Payment (DP)	**IDR7.525.000**
Maximum Loan Amount	IDR142.975.000
Bank Fees	
Appraisal	IDR1.000.00
Administration	IDR0
Processing	IDR0
Province	IDR1.429.750
Insurance	IDR1.429.750
Total Bank Fees	IDR3.979.900
Notary Fees	
Deed of Sale and Purchase	IDR1.429.750
Ownership Transfer Fee	IDR1.429.750
Power of Attorney Charging Mortgage Rights (SKMHT)	IDR7114.875
Registration of Granting Mortgage Right (APHT)	IDR1.429.750
Mortgage Right (HT) Agreement	IDR1.429.750
Certificate, ZNT, PNBP HT Check	IDR714.875
Total Notary Fees	IDR7.148.750
Monthly Instalment	**IDR 1.352.028**
First Payment (Instalment + Down Payment + Total Bank Fees + Total Notary Fees)	**IDR19.885.278**

Source: (BTN's KPR Calculator, 2023)

Table 7. Comparison of The Amount of The First Payment with The GEMPITA Savings Simulation in 5 Years

Period	The Amount
First payment	IDR 19,885,278
1 year	IDR 4,360,744
2 years	IDR 8,721,489
3 years	IDR 13,082,234
4 years	IDR 17,442,979
5 years	IDR 21,803,724

Source: (Authors' Analysis, 2023)

CONCLUSION

This study on the GEMPITA program in Bandung draws two essential points. First, integrating temporary apartments with the savings scheme for apartment renters promises to overcome traditional barriers to homeownership for low-income. The scheme shows its ability to empower families to build financial equity and enter the process of long-term homeownership. However, the program must consider the real challenges that come with the impact of dynamic urbanization in this area on the housing market. In most cases, it will affect the socio-economic condition of low-income people and their capacity to afford homeownership.

Second, the program must consider the impact of new house locations, as most are in the sub-urban area. The distance to the workplace will influence the low-income household's productivity as it increases transportation costs. In turn, it will reduce the saving ability of the households to make monthly instalments and other domestic spending. It is critical as the loans require up to 20 years for the household to maintain their instalment ability. Its sustainability becomes crucial and requires a strategy to ensure the homeownership process continues until the completion of the mortgage.

To conclude, enhancing sustainable homeownership for low-income households in Bandung requires an integrated program that considers the financial and social aspects and its context. It also should have a continuous evaluation for the program improvement to deal with urban growth.

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THE USER PERCEPTION ON VERTICAL PUBLIC RENTAL HOUSING (RUSUNAWA) IN JAKARTA: AN ONLINE USER REVIEW

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Abstract
Jakarta is confronting challenges in providing affordable public housing to mitigate the proliferation of slums triggered by urbanization. However, the reluctance of slum residents to relocate is creating potential conflicts between local government authorities and the community. It is essential to understand the user's perception of public rental housing property to address this issue. This study used online user reviews to identify the factors individual decision-making when residing in public rental housing (Rusunawa) in Jakarta. This study explores user perceptions of Rusunawa in Jakarta and identifies key factors influencing their decision-making based on online reviews. Through a content analysis of online reviews, several key factors have emerged as significant in influencing the decision to reside in public housing. These factors include the maintenance and management of the building, the design and material quality of construction, the accessibility where includes public transportation access, the availability of public facilities, and the presence of green and public spaces. This research provides valuable insights into the user's perception and priority regarding public housing provision. Understanding these factors is crucial for the Provincial Government of Jakarta to address the challenges in public housing provision effectively.

Keywords: *Affordable public housing*; *user perception; online user reviews; content analysis*

INTRODUCTION

In Jakarta, rapid urbanization has led to increased slum settlement (Ooi & Phua, 2007), threatening the city's structure with its high density and lack of essential services. The public housing known as Rumah Susun Sederhana Sewa (Rusunawa) initiative by the government aims to provide low-income families with affordable public housing to stem the growth of slums and offer a respectable alternative to informal settlements. Even the shift from unstructured to organized living spaces often meets resistance from the residents, potentially leading to conflicts between the authorities' goals and the community's lived realities. Understanding user perceptions is vital to crafting policies and designs that resonate with the aspirations of the residents (Osada et al., 2022).

Public housing quality significantly influences the mental well-being of its occupants, offering stability, affordability, and social engagement, which contribute to mental health and the alleviation of stress (Sharpe et al., 2018). Affordable housing options reduce financial burdens, while community initiatives within public housing foster social ties essential for emotional health. Studies indicate that public housing offers improved residential stability, which is beneficial for the mental well-being of children (Clair, 2019). The World Health Organization identifies several housing aspects that support health, such as safety, security, and access to services. Economically, public housing contributes positively to growth,

although the benefits might unfold over time (Newman & Harkness, 2002). Public housing investments yield considerable external benefits, mainly when supporting previously homeless individuals. Public housing is pivotal in addressing the needs of low-income families, significantly affecting their health, economic status, and quality of life (Clair, 2019; Kadhim & Shok, 2021; Newman & Harkness, 2002). It is critical to prioritize residents' needs and engage with community-driven public housing development to forge sustainable and beneficial solutions for society.

The government should consider these insights in Rusunawa's design and policymaking, enhancing housing solutions that provide shelter and improve residents' lives. Many Rusunawa residents having migrated from various Indonesian regions, carry a strong sense of community from their previous homes. This sense of belonging is critical to their readiness to transition and adjust to new living environments (Tri Hartanto & van Eerd, 2015).

This study aims to discover user perceptions of vertical public rental housing properties (Rusunawa) in Jakarta and the key factors that the user while selecting Rusunawa by analysing text data from online reviews. In the current technology era, the opinions and experience of fellow consumers are a significant factor for people when they buy products (Zhao et al., 2018; Zhou & Guo, 2017). Online reviews are critical in providing potential buyers with the necessary information to assess the quality, dependability, and authenticity of a product before making a purchase. Reviews contribute valuable insights into a product's features, capabilities, and potential drawbacks. This research offers a detailed view of the perception influencing occupancy in Rusunawa. Utilizing online reviews provides an in-depth perspective that can be greatly inform the design and policymaking process, leading to more effective public housing solutions that meet the needs and wishes of Jakarta's urban residents. The rapid urbanization in Jakarta necessitates strategies like Rusunawa to address the pressing challenges of expanding slums, emphasizing the importance of aligning government actions with resident aspirations.

LITERATURE REVIEW

Housing Policy Provision in Indonesia

The policy of housing and settlements has been regulated in Law Number 1 of 2011 concerning Housing and Settlement Areas (UU No. 1 Tahun 2011 Tentang Perumahan dan Permukiman). The existence of this policy is one of the basic needs for all levels of society to live in a liveable and affordable manner in a healthy, safe, harmonious, and sustainable environment. Housing development includes single houses, row houses, and vertical housing. Local governments must provide easy access for low-income people to reach housing. One of the local government programs in providing housing for low-income people is the construction of vertical housing. The construction of vertical housing aims to improve the quality of liveable housing supported by a healthy and sustainable environment. To improve the quality of housing and slums, the local government sets policies and handling patterns in restoration, rejuvenation, and resettlement. The construction of vertical housing is one of the patterns of handling urban rejuvenation for slum areas. In addition, it is also to solve the problem of fulfilling the need for affordable housing for all levels of society, especially in urban areas with an ever-increasing population, considering that urban land is increasingly in debt. The definition of a flat based on Law No. 1 of 2011 concerning Housing and Settlement

Areas (UU No. 1 Tahun 2011 Tentang Perumahan dan Permukiman) states that it is a place to live arranged vertically. Vertical housing is multi-story buildings built vertically in an environment structured functionally and used separately, especially in residential places equipped with shared objects and land.

The law is derived into Governor regulations in Jakarta to be implemented in accordance with its designation. The housing policy in Jakarta includes the provision of public rental vertical housing (Rusunawa) and the Affordable Housing Program. By Gubernatorial Regulation No. 111 of 2011 on the Occupancy Mechanism of Public Rental Vertical Housing (Rusunawa), Rusunawa is prepared for 'programmed communities'. 'Programmed communities' are communities affected by a) development programs for the public interest, b) natural disasters, c) urban space control, and/or d) other similar conditions. Meanwhile, the unprogrammed/general community is a low-income community that meets the occupancy requirements. Furthermore, the 'Affordable Housing Ownership' program is a home ownership subsidy program provided by the Jakarta provincial government for low-income people to own permanent housing.

Gubernatorial Regulation No. 1 of 2022 concerning Incentives for the Construction of Public Vertical housing Owned without Down Payment and Public Vertical housing for Rent regulates the construction of Vertical housing, that the construction of Vertical housing must be accompanied by supporting facilities and must follow the minimum requirements of technical specifications. Supporting facilities at least include a) worship facilities; b) public parks; c) entrance access road; d) building utilities; and e) other facilities. Building utilities are at least equipped with clean water installations, electrical installations, telephone installations, gas installations, and firefighting installations. Meanwhile, other facilities are prepared as a form of adaptation for residents of vertical housing so that their economy continues to be sustainable, including business kiosk facilities, micro, small, and medium enterprises centres (UMKM), and job training centres with themes that adjust to the needs of flat residents.

The User Perception on Public Housing Property

Perception is a cognitive process by interpreting sensory information or ways of thinking about things (Qiong, 2017). Robbins & Judge (2017) outlines two categories of perception: positive and negative. Positive perception is a personal evaluation of an object that results in a positive outcome, which is expected from certain objects. This perception stems from individual satisfaction with the particular object that is the source of perception, knowledge, and individual experience about felt objects. In contrast, negative perception is a personal evaluation of something that results in a negative outcome, which is not what one would expect from a particular object. Negative perception is caused by dissatisfaction with certain objects, perceptions of the source, individual ignorance, and lack of experience with unidentified objects. When making decisions or choices between two or more alternatives, individuals are influenced by their perceptions, which in turn affects the quality of their decisions. While decision-making should ideally be an objective process, the impact of perceptions cannot be ignored.

Furthermore, Rusunawa represents a critical component of Indonesia's strategy to address urban housing shortages. Understanding user perception of the housing quality of these dwellings is essential for improving living conditions and ensuring the sustainability of such housing solutions. Housing quality is a complex concept contextual without a static meaning and varies according to user groups (Sengupta & Tipple, 2007). Quality housing is not confined to structural stability but depends on housing location and neighbourhood, indoor living environment, architectural design features, and housing maintenance (Chohan et al., 2015). Lawrence (1995) mentioned that quality housing should have a proper interrelation between architectural, economic, demographic, political, and ecological factors. Moreover, housing and neighbourhood satisfaction are critical indicators of housing quality, which affect occupants' quality of life (Salleh, 2008). The housing quality of Rusunawa is a consideration for the community to determine the choice to live in because people are used to landing housing. Factors that are considered to live in Rusunawa have been explored in previous studies.

According to Widya et al. (2023), apartment housing quality can be categorized into three types: requirements, supplementary, and complementary. The first category refers to basic residential necessities such as safety, competent management, and freedom from physical disturbances. Meeting these basic requirements is crucial in encouraging individuals to refer or relocate to that unit. The second category includes elements that improve the quality of residential life, such as functional adaptability, attractive design, desirable location, financial advantages, and effective management. The third category focuses on preserving the property's physical state and delivering outstanding service.

Green space within Rusunawa is vital for resident well-being and environmental sustainability (Reyes-Riveros et al., 2021). Larcombe et al. (2019) mentioned living in high-rise vertical housing may disrupt the natural balance between architecture and the environment cause sense of isolation for residents. This disconnects from nature can cause mental stress that may lead to physical ailments and psychological issues. Incorporating green spaces into the environment can enhance its quality and beauty while providing a communal area for residents to gather, socialize, and engage in recreational activities (Suminah et al., 2017). In Rusunawa, communal space is vital in cultivating social harmony and community engagement. These spaces are just as crucial as green areas, as the vertical housing structure differs significantly from traditional horizontal patterns may affecting the dynamics of resident's social interaction (Kusliansjah & Histanto, 2017). The shift of private ownership to shared communal facilities, such as corridors, main stairs, emergency stairs, communal space, parking areas, building entrances, open spaces, and mosque playing role in enhancing sense of community (Bunawardi et al., 2016). Therefore, shared space in vertical housing playing important role in fostering a strong sense of community.

User perceptions often reflect concerns about crime and building resiliencies (Palmiotto, 1998; Sheppard et al., 2022; Widya et al., 2023). Mulyandari and Luhur (2016) emphasized the importance of infrastructure in public housing that affects residents' sense of security and comfort, including disability access, electrical installation security, and lightning rods that refer to building resiliencies. Moreover, the feeling of security is generated from the planning and design of the Rusunawa design and criminal prevention. The low crime rate is a consideration for people to living in Rusunawa (Julistia & Haryatiningsih, 2023). The community sees the availability of security guards as essential to provide a sense of security.

Accessibility to essential services and transportation networks is critical to people who are living in Rusunawa (Widya et al., 2023). Residents value the proximity to workplaces, schools, and public transport, facilitating daily commuting and enhancing quality of life. The location and surrounding neighbourhood significantly affect residents' satisfaction and social integration. Rahma et al. (2020) revealed four priority factors in selecting Rusunawa locations: conformity with the spatial plan, disaster vulnerability, land price, and accessibility. Additionally, Irvanda & Navitas (2022) uncovered a number of pressing issues within the community regarding the amenities available at Rusunawa Sombo, which was used as a case study. These concerns spanned the state of the building, the living quarters' size, security measures, access to education and healthcare, rental rates, environmental cleanliness, and additional features like parking, fire safety equipment, and recreational spaces.

Based on this previous research, several variables can be used as categories to reveal the user perceptions, including green space, communal space, accessibility, security, building quality, and public facilities. These variables align with the Governor regulation's basic standards regarding the minimum requirements for constructing vertical public housing.

METHODOLOGY

Case Study

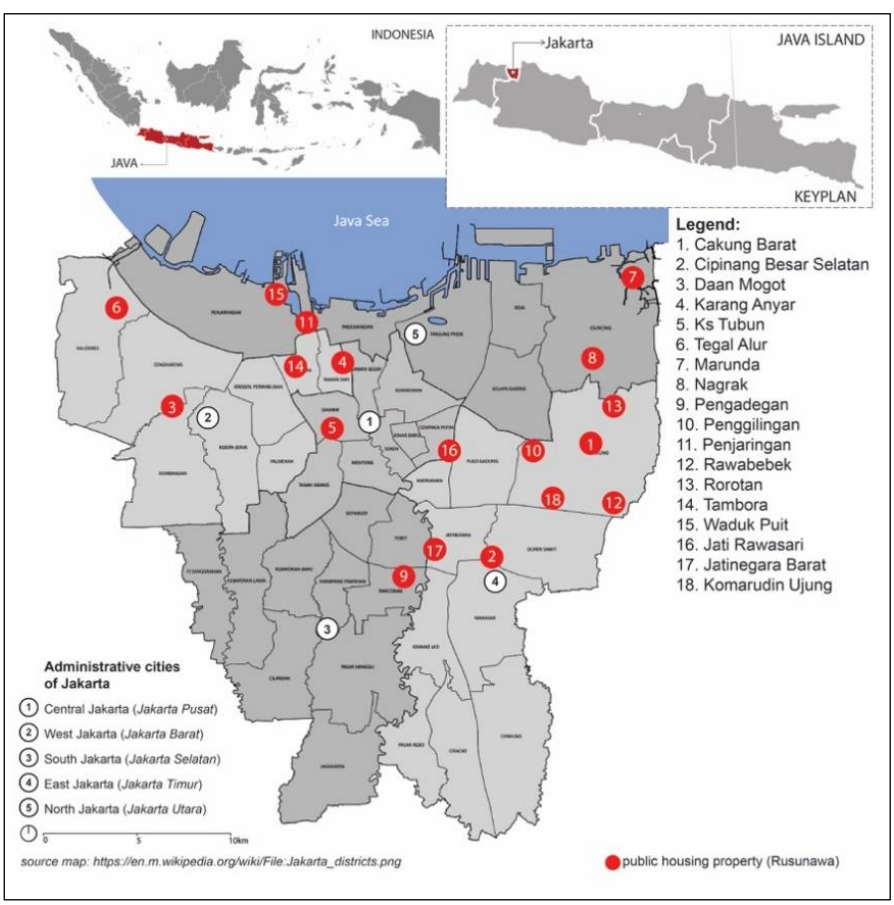

Figure 1. The Map of The Rusunawa Distribution Chosen as A Case Study

This research was conducted in Jakarta, Indonesia. In Jakarta, there are 44 vertical public housing or Rumah Susun Sewa Sederhana (Rusunawa) managed by the DKI Jakarta Provincial Government under the Housing and Settlement Authority. However, there are only 18 Rusunawa (Figure 1) that can be explored as case studies based on search reviews from Google Maps users. To achieve the research objectives, the selection of 18 Rusunawa from a total of 44 is determined by the number of reviews on Google Maps, specifically those that exceed 50 reviews as of 31/01/2024. Some vertical housing that did not get user responses were not selected as case studies in this research.

Limitations

The study on public housing in Jakarta which used online reviews as a source of information has its share of limitations. One of the primaries constrains is the sample size as only 18 out of 44 Rusunawa were examined, leading to a potentially biased interpretation of user perception. Furthermore, online reviews can be subject to various biases, demographics, and motivations of the reviewers, making them an incomplete representation of the population. Reviews can differ significantly in quality and depth with some failing to provide crucial insights in the condition of housing units and the perceptions surrounding them. Furthermore, online reviews are dynamic and may change over time, potentially not reflecting current experiences. Researchers also face limitations in controlling review variables, such as timing and demographic characteristics, which can act as cofounding factors.

Data Collection

Chang et al. (2014) acknowledged the emergence of digital era has brought a paradigm alteration in analysing and interpret vast datasets using big data technologies. The internet has made it easier to access these datasets, which offer high accuracy and value for decision-making process (Sarker, 2021). This has positively impacted multiple areas, including public policy, scientific research, and consumer feedback evaluation. The benefits of online reviews are diversified for both consumers and businesses alike (Zhu et al., 2020). Reviews provide insights that can guide buying choices and business approaches. Nonetheless, they can be influenced by personal bias stemming from unique experiences and might not reflect the broader user community. Despite this, online reviews are considered digital word-of-mouth and valuable information sources for prospective customers. Reviews expressing strong opinions tend to be more valuable than moderate or neutral ones.

For business owners and service providers, online reviews are significant as they can influence potential users' judgments and overall impressions of products or services. Numerous studies have been conducted on the influence of online reviews on consumer decision-making processes. However, research on housing quality using online reviews, particularly for vertical public housing in Indonesia, is scarce.

Traditional research on housing quality typically involves primary and secondary data (Widya et al., 2023). However, data research is susceptible to the credibility of user-provided reviews, which significantly impact potential users' attitudes and subsequent decisions. This study is innovative in examining user perceptions of public housing through online reviews, drawing from a rich and varied dataset collected from Google Map reviews.

To collect the data (Figure 2), the researcher used the Outscrapper web crawler, which integrates with multiple web services and can aggregate large amounts of data rapidly. Outscrapper is user-friendly and offers data in several exportable formats like Excel. During the data collection phase, the researcher's subjective judgment played a role in selecting the reviews to be analysed. However, this limits the research, as the credibility of user-generated reviews must be considered. The researcher selected 702 reviews from 18 different Rusunawa for further analysis from the collected data.

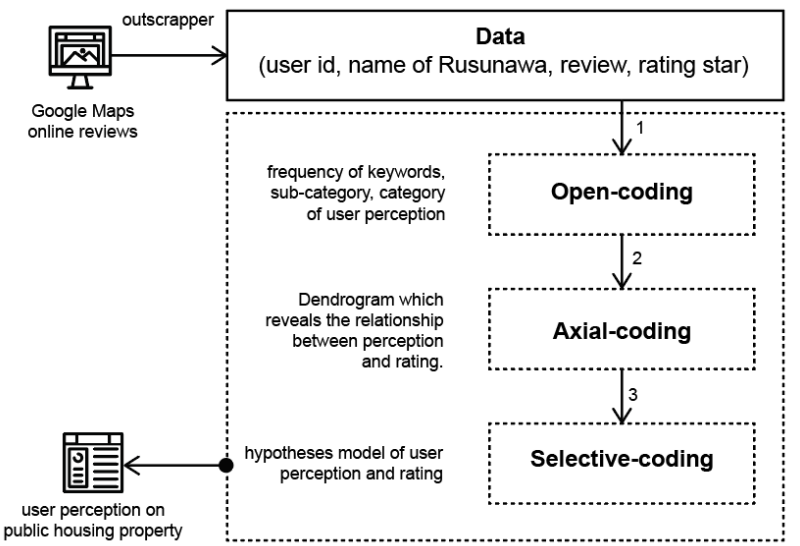

Figure 2. Methodology Diagram

The process of gathering data utilized Outscraper's Google Maps Reviews Service v3 to acquire user reviews for Rusunawa across Jakarta. To focus our analysis on higher-rated housing options, we established a minimum rating threshold of 4.0. This approach enabled us to spotlight only the most acclaimed locations, with reviews systematically organized to prioritize those receiving top ratings, thus providing a clearer perspective on the most positively regarded choices. A series of filtering processes were implemented to ensure the integrity of collected data. Duplicate reviews were eliminated to remove redundancy. Empty reviews were discarded to ensure that each included review offered meaningful insights. Each search query focused on a single organization at a time, preventing data fragmentation and maintaining clarity in the analysis. A cap of 250 reviews per location was established to refine the dataset for targeted research which reduced data noise. The collected reviews were systematically organized in Excel format, enhancing structured analysis and accessibility for further processing. This dataset provides insights into the Rusunawa in Jakarta and capturing user experiences for understanding public perceptions through Google Maps reviews.

Data Analysis

This study employed a qualitative exploratory approach, along with both qualitative and quantitative analyses. Qualitative were applied to assess public perception and ratings through content analysis, while quantitative methods were used to evaluate the frequency of identified factors and their correlations using correspondence analysis. Essentially, data was analysed through a combination of content, distribution, correspondence, and cluster analyses.

Content analysis is a widely used method for interpreting textual data in social research. It involves a systematic coding process to derive direct or contextual meanings from the text. Hsieh & Shannon (2005) view it as a method for subjective interpretation of text data through thematic coding, which can be conducted manually or via computer-assisted text analysis. Content analysis proceeded through open, axial, and selective coding phases, transforming reviews into numerical data within Excel, followed by keyword identification, categorization, and formulation of a hypothetical housing quality model. Axial coding pinpointed relationships between user perception categories and housing quality ratings, facilitated by JMP Pro 16 software to manage data volume and enhance accuracy. The correspondence analysis culminated in a dendrogram illustrating category correlations, guiding the creation of testable ideas for future research.

RESULT AND DISCUSSION

Result

The content analysis yielded 47 distinct keywords reflecting public sentiment towards Rusunawa. These keywords were then organized into 33 sub-categories (Table 1). During the initial analysis phase, the researcher recognized eight main categories associated with their experience of Rusunawa: green spaces, communal spaces, safety and security features, accessibility, affordability, building maintenance, public facilities, and the surrounding environment and services. These categories were further classified based on whether they conveyed positive or negative feedback.

As explained in the methodology, in the open coding phase, researchers have a very subjective role in interpreting the data contained in user reviews. The interpretation is based on the word's meaning, researcher's knowledge and experience. Furthermore, when examined from the correspondences analysis, results of user perception towards rating star, the number of p-value is <0.0001, which means the analysis results have a high significance value.

The distribution analysis could be explained as follows;

Green spaces include parks and the atmosphere experienced by users. The atmosphere is mostly represented by the word 'asri', which is associated with beauty due to greenery. Users give positive appreciation (f=21) comparing to the negative value (f=4), which include green environments or 'asri' (f=17) and the availability of public parks (f=4).

Researcher defined communal space as a playground (f=13) for children to play, whereas it can be corridors, mosque, and other public spaces. According to the governor's regulation, the playground is a minimum requirement for public housing, so its categorization is separated from public facilities.

Safety (f=32) is interpreted by researchers as something that provides a sense of safety. In many reviews, it is represented by the word 'aman,' which means 'safe.' At the same time, good security (f=25) is an effort in criminal prevention by providing proper security system mechanisms, such as security guard provision and security checking. The perspective on the 'kids friendly' category (f=6) is interpreted as safety because it provides a sense of safety for children to do activities through the quality of the environment. Users give a positive

perception of safety and security (f=63). Accessibility includes several variables, including strategic location, quality of environmental roads and side entrances, and availability of public transportation. Based on the distribution analysis results, positive appreciation (f=63) is not much different from negative appreciation (f=49).

Researcher classified cleanliness and tidiness, good management, and availability of clean water into building management categorization. The variable cleanliness (f=136) was mentioned the most in the reviews, followed by tidiness (f=45).

Other variable that mostly mentioned is public facilities with positive recognition (f=83); some users explicitly mention facilities such as mosques, ATMs, cafes, canteens, and sports fields. While others mentioned that the residence is supported by 'complete facilities,' the word complete could be elucidated with fulfilling user needs.

Researcher classified the environment with the neighbourhood, which includes the friendliness of residents, noise, and rules set by the building management. Rusunawa is managed by a technical management unit (UPT) that is responsible for the management and maintenance of the building, so the service refers to the unit's performance. This category recognized the highest positive value (f=189) among the categories.

In addition, the correspondences analysis (Figure 3) of user reviews for the Rusunawa public housing in Jakarta provides a structured insight into the residents' satisfaction levels and specific concerns. The clustering of star ratings indicates varying degrees of satisfaction and highlights particular areas that influence residents' perceptions.

Cluster 1: Low Satisfaction (Star 1 and Star 2)

Residents who rated the housing as 1 or 2 stars expressed significant dissatisfaction, primarily concerned with the quality of the buildings and safety measures. The low building quality and inadequate safety and security suggest a failure to meet basic expectations for decent housing. Moreover, the poor environment and service quality at the 2-star level imply that not only are the physical aspects subpar, but also the supportive services need to be improved. This cluster points to a critical need for interventions focusing on fundamental improvements in construction integrity, enhanced security, and betterment of service provision.

Cluster 2: Moderate Satisfaction (Star 3)

The middle-ground ratings given a 3-star score indicate a moderate level of satisfaction among users. Issues such as poor public facilities, limited green spaces, challenges in accessibility, and suboptimal building maintenance need to be addressed to raise the living standards to a higher satisfaction rating. These factors suggest that while some basic needs may be met, there is significant room for enhancing the quality of life by improving both the physical infrastructure and the amenities offered. Enhancing public facilities and maintaining existing infrastructure could be the key to transitioning these average ratings to more favourable outcomes.

Cluster 3: High Satisfaction (Star 4 and Star 5)

On the other hand, when users give a rating of 4 or 5 stars, it signifies a notable level of contentment. Such high ratings are typically linked to superior accessibility, excellent communal space, and the availability of public facilities. The strong correlation between positive ratings and positive mentions of building maintenance, safety and security highlight the significance of prompt management and continuous maintenance in public housing. The presence of well-maintained green spaces is also noteworthy, as it aligns with the worldwide recognition that access to nature is critical for enhancing well-being in urban areas.

Table 1. Grouping Sub-Categories and Categories of User Perception

Positive Perceptions			
Sub-Categories	***f***	***Categories***	***f***
green environment	17	good green space	21
public park	4		
good playground	13	good communal space	13
good security	25	good safety & security	63
safety	32		
kids friendly	6		
good access road	7	good accessibility	64
public transportation	19		
strategic location	38		
clean environment	136	good building maintenance	189
clean water provision	3		
tidy	45		
well maintained	5		
public facilities	83	good public facilities	83
affordable price	8	affordable	8
friendly neighbourhood	16	good environment & services	31
good building management	15		
Negative Perceptions			
Sub-Categories	***f***	***Categories***	***f***
public facilities	13	poor public facilities	13
lack of religion facilities			
low parking space			
poor security	7	poor safety and security	7
poorly maintained	11	poor building maintenance	26
dirty	14		
untidy	1		
remote location	4	poor accessibility	49
lack of access road	33		
congestion	8		
lack of public transportation	4		
lack of public park	3	poor green space	4
poor green environment	1		
poor playground	1	poor communal space	1
low building quality	4	low building quality	4
rules dissatisfaction	4	poor environment & services	24
noise neighbourhood	2		
poor building management	18		

DISCUSSION

The analysis of the dendrogram presented above (Figure 3) indicates that the distribution of key factors (Figure 4) identified in Google Maps reviews provide insights for management of Rusunawa in Jakarta. The factors ranked in order of significance, are: building maintenance, accessibility, public facilities, safety and security, environment and services, green space, communal space, affordability, and building quality.

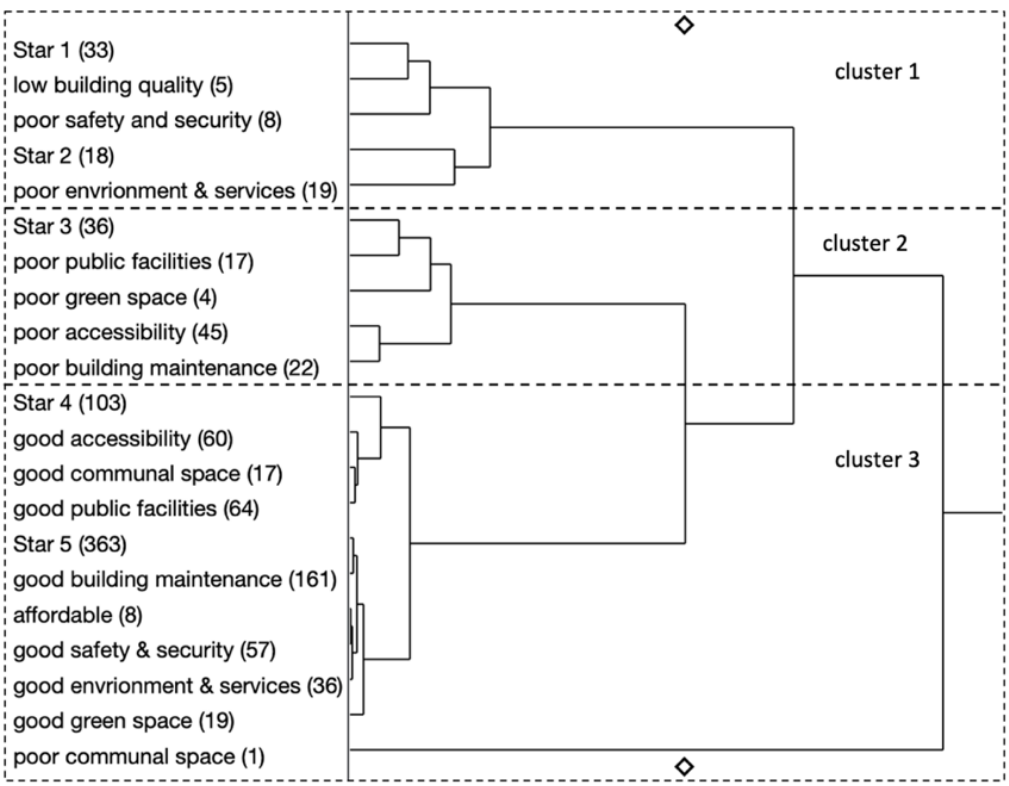

Figure 3. Correspondence Between The Rating and Categories (Positive and Negative User Perception)

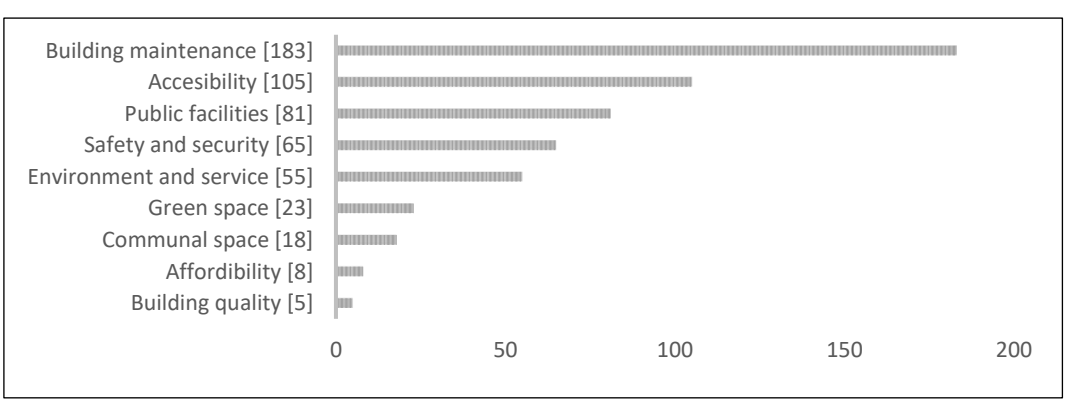

Figure 4. Key Factors That are Considered by Users in Choosing Rusunawa

This research portrays user perceptions on the government initiatives to provide liveable public housing through the reviews of 18 Rusunawa that were examined. The Rusunawa examined were constructed between 2006 and 2022. Users concern about building quality, environment and service, safety and security and neighbourhood characteristics identified by giving 1 and 2 rating stars. However, this study does not delineate which properties received low ratings, thereby constraining the ascertainment whether particular policies influenced the noted issues. This should concern the government when evaluating the Rusunawa after occupied. This research offers critical feedback on housing provision in Jakarta from users' perspectives that enlightened preferences. The availability of green space in Rusunawa highlights positive feedback since Jakarta lacks green areas which may contribute to urban well-being. Furthermore, the communal space became another concern in facilitating social interactions and creating a safe environment for children. Nonetheless, safety issues were delivered under maintenance constraint.

User perceptions on Rusunawa mainly focus on three aspects: maintenance, accessibility and security. Accessibility is an issue that users most frequently review, indicating the importance features in planning. Two primary aspects related to accessibility consist of access to public transformation and side entrances connecting to the surrounding public and social facilities. Side entrance is often deactivated due to security concerns and the limitation of security officers who play a significant role in shaping users' perceptions of security. Considering these limited resources in building management, involving the residents in managing Rusunawa is important. The management approach of Rusunawa significantly affects user preferences, subsequently influencing the well-being and comfort of residents. Additionally, the amenities received positive reviews, particularly the presence of a mosque and accessible recreational facilities. Nevertheless, some deficiencies were reported in some of these facilities. Living in the Rusunawa may enhance social interaction for some residents. At the same time, some of them confront noise-related issues and irreconcilable management regulations, raising questions about the government's sincerity in managing Rusunawa. These perspectives underscore the complexities associated with housing provision and the policies that reciprocate the distinct need of residents.

The Jakarta government is responsible for providing Rusunawa that aligns with laws and technical standards. Physically, the infrastructure of Rusunawa mostly met the technical requirements. However, a significant gap remains on the non-technical aspects, such as building management and maintenance, that must be considered to achieve sustainability and well-being. Considering these purposes is important because the government offers Rusunawa as a solution for low-income community and to relocate residents from slum and illegal settlements. Thus, it is essential to consider non-technical factors that enhance living comfort to prevent residents from returning to occupied vacant spaces that may lead to re-informalization. Understanding these complexities is beneficial for optimizing resource allocation. Authorities can optimize the physical infrastructure and the non-physical components of governance and community engagement within Rusunawa.

This study presents the user perceptions on Rusunawa while recognizing methodological limitations. Online reviews often reflect highly positive or negative rather than objective perspectives that may lead to misinterpretation and bias. Future research should address this limitation by incorporating interviews or questionnaire to enhance the reliability of the data. Aside from methodological limitations, as an ongoing feedback mechanism for evaluating the

effectiveness of current policies, online reviews provide valuable insight for policymakers. These reviews enable policymakers to identify recurring issues related to non-technical aspects and allow for data-driven policy adjustment that enhance resident satisfaction and ensure the long-term sustainability of public housing initiatives.

CONCLUSION

User reviews on Rusunawa in Jakarta offer valuable insights, although the findings require further validation through more reliable research methods. However, analysing these online reviews suggests that building maintenance is a primary concern for residents, alongside other critical factors such as accessibility and public facilities. These aspects warrant greater attention from policymakers in developing housing provision policies, ensuring that the focus extends beyond physical infrastructure to include non-physical aspects that influence residents' well-being.

Recognizing the government's limitations in fully addressing all aspects of Rusunawa management is also essential. Failure to acknowledge these constraints may lead to negative perceptions among residents. As a potential solution, community involvement in managing Rusunawa should be considered to bridge the gaps that housing administrators may be unable to address effectively. The contrast between positive and negative resident perceptions highlights the complexity of urban housing needs. While the government has set technical construction standards for Rusunawa, the management, and maintenance of these facilities would benefit from a more localized approach, allowing each Rusunawa to establish its system while actively involving residents. Since residents have diverse social backgrounds and expectations, this participatory model may help mitigate potential conflicts between tenants and administrators. A responsive and adaptive housing policy is essential to accommodate the dynamic nature of Rusunawa communities.

Future research should focus on a more in-depth investigation of these key factors. Adopting a mixed-method approach that integrates quantitative analysis of user reviews with qualitative methods such as interviews would provide a more holistic understanding of resident experiences. This methodological approach would help address the limitations associated with relying solely on online reviews, thereby enhancing the reliability and validity of the findings.

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PROPOSING THE URBAN FLOOD RESILIENCE: CASE STUDY OF COMMUNITY ADAPTATION IN THREE MAJOR RIVER IN JAVA, INDONESIA

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Abstract
The Flooding phenomenon in Indonesia is gaining attention. Statista saw that about 1.5 thousand floods occur in 2022 compared to 1.1 thousand in 2020. Climate change, which influences a community's need to adapt, is one of the reasons that contribute to this increasing number. It is figured out that climate change has really been the fact that communities must be noted. In the context of Indonesia, community flood resilience has been implemented since 2013 in the three major river in Java as the respond to flooding. Urban Flood Resilience emerged as a new approach in urban planning and design to combat this occurrence. However, there is not much discourse about Urban Flood Resilience particularly in the context of Indonesia whereas it has a lot of evidence of how the communities has faced and self-reliant to river flooding. Otherwise, combining non-physical and physical factors through urban design principles would support the goal of sustainable development of the cities. This article discusses the issue of urban flood resilience and includes reviews of several academic journals covering this topic and previous initiatives. Furthermore, Content analysis is used to develop urban design principles for urban flood resilience. The article also focuses on how urban village communities adapt to flood risks and regenerate neighbourhood flood management systems. The purpose of this article is to provide a synthesis of the reviewed material applicable to the Indonesian situation, with the goal of improving the country's resilience to urban floods.

Keywords: *Urban Flood Resilience; Climate Change; Community Adaptation; Flood Resilience*

INTRODUCTION

In Indonesia, flooding has periodically grown more complex. News of flooding that has engulfed several communities appears almost every rainy season, especially on local communities residing close to water bodies area. Data shows that there are more than 1500 flooding occurs in 2022 compared to around 1100 flooding in 2020 (Annur, 2023). Flooding phenomenon in Indonesia are caused by several factors, including rainfall, topography, soil type, land slope, river waste, and population density (Ariyani et al., 2023). As stated previously, one of the factors that contribute to floods is population density. The population, particularly in urban areas, has the potential to worsen the conditions that occurred as a result of the land use change from floodplain area to the residential area. For example, there are densely populated settlements along the riverbanks, usually the informal settlements, some belong to slums. On the other hand, it cannot be denied that the river has long been an integral part of Indonesian history. As explained by Dhahiyat, Prasetiya, and Rossiana (2018), the majority of Indonesia's population lives near water. Indonesian history also reveals that Indonesians are known for their affections of river and maritime transportation, as well as their continual movement between islands (Karyono, Melyan, Salsa, & Fariz, 2017). Thus, making people inclined to choose riverbanks as one of the strategic areas to settle especially for those who work in non-agriculture sector (Hardati et al., 2022).

In addition, climate change also has an impact on Indonesia's rainfall variability, increasing the frequency of extreme rainfall and drought in practically all regions of the country (Rani, Lange, Cameron, & Schroth, 2018). Recent studies have demonstrated that continued greenhouse gas emissions are causing climate change, which includes increasing the frequency of extreme El Nino and La Nina events where the previous record showed that it was able to raise the quantity of precipitation by up to 200 mm/month (Cai et al., 2015; Rani et al., 2018). Although the precise rainfall patterns impacted by climate change at local scales remain uncertain in the future, excessive precipitation in tropical regions is predicted to rise (Jha, Bloch, & Lamond, 2012; Rani et al., 2018). Therefore, climate change factors must be considered while proposing flood risk management at the regional level (Rani et al., 2018). As mentioned by Khailani & Perera (2023), climate change contributes to the flood phenomenon, impacting to urban community resilience. Furthermore, the large number of informal communities living along the river's banks makes them more vulnerable to the adverse effects of climate change. Additionally, Moser and Stein (2011) argue that informal communities are the most vulnerable to climate change.

In urban areas, severe flooding commonly occurs during heavy rainfall and high tidal flow (Junaidi, A., Nurhamidah, N., and Daoed, D., 2018). Tidal flooding is a frequent disaster in Indonesia due to rising sea levels, while fluvial floods also occur regularly as the country is intersected by major rivers such as the Bengawan Solo, Cimanuk, Brantas, and Citarum Rivers. Some of these rivers are among the most polluted in Indonesia, which likely exacerbates the impact of river flooding on urban areas. It can also emerge as a consequence of the overload of the current drainage systems as the impact of urbanisation, which permits deforestation and therefore increases hard surfaces area (Napier, 2021). For instance, Jakarta as the most populous city in Indonesia, had severe floods in 2007, 2013, and 2014 due to river and flash flooding caused by intense rainfall (Napier, 2021).

In the context of Indonesia, community flood resilience initiatives have been implemented since 2013 by Palang Merah Indonesia in the three major river systems in Java including Citarum, Ciliwung, and Bengawan Solo River (Dharmawan, 2018). In addition, the Urban Flood Resilience (UFR) emerged as a new discussion in urban planning and design that explain how urban communities can cope with flooding in a more persistent. Unfortunately, there is not much discourse about Urban Flood Resilience especially in the context of Indonesia whereas there's a lot of evidence of how the community is self-reliant to river flooding. The responses that have been implemented need to be summarized to find out the patterns of community resilience facing to flood. The field of urban design could act as a bridge in realizing UFR principles for urban areas. Thus, the formulation of the urban design principles became important as a benchmark in the planning of areas that are resilient to river floods.

In relation to urban design principles for flood resilience area, it is also crucial to include both physical factors related to infrastructural strategy and non-physical factors related to local wisdom. As Dharmawan (2018) stated that flooding phenomenon lacks an ideal anticipation system, causing similar impacts each time due to bureaucratic structure, coordination, communication, and access to affected areas (Dharmawan, 2018). It is revealed that nonphysical factors still became a challenge in creating a flood resilience area. As a result, to gain a deeper knowledge about how the appropriate principles for flood resilience design, this study aims to propose urban design principles for flood resilience community living close to river basin area where flooding frequently occurs, especially in Java.

METHOD

Methodology

This study aims to develop design principles for Urban Flood Resilience (UFR) in watersheds where flooding frequently occurs in Indonesia, particularly in Java. It compares two kinds of literature reviews both theoretical and practical framework. Specifically, theoretical framework contains UFR explanation from previous research, while practical framework contains lesson learned from previous adaptation strategies in similar river regions. Content analysis is used to develop these principles, which are then compared to the Indonesian context, particularly in the context of the Citarum River in Bandung, Ciliwung River in Jakarta, and midstream Bengawan Solo River in Surakarta.

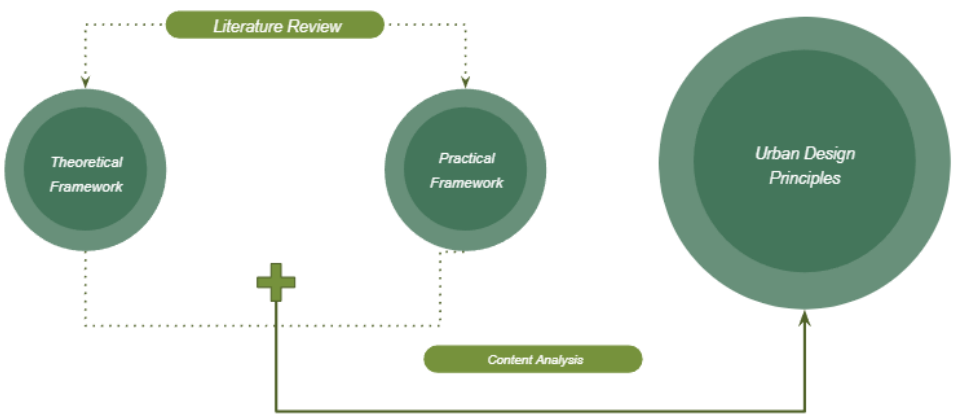


Figure 1. Methodology Diagram

While Content Analysis is a rule-guided technique by analysing characteristic of visual, verbal, and/or written documents consisting of descriptive process based on certain scope, and could be done by extracting categories from data (Khirfan, Peck, & Mohtat, 2020). The data collection is based on the result of literature reviews that is previously conducted. Specifically, the process in this study consists of four steps (Figure 2).

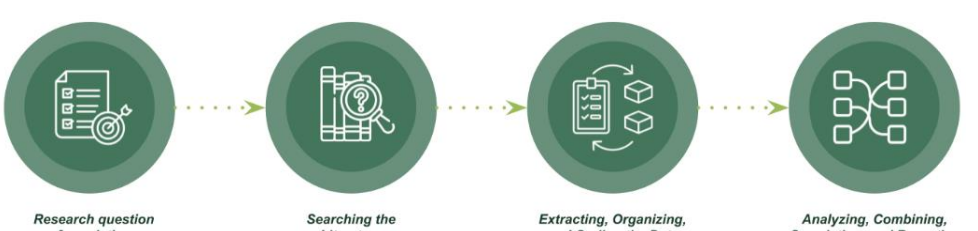


Figure 2. Combination of Literature Review and Content Analysis Process

Research Question Formulation

The formation of research questions is relying on background and aims of this study. Divided into three categories regarding to Disciplines, Description and Terminologies, and Case Studies, the research questions for this study are described in the following table.

Table 1. Research Questions

Disciplines	Description and Terminologies	Case Studies
1. How has the discussion on Urban Flood Resilience emerged and evolved over time?	1. How does literature review describe Urban Flood Resilience?	1. What are case studies for Urban Flood Resilience that literature cite the most?
2. How have the urban design principles for flood resilience been researched over time?	2. Which synonyms does literature use to describe the Urban Flood Resilience?	

Source: (Author, 2024)

Searching The Literature

In this step, an iterative process takes place during literature search in order to gather relevant data. It involves keyword search, research content assessment, and result evaluation. Keywords that are used for gathering theoretical literature consists of the keywords in this study including "Urban Flood Resilience", "Community Adaptation", "Flood Resilience", and "Climate Change". Regarding practical literature, the keyword used is added with "Precedent". Literature will be adopted if it provides answers to questions on disciplines, descriptions, and terminology. Practical literature is not only regarding the precedent of urban flood responds and strategies that is used apart from case studies, but also regarding the case study itself.

Extracting, Organizing, and Coding Data

In this step, each data that have determined was extracted in tables by dividing into two categories which are manifest data and latent data. (Khirfan et al., 2020). The data is then organized to answer previously explained research questions. In addition, to answer the research questions, it is described in a descriptive narrative form primarily to answer first questions at "Disciplines" category regarding how UFR have been used over time leading to UFR paradigm from several literature, also the description of UFR in previous literature. Whereas the questions of the category "Description", "Terminologies", and "Case Studies" are presented as tables. Data Coding is conducted to get the synonym or other terminologies related to UFR, also interpreting description and definition of UFR.

Analysing, Combining, Correlating, and Reporting

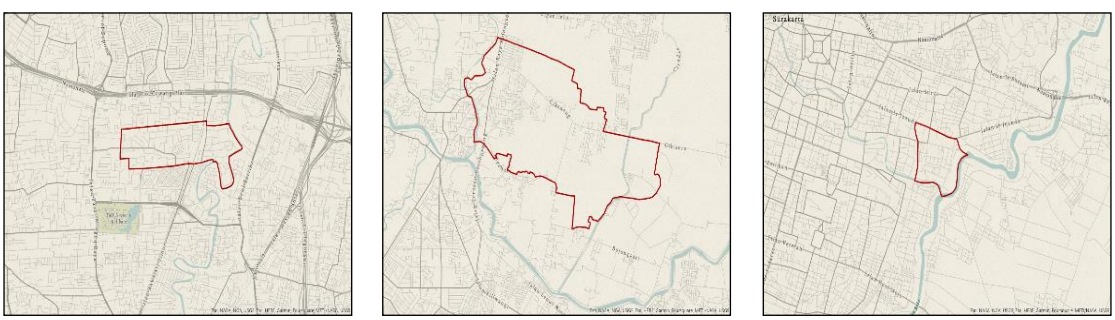
After finishing the data extraction, organizing, and coding, the analysis is carried out by combining and correlating the resulting data so that patterns of the strategies applied in the UFR can be found for subsequent reporting. This process results the Urban Flood Resilience Component to be considered particularly in Indonesian context.

Case Study

Java Island, one of the most densely populated islands in Indonesia, is home to three major rivers that pass through urban areas with high population densities. The frequent occurrence of flooding in these rivers results in floods affecting the residents' settlements. The river areas, originally serving as floodplains, have now been repurposed as residential areas, leading to this natural response from the rivers. According to Farid et al. (2022), hydrological analysis based on the trend history carried out on the Ciliwung River Basin found that land use and land cover change influenced the rise in highest river water drainage, so the size of the flood

and the volume of flooding could also increase. In addition, supported by data from Citarum-Ciliwung Watershed Management Agency/BPDAS Citarum-Ciliwung (2002) that river flood that has occurred in Bandung Basin almost every year within the period of 1990-2002. Similarly, the flooding of the Bengawan Solo River in Surakarta, which occurred at the end of December 2007 was more severe than in previous years, then occurred again in 2008 and 2009 and became an annual flood in the city of Surakarta (Niam, 2019).

Belong to previous explanation, these are the delineation for the case study in selected urban village located in riverbank areas, including Ciliwung River, Citarum River, and Bengawan Solo River. Ciliwung River, measuring 120 km in length with a watershed area of 387 km^2 whereas Citarum River, spanning 269 km with a watershed area of 6614 km^2, and Bengawan Solo River as the longest, have approximately 600 km in length with a watershed area of around 16,000 km^2. These rivers are chosen as they are major rivers in Java, Indonesia, and are chosen as sample objects for research (Figure 3).



(a) (b) (c)

Figure 3. (a) The Selected Location in Ciliwung River, (b) The Selected Location in Citarum River, and (c) The Selected Location in Bengawan Solo River

RESULT AND DISCUSSION

Theoretical Literature Result

Theoretical Literature describes UFR through UFR Paradigm from several previous research. It also provides a table explaining the latent and manifest data from previous literature that connects with Urban Flood Resilience. From this table, it also provides the explanation of lesson learned regarding UFR strategies and principles in developing a flood prone area.

Paradigm for Urban Flood Resilience

According to Liao (2012) Urban resilience to floods is the ability of a city to tolerate flooding as well as quickly reorganize in a situation where there is physical harm and socioeconomic disruption, to avoid fatalities and injuries and protect the city's current socioeconomic identity, it derives communities to perceive floods that occur periodically as a learning opportunity to prepare them for extreme floods. This concept leads to three conclusions: (1) Community must be able to tolerate the flood phenomenon; (2) Able to quickly reorganize and get back to the normal situation, and (3) Able to learn from present events to prepare for the worst-case scenario in the future. According to Vitale et al. (2020),

urban flood resilience is categorized using these three resilience concepts: (1) engineering resilience, (2) ecological resilience, dan (3) socio-ecological resilience. Engineering resilience also refers to static equilibrium which is the equilibrium between a community's resistance response toward shocks and the speed of recovery. (Moura Rezende et al., 2019). When used in engineering, the term "resilience" refers to a material's ability to recover from brief stress, it provides optimal design elements so that, after a specific amount of disruption, an entity may return to its original form (Mehmood, 2016). Thus, technical aspect is generally the driving force behind engineering resilience (Chandler, 2019). To overcome issues like floods and other disruptions, policy-making institutions usually adopt the notion of this engineering resilience, which generally takes the form of a top-down approach. (Esteban & Edelenbos, 2023).

Ecological and socio-ecological resilience refers to a system's ability to adapt to disturbances and maintain equilibrium, involving persistence, change, and unpredictability. It is a dynamic aspect of a system, and it is possible that the evolved system will not return to its original state (Moura Rezende et al., 2019) Ecological resilience is determined by a system's ability to recover quickly from shocks and tolerate disruptions while maintaining critical limits (Abdulkareem & Elkadi, 2018). Ecological and socio-ecological resilience are interconnected, crucial for disaster preparedness and response, involving the adaptive cycle of natural systems and the role of humans in ecosystems. (Vázquez-González et al., 2021). Urban adaptation to climate change involves strategies like simulations, risk reduction, and flood-resistance capability, considering factors like permanent residents, ecological environment, economic development, socioeconomic status, flood control capacity, and drainage system (Gao et al., 2022).

Finally, the term used in defining urban flood resilience theory is still often focused on the infrastructural aspect or in the engineering context, which will be closer to the term flood control than flood adaptation. (Liao, 2012). Flood adaptation should view flooding as a beneficial community phenomenon, influencing community development of mitigation strategies and promoting a shift in perspective. This shift in perspective could potentially change the flood-related paradigm.

Detailed Literature Review for Urban Flood Resilience

Detailed literature review provides detail information regarding the selected previous research in UFR both manifest and latent information. The following is table of Literature Reviews of Urban Flood Resilience. There are 11 literatures utilized in this study, conducted over several years from 2012 to 2023. The case study spans across Germany, Vietnam, Indonesia, Italy, and South Korea. Diverse case studies were selected to serve as references for exploring principles in efforts to adapt to flooding.

Table 2. Literature Reviews of Urban Flood Resilience

Manifest Data					Latent Data			
Publication Tittle	**Authors**	**Year**	**Type**	**Keywords**	**Terminology UFR**	**Description**	**Case Study**	**Lesson Learned (Principle and Strategies)**
A Theory on Urban Resilience to Floods-A Basis for Alternative Planning Practices	Liao, Kuei Hsien	2012	Journal Article in *Ecology and Society*	Flood adaptation; Flood control; Flood hazard management; resilience-based management; resilience surrogate; resilience cities; urban floodplains; urban resilience	Urban resilience to flood; Urban River resilience; Flood resistance; Engineering resilience; Ecological resilience	UFR is the capacity of the city to tolerate flooding and to reorganize should physically damage and socioeconomic disruption occur, so as to prevent deaths and injuries and maintain current socioeconomic identity	–	1. Flood safety for individual citizens 2. Maintenance of the city's identity
Planning in urban flood prone areas: Focus on six principles to reduce urban vulnerability	Moreau, Anne-Laure	2016	Conference Paper in *European Conference on Flood Risk Management*				Frankfurt, Germany	1. Multifunctionality or multiuse concepts 2. Avoidance, Solidity, Meshing 3. The culture of risk 4. Territorial equity 5. Sustainable Development 6. Crisis Management
Urban design principles for flood resilience: Learning from the ecological wisdom of living with floods in the Vietnamese Mekong Delta	Liao, Kuei Hsien Le, Tuan Anh Nguyen, Kien Van	2016	Journal Article in *Landscape and Urban Planning*	Adaptation; Flood hazard mitigation; Living with floods; Mekong Delta; Urban design; Urban resilience	Flood adaptation Living with floods	UFR is theorized to have three key properties: localized flood-response capacity, timely adjustments after every flood, and redundancy in subsystems	Vietnamese Mekong Delta, Vietnam	1. Anticipate and accommodate flooding 2. Incorporate the ecological process of flooding 3. Reveal the flood dynamics to the public space
Culture and Community Resilience to Flooding: Case Study of the Urban Coastal Community in Jakarta	Surtiari, Gusti Ayu Ketut Djalante, Riyanti Setiadi, Neysa Jacqueline Garschagen, Matthias	2017	Book	Community resilience; Flood; Disaster; Culture; Coastal; Urban; Jakarta	Community Resilience		Muara Baru Kampung, North Jakarta, Indonesia	1. Mutual assistance 2. Self-organize 3. Networking 4. People Beliefs

Table 2. Literature Reviews of Urban Flood Resilience (continued)

Manifest Data					Latent Data			
Publication Tittle	**Authors**	**Year**	**Type**	**Keywords**	**Terminology UFR**	**Description**	**Case Study**	**Lesson Learned (Principle and Strategies)**
Enabling water sensitive urban design principles in Ho Chi Minh City for flooding resilience	Oliveira, Cunha	2018	Conference Paper in International Forum on Urbanism	Flood resilience; Climate change; Water sensitive urban design	Water sensitive urban design		Ho Chi Min City, Vietnam	1. Permeable surface in outdoor areas 2. Green facade, connection between detention tank, Light green roof, 3. Storm water collection Grass swales, Retention basin
Urban flood resilience, a discursive-institutional analysis of planning practices in the Metropolitan City in Milan	Corinne Vitale, Sander Meijerink, Francesco Domenico Moccia, Peter Ache	2020	Journal Article in Land Use Policy	Institutional analysis; Discursive analysis; Flood risk management; Urban flood resilience; Spatial Planning	Flood risk management; Engineering resilience; Ecological resilience; Socioecological resilience;	flood risk management strategies are mainly directed to flood probability reduction or potential damage reduction. Flood	Lambro River, Milan, Italy	1. Technical measures (Dams, Dykes, Spillways, etc) 2. Spatial measures (Retention River basin, Multifunctional flood defence, Infiltration areas, Water storage, Polders, Wetland) 3. Early warning and Emergency measures (Flood insurance, evacuation system, Education, etc) 4. Adjustments to individual houses and infrastructure (Green-Blue Infrastructure, Waterproof architectures, building regulations, etc) 5. Developing satellite cities (De-urbanization, Prevent urban expansion in floodplain)
Flood-resilient urban design based on the indigenous landscape in the city of Can Tho, Vietnam	Long, Nguyen Van Cheng, Yuning Dam, Tu Le, Ngoc	2020	Journal Article in Urban Ecosystem	Indigenous landscape; Can Tho City; Agricultural landscape; Floods; Urban design; Urban resilience			Can Tho, Vietnam	
Review of Urban Flood Resilience: Insights from Scientometric and Systematic Analysis	Meiyan Gao, Zongmin Wang, Haibo Wang	2022	Review in International Journal of Environmental Research and Public Health	Urban flood; Resilience; Climate Change; Bibliometric; Cite Space	Urban Flood Resistance; Urban Flood Restoration;	UFR is the capacity of urban areas to adapt to and cope with floods caused by climate change, aiming to reduce disaster risks and enhance disaster response capabilities which are stabilization, resilience, and adaptive capacity	–	1. Urban planning and design and the Urban drainage system 2. Related to climate change, urban infrastructure, urban management, environmental vulnerability, applied models. 3. Green infrastructure, Urban water regulation, community differences

Table 2. Literature Reviews of Urban Flood Resilience (continued)

Manifest Data					Latent Data			
Publication Tittle	**Authors**	**Year**	**Type**	**Keywords**	**Terminology UFR**	**Description**	**Case Study**	**Lesson Learned (Principle and Strategies)**
								- Enhance institutional adaptive capacity by offering districts to manage for the flood risk - Dimensions of adaptive capacity practice
Building urban flood resilience through institutional adaptive capacity: A case study of Seoul, South Korea	Ro, Bokjin Garfin, Gregg	2023	Journal Article in International Journal of Disaster Risk Reduction	Adaptive capacity; Flood risk management; Institutional system; Resilience; Urban flood risk	Flood risk management; Adaptive capacity	Resilience as the capability of a socio-ecological system to absorb and adapt to disturbances and for the system to improve its capabilities to handle future disturbances	Guro-gu and Gwangjin-gu, Seoul, Korea	1. Variety (Variety of problems, stakeholders, policy options) 2. Learning Capacity (Redundancy, Trust, Single-Double loop learning) 3. Room for autonomous change (Access to information, act to according to plan) 4. Leadership (Visionary, Collaborative, Entrepreneurship) 5. Resources (Human, authority, finance) 6. Fair governance (Legitimacy, equity, etc)
Green Infrastructure for Urban Flood Resilience: A Review of Recent Literature on Bibliometrics, Methodologies, and Typologies	Khodadad, Mina; Aguilar-Barajas; Ismael. Khan; Ahmed Z	2023	Journal Article in Water	Flood mitigation; low-impact development; management practices; nature-based solutions; sustainable drainage systems; systematic literature review; urban flood risk	–	UFR could connect with Green Infrastructure (GI) as GI popularly known as a solution for minimizing the flood consequences by preserving green space	–	1. Resilience Green Infrastructure 2. Low-Impact Development Climate Change 3. Nature-Based Solutions Flooding 4. Ecosystem Services 5. Blue-Green Infrastructure Stormwater Management 6. Sustainable Drainage Systems Urban Planning 7. Urbanization Biodiversity

Practical Literature Result

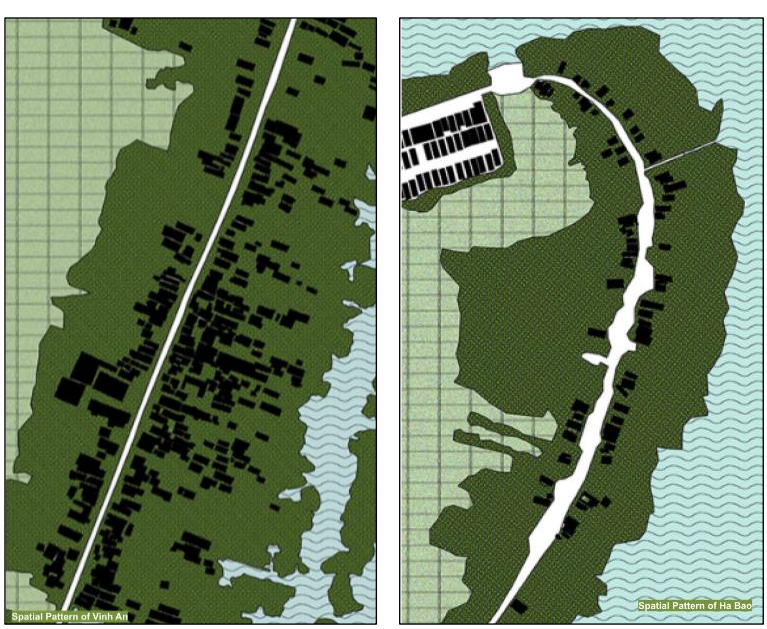
The case study of the Vietnamese Delta Mekong, which depicts UFR in dealing to floods that occurs regularly, is one example of practical literature that is used. Principles and strategies are identified throughout the review process. Thus, it could be utilised as practical reference in developing UFR principles.

Lessons from Vietnamese Delta Mekong (VMD)

One example of a paradigm shift related to urban flood resilience can be seen in the community adaptation strategies in the Mekong Delta region in Vietnam. The Mekong Delta region in Vietnam has implemented community adaptation strategies to improve urban flood resilience. Floods have forced communities to adapt and embrace living with floods as a new way of life. The agricultural sector has adjusted planting and harvesting seasons and developed Full-dike Protected Systems (VNS, 2019). Mekong river is one of the longest river in Southeast Asia and the tenth largest in the world (WWF, 2015). The VMD is characterized by a hydrological landscape comprising the principal distributaries of the Mekong River and an intricate network of various natural and artificial channels (Liao et al., 2016). Seasonal flooding is a common occurrence in the VMD region. It has been a natural event that requires the surrounding communities to adapt to it, a concept they refer to as living with flood as their lifestyle (Liao et al., 2016). The following are examples of lesson learned employed by these communities to adapt to living with flooding:

1. Vegetation as Buffer Zone

Vinh An and Ha Bao are two case studies of communities in the VMD region that reside near the river.



Source: (Liao et al., 2016)

Figure 4. Spatial Pattern of Vinh An and Ha Bao, Vietnam

In this spatial pattern figures (Figure 4), a buffer zone can be observed that separates the settlements from the river in the form of a vegetated area. This design ensures that the houses are not directly facing the river but rather have a floodplain space that serves as floodable storage for the Mekong River. This is also supported by the argument of Napier (2021), creating space for fluvial water could be conducted by restoring wetland or providing storage for hard-floodable area in the middle of a populous urban area. This buffer area not only serves as a green space but also provides protection for the surrounding houses from the high waves that result from floods and storms (Liao et al., 2016).

2. Living in Stilt Houses

The development of stilt houses occurred after the year 2000. Prior to 2000, floods almost always inundated the floors of residents' homes every year, even every week when seasonal flooding arrived. This forced them to elevate their houses into raised houses to prevent them from being flooded when the floods came. During the flood season, there is a risk of homes collapsing due to strong waves. Wealthier households tend to build stronger foundations, while others use bamboo poles for support (Liao et al., 2016).

Source: (Liao, 2016)

Figure 5. Stilt House in Vinh An and Ha Bao, Vietnam

3. Maintaining Mobility with Boats and Footbridges

To maintain mobility when seasonal flooding comes, residents prepare boats as an alternative means of transportation. In addition to being used as a means of transportation, the boats are also often used by local people who migrate to fish in the flooded agricultural fields. (Ehlert, 2012). On the other hand, those who do not have boats use footbridges as an alternative to facilitate their movement during floods (Liao et al., 2016).

4. Livelihood Impacts

Vietnamese riverbank communities typically work as farmers outside of the flood season, with agricultural areas located near the river which become flooded during heavy rains. Due to the frequent and predictable occurrence of floods, residents are forced to consider their situation when the flood season arrives, leading them to switch professions to become fishermen who catch fish in the flooded agricultural areas (Elhert, 2012; Liao et al., 2016). This serves as an effective hallmark of adaptation for the farmers in the area, enabling them to develop proficiency in both agriculture and aquaculture. In addition to transitioning

livelihood roles, farmers also construct infrastructure such as semi-dykes to safeguard rice paddies from water until mid-August, when the peak of the rainy season occurs. During this period, a full-dykes system is employed to provide comprehensive protection to the fields against inundation before cultivation period. (Duong et al., 2016).

According to Liao et al. (2016), there are three design principles to develop Urban Flood Resilience based on the case of Vietnam Mekong Delta which are (1) Anticipate and Accommodate Flooding; (2) Incorporate and Ecological Process of Flooding; (3) Reveal the Flood Dynamics to the Public Space.

Flood Resilience in Indonesian Context

Downstream Ciliwung River

The Ciliwung River is one of the rivers that flows from the mountainous region of West Java through Bogor and Depok before reaching Jakarta. As a downstream area of Ciliwung, Jakarta is often hit by floods. One of the areas prone to flooding around the Ciliwung watershed is Pengadegan village. (Direktorat Jendral SDA, 2013). According to Dharmawan (2018), some initiatives carried out in this area include urban greening through hydroponic planting, biopore infiltration spreads across the village, and waste bank improvement through actively socialized to reduce littering. The hydroponic initiation received special attention since it was warmly accepted by the local community, establishing the farmer organisations (Annisa, 2023). Hydroponic efforts in urban farming are not only a greening effort, but they also contribute to food security for the population. In addition, training for local residents is also conducted particularly related to flood preparedness. The local community from Palang Merah Indonesia also plays a significant role as a stakeholder in implementing initiatives in the form of adaptation to floods.

Upstream Citarum River

As the third largest river on the island of Java, the Citarum River provides many benefits as well as some challenges in its development to this day. The river has also been the most polluted river in Indonesia with a water quality index of 33.43 (Nurulliah, 2022). One of the real challenges is flooding, especially in the south of Bandung and its surroundings, including in the areas of Bojongsoang and Dayeuhkolot. According to Ilhami and Affandy (2018), part of the Citarum Riverbank that passes through Kelurahan Bojongsoang is used for agriculture such as seed vegetables and corn. In addition, Tree planting effort along the border are also being made to contain the flood. The effort in this area is to build a retention pool infrastructure so that it can lower the blockage to 1 meter. Besides, there are many other efforts like socialization, training, and cleansing (Dharmawan, 2018). However, the impoverished residents of Bojongsoang still rely more on outside assistance during floods, even if there are NGOs offering technical support (Muhamad et al., 2017).

Midstream Bengawan Solo River

Sewu Village in Surakarta is one among the cities located on the Bengawan Solo River, specifically in the Solo midstream area. The community, which has been regarded as one of the flood-resistant villages, is already used to living next to the river. Unfortunately, the

community's lack of expertise about river management means that the area is still often impacted by floods. Nonetheless, local communities, namely Sibat have been able to create and start community-based initiatives, especially in flood control, resulting in a growing knowledge of the need for disaster resilience. (Sari, 2018). The community's initiatives include 'akarwangi' planting to curb erosion and biopore infrastructure, as well as various kinds of socialisation and disaster resilience training (Dharmawan, 2018).

Lesson Learned

The lessons learnt from the initiatives undertaken in the three regions are summarised in the following table below.

Table 3. Lesson Learned of Community Resilience in The Selected Case Studies

Location	Strategic Planning	Lesson Learned
Downstream Ciliwung River Pangadegan Village)	• Create and install 90 evacuation signs. • Provide one clean water purifier or treatment. • Flood disaster preparedness and health training. • Water rescue training for flood preparedness • Disaster information and education • Hydroponic socialization and training	The programs emphasize the importance of societal participation and balanced coordination to foster ownership and prevent overlap. Implementation should align with existing village programs, ensuring new stakeholders complement areas not yet addressed.
Upstream Citarum River Bojongsoang and Dayeuhkolot Village)	• Constructing 6 deep well or water infrastructure • Training for flood disaster preparedness and management • Constructing evacuation building • Clean environment activity • Disaster information and education • Providing fiber boats and life vests	Community Flood Resilience program from PMI collaborated with Bojongsoang and Dayeuhkolot Village authorities to build a two-story temporary shelter on village-owned land, managed by the local council. The facility allows the village to rent it for community activities and evacuate residents in floods.
Midstram Bengawan Solo (Sewu Village)	• Greenbelt development plantation for soil erosion control more than 3000 in 3 communities • Biopore > 3200 in 3 communities • 68 absorbing walls in 3 communities • Installing signboard for evacuation routes • Disaster and emergency response training • Socialization UPRB and PHBS in community and at schools • Public kitchen management training • Vertimina >200 in 3 communities	The development of initiatives and mitigation measures that completely meet the community's expectations, as well as the support of interdisciplinary collaboration, can boost a program's success level, even allowing it to expand into the domain of local economic growth.

Reference: Author, 2023 Retrieved from Dharmawan (2018)

Design Principles of Urban Flood Resilience Formulation

The design principles for urban flood resilience are based on lessons learnt from prior cases, both theoretically and practically. Most flood resilience strategies include two components: tangible and intangible. Tangible aspects refer to physical aspects, such as engineering resilience in the form of infrastructure development. Intangible aspects refer to social resilience include capacity building, community involvement, and so on. Both needs to be integrally collaborated in order to complement one another. Formulated tangible aspects include:

1. Sustainable Open Space Interventions: Including permeable surfaces, green facades, grass swales, retention areas.
2. Water Management: Including stormwater management, prioritizing rainwater storage, water infrastructure such as retention pond, and water basin.
3. Providing a proper flood risk infrastructure: Including a multifunctional and dynamic infrastructure so it could be beneficial in any conditions.

On the other hand, intangible aspects for Urban Flood Resilience principles, include:

1. Public Sector Initiatives: Including government Including government support through initiatives, funding, and ensuring the safety of community, and emergency measures and regulatory aspects could give significant role.
2. Social Value of Community: Including how the community interaction could trigger adaptations, including the networking, culture, wisdom, beliefs, and self-organize aspects.
3. Private Sector Initiatives: Sometimes act as connecting bridge between community and public sectors, provide funding opportunities and flood insurance, as well as act as facilitator to fulfil the gap and the missing link to get reach to resilience community.

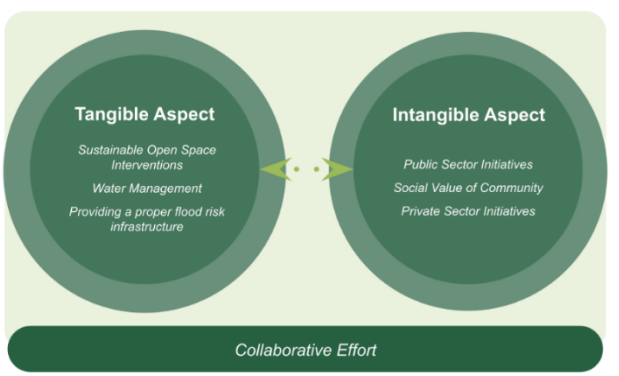


Figure 6. Principles for Urban Flood Resilience

CONCLUSION

This study aims to propose urban design principles for flood resilience community living close to river basin area where flooding frequently occurs, especially in Jav. Urban Design Principles for Urban Flood Resilience could be generated from the lessons learned from a case study and a literature review from previous research. However, it remains need to get a deeper context to local site of study area to know the specific conditions in each site. As the most populous area in Indonesia, the rivers in Java may have their own character that needs to be explored further, so the formulation of the principle will be more contextual. Prior knowledge is necessary as the distinctions between upstream, midstream, and downstream may have special characteristics of their own. In this case, direct observations still need to be carried out ahead of it to obtain more concrete and contextual data, for then to reassess the formulations of design principles for flood resistance in Indonesia especially on the island of Java. Design principles for riverbank areas should promote community resilience and involve systematic adaptation for flood-prone areas, ensuring future planning and design initiatives are integrated and mutually supportive.

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ENHANCING THE ENVIRONMENTAL RESILIENCE OF LOW-INCOME URBAN SETTLEMENT THROUGH COMMUNITY-BASED URBAN GREENING INITIATIVES: A STUDY OF THE KAMPUNG HIJAU PROGRAM IN SURABAYA, INDONESIA

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Abstract
Urban growth must be accompanied by adaptation to the environment for the resilience of urban areas. To meet these needs, an urban greening initiative with a community-based approach can be a successful way. By analysing household characteristics, community engagement, and the implications for urban sustainability, this research will help us comprehend how community-based urban greening initiatives promote social inclusion, environmental resilience, economic stability, and sustainable urban development. A survey of 193 respondents from five *kampungs* found important insights. Findings on household characteristics, engagement levels, and sustainability performance were investigated, providing a comprehensive picture of the implications of the *Kampung Hijau* program. The study reveals that women's associations among *kampung* inhabitants play an important role and are actively engaged in the program. Moreover, community engagement level is intense, with notable social, economic, and environmental benefits. Based on sustainability performance, this research emphasizes the multilayered importance of environmental resilience in urban contexts. This study also inferred the significance of this initiative being maintained as a contributing element to the broader goal of urban sustainability.

Keywords: *Urban greening initiative; Kampung Hijau program; urban sustainability; environmental resilience*

INTRODUCTION

Research Background

Urban infrastructure growth is needed to accommodate urban population growth. This infrastructure growth must be accompanied by adaptation to the environment and the provision of green infrastructure for the resilience of urban areas. One of the challenges faced by countries in the Southeast Asia region such as Indonesia is that the development must take into account the structure of urban areas which are dominated by *kampung* as the main residential area. *Kampung* is mainly inhabited by the majority of people who live in the urban area, especially those belonging to the low to middle income category.

Kampung as the main urban settlement provides resilience and a support system for the city (Shirleyana, Hawken, & Sunindijo, 2018). These densely populated vernacular urban settlements usually have limited space and less priority for urban greenery. In actuality, the presence of urban greenery is critical for society to encourage physical activity, psychological well-being, and overall public health (Wolch, Byrne, & Newell, 2014). To meet these needs, an urban greening initiative with a community-based approach can be a successful way. In general, the term commonly used for such kind of initiative in Indonesia is called the *Kampung Hijau* program. This term has similar principles such as *Kota Hijau* (green cities),

Bangunan Hijau (green buildings), *Ekonomi Hijau* (green economy), etc. The term *Hijau* (green) is associated with a form of commitment and dedication that prioritizes environmental considerations (Nurmansyah, 2015). *Kampung Hijau* program is a community-based urban greening initiative on a *kampungs*cale. The main goal of this program is to establish green spaces in residential areas within the *kampung*. Through the optimization of green space on privately owned land, such as home gardens, and accessible public spaces, such as community gardens, this initiative intends to improve the quality of the environment.

Surabaya as the second largest city in Indonesia is an example of a city that has succeeded in implementing this program. The *Kampung Hijau* program in Surabaya is held in the form of an environmental competition with the title Surabaya Green and Clean that was run from 2005 to 2018 (Prasetiyo, Kamarudin, & Dewantara, 2019). Due to the accomplishment of this initiative, Surabaya gained recognition on an international scale as the UN Global Green City Award winner in 2017 (UNESCAP, 2020). This initiative is an advanced development of the *Kampung* Improvement Project program which started in 1969, with emphasis and focuses on environmental aspects (Silas, 1996). The existence of *Kampung Hijau* program in Surabaya take important role as key themes emerge within the local resilience framework, especially for the community initiative and environmental protection. *Kampung Hijau* program focused on environmental resilience of vernacular urban settlement in the city of Surabaya.

Literature Review

The *Kampung Hijau* program is a community-based initiatives at the *kampung* scale that aims to improve the management of residential environments in urban areas (Junpahira & Azzahro, 2023). This program emphasizes the importance of active participation and empowerment of the community in their residential environmental management. The success of this program also requires support from local authorities, non-governmental organizations, community organizations and city governments. The participation and involvement of various parties aims to ensure that the program is tailored to the specific needs and conditions of each village (Solihkah & Fatimah, 2020). In general, this program aims to make the living environment in urban villages cleaner, healthier, and greener with the active participation of local residents (Prasetiyo et al., 2019). This program also seeks to improve the quality of life of the community by promoting clean and healthy living behaviors (Hartini et al., 2017). Furthermore, this initiative promotes the development of a more sustainable urban environment (Surya et al., 2021; Zain et al., 2022). This initiation program is carried out through a variety of initiatives, including the waste management plans, improvement of green open spaces, and the promotion of urban agriculture in dense urban settlement to increase food security.

According to Hartini et al. (2017), community-supervised garbage banks are the most popular waste management practice. Because it not only helps to minimize environmental pollution but may also generate additional income, the garbage bank serves as a platform for the community to manage garbage properly (Aziz et al., 2020; Sekito et al., 2019). On the limited amount of land accessible in residential neighbourhoods, green open spaces are developed in the home gardens by planting a variety of plants, including ornamental plants, medicinal plants, and edibles including fruits and crops (Franchini et al., 2023; Kehlenbeck & Masss, 2004; Park et al., 2019). Cultivating plants in these home gardens holds significant

importance for the preservation of biodiversity within urban environments by offering habitats for a multitude of plant and animal species (He et al., 2024). The variety among these plant species enhances ecosystem services that are also essentials for urban sustainability (Park et al., 2019). This initiative not only fosters community engagement but also contributes significantly to advancing urban farming practices, which is essential in enhancing food security and enhancing sustainable urban development. Presently, urban farming aims to align with sustainability development objectives by encouraging local food production, diminishing reliance on extensive food supply chains, and mitigating environmental impacts (Nicholls et al., 2020). Activities in this program help build social capital and strengthen community social bonds (Nazuri et al., 2022). Moreover, through the implementation of urban farming practices within this initiative, the community also gets health benefits with increased mental and physical well-being, as evidenced by research on the urban farming initiative in Singapore (Sia et al., 2023).

In a case study conducted in *Kampung* Ketandan, Surabaya, the *Kampung Hijau* program implemented by actively engaging the community resulted in significant environmental quality improvements such as increasing the number of green open spaces and better waste management (Ardianta et al., 2023); (Ernawati et al., 2014). Furthermore, environmental management with active community involvement can contribute to sustainable development and address various environmental challenges. A study conducted in the peri-urban area of Bekasi found that community empowerment and participatory methods are essential for effective environmental management to tackle environmental issues such as flooding, waste management, and disease prevention within peri-urban communities (Sumarjo et al., 2022).

Research Objectives

Kampung Hijau as a community-based program has indeed been running for several years, but there is no sufficient data or research regarding the detailed characteristics of the residents who participate as the main subjects in this program. In addition, to have a comprehensive understanding of the *Kampung Hijau* program, it is necessary to consider the degree of involvement and the implications for urban sustainability during the course of its being implemented. Furthermore, it can be an important reference for better program implementation in the future. Not only for the city of Surabaya, it is hoped that this understanding can also be useful as a lesson for other cities. Based on this, the objectives of this study are to investigate the profile of household characteristics, measure the level of community engagement in the program, and analyse the implications of the *Kampung Hijau* program in the context of urban sustainability. Hopefully, this research will help us comprehend how community-based urban greening initiatives promote social inclusion, environmental resilience, economic stability, and sustainable urban development.

METHODOLOGY

Data Collection

This research is conducted in five selected *Kampung Hijau* in Surabaya City, Indonesia. These locations that were purposefully selected consist of *Kampung* Genteng Candirejo, *Kampung* Lawas Maspati, *Kampung* Herbal Nginden, *Kampung* Jemurwonosari, and *Kampung* Jambangan. Data was collected by the interview method using a questionnaire from

193 respondents involved in the *Kampung Hijau* program. The questionnaire consists of four parts, including household characteristics, *Kampung Hijau* program engagement, motivation and preferences, and home garden structure and management. Data was collected during field work from May 21st, 2022, until June 21st, 2022. The detailed research location and number of participants of each *kampung* can be seen in Table 1.

By using the questionnaire, for the household characteristics part, we collected data regarding gender, household position, age, education level, household income, length of stay, and ethnicity. For the *Kampung Hijau* program engagement part, we collected data regarding the physical activities, non-physical activities, and community benefits of the urban greening initiatives in the social aspect, economic aspect, and environmental aspects. For the *Kampung Hijau* program engagement part, the data were collected using a Likert scale (Likert, 1932). For the motivation and preferences, as well as the home garden and management part, the data were collected and used as materials for the assessment of sustainability performance. There are four sustainability pillars that consist of environmental, social, economic, and sustainable urban design.

Table 1. Research Location and Participant Number

No	Name of *Kampung*	District	Subdistrict	Number of Participants
1	*Kampung* Genteng Candirejo	Genteng	Genteng	33 people
2	*Kampung* Lawas Maspati	Bubutan	Bubutan	40 people
3	*Kampung* Herbal Nginden	Sukolilo	Nginden Jangkungan	40 people
4	*Kampung* Jemurwonosari	Wonocolo	Jemurwonosari	40 people
5	*Kampung* Jambangan	Jambangan	Jambangan	40 people

Data Analysis

Data on household characteristics was then analysed using statistical descriptive analysis to understand the current state of the participants characteristics in the program. The engagement levels were assessed using the data from the Likert scale for physical activities, non-physical activities, and community benefits (Permatasari, Parining, & Anggraeni, 2021). Then the data was analysed to get the engagement score in the form of a percentage that was calculated by a formula as follows:

$$\text{Percentage} = \frac{score}{maximum\ score} \times 100\%$$

The percentage of the engagement score was then categorized into five categories, including very low, low, normal, high, and very high. The percentage range of each category can be seen on Table 2. These categories explain the current state of the engagement level of each participant in the *Kampung Hijau* program.

Table 2. Engagement Score Category

No	Percentage (%)	Engagement Category
1	20 – 36	Very low
2	37 – 52	Low
3	53 – 68	Normal
4	69 – 84	High
5	85 – 100	Very high

Sustainability performance was assessed across four pillars: environmental, social, economic, and sustainable urban design, with various dimensions within each pillar. The data was analysed using an indicator-based framework that was adapted and modified from the previous research conducted by Tapia, Randall, Wang, & Borges (2021). This framework was used to monitor and evaluate the implication of community gardening activities in the *Kampung Hijau* program on urban sustainability. This framework measures four sustainability pillars, including environmental (environmental resilience and resource efficiency), social (inclusive society), economic (food security and income generation), and sustainable urban design. Measurements are taken on a specific mechanism that impacts urban sustainability for every sustainability pillar, which is later referred to as the sustainability dimension. The list of the sustainability dimensions for each sustainability pillars can be seen on the Table 3.

Table 3. Sustainability Dimensions for Each Sustainability Pillars

Sustainability Pillars	Indicator Code	Sustainability Dimensions	Settings
Environmental Resilience and Resource Efficiency	A1	Land repurposing	Increasing utility
	A2	Soil conservation	Increasing utility
	A3	Soil amendment	Increasing utility
	A4	Water management	Increasing utility
Inclusive Society	B1	Participation	Increasing utility
	B2	Community spirit	Increasing utility
	B3	Interaction	Increasing utility
	B4	New relationship	Increasing utility
	B5	Connection to culture	Increasing utility
	B6	Connection to nature	Increasing utility
	B7	Environmental stewardship	Increasing utility
Food Security and Income Generation	C1	Production of food: stability	Increasing utility
	C2	Production of food: accessibility	Increasing utility
	C3	Preparedness for food sovereignty	Increasing utility
	C4	Financial resilience of households	Decreasing utility
	C5	Financial resilience of the urban agriculture initiative	Increasing utility
Sustainable Urban Design	D1	Perceived private utility	Increasing utility
	D2	Perceived public utility	Increasing utility
	D3	Land access and tenure	Increasing utility
	D4	Civil steering	Increasing utility
	D5	Accessibility	Increasing utility

For this analysis, the evaluation was assessed by a score that was derived from the answers to the questionnaire and then coded in numerical form. In the scoring framework, side-by-side comparisons of sustainability dimensions are facilitated using a simple linear transformation that adjusts indicator values individually, based on reference minimum and maximum values. The transformed indicator scores *Vi'* gets a value ranging from 0 to 1 based on a theoretical minimum (min *Xi*) and maximum (max *Xi*) score. In this setting, a higher score represents higher performance and called as increasing utility with beneficial direction in performance matrix. Moreover, to account for decreasing utility situations with detrimental direction in performance matrix, the normalization of formula (1) was reversed as seen on formula (2) where a lower score represents higher performance. Then the value was multiplied by 100% to get the percentage of performance for each indicator.

$$Vi' = \frac{Xi - \min Xi}{\max Xi - \min Xi} \quad (1)$$

$$Vi' = \frac{\max Xi - Xi}{\max Xi - \min Xi} \quad (2)$$

RESULTS AND DISCUSSION

Household Characteristics

According to the descriptive analysis of data on household characteristics (Figure 2), this study revealed that female participants (72%) make up the majority in the *Kampung Hijau* program, with the majority of them being housewives (67%) than household leader (29%) and dependent (4%). The other result is the male participants (28%) are dominated by retired employee. This is strongly tied to the fact that housewives have more time at home to take care of their home garden than their children and working husbands, who must attend school and work to support their families. In addition, women's associations are an active and significant community group when it comes to local concerns like neighbourhood activities and residential environmental management. This is one of the characteristics of Indonesian urban *kampungs* in general.

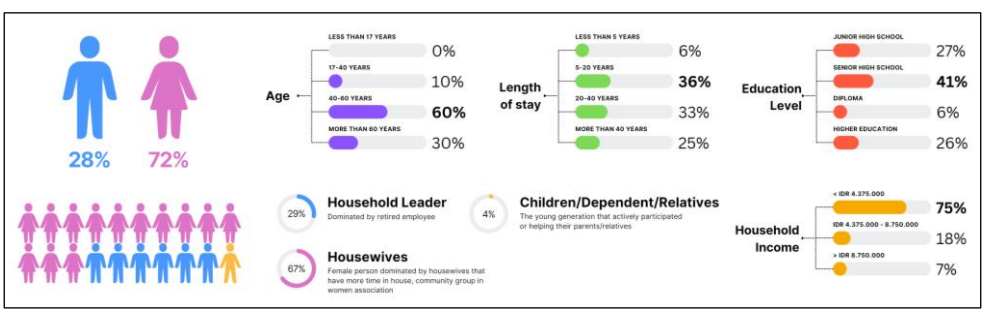

Figure 1. Household Characteristics of *Kampung Hijau* Program Respondents

Most of the participants were aged 40–60 years old (60%) or more than 60 years old (30%). The participants of *Kampung Hijau* program are dominated by post-productive age as the main activity after retirement to keep them active and healthy. The education level result is up to senior high school (41%) and they belonged to the low-middle income community class. This result is derived from the data that 75% of the participants have income under Rp 4.375.000 as the regional minimum wage in Surabaya city on year 2022. This is in line with data regarding low-income communities in the city of Surabaya in 2022, which reached 38% of total households, and most of them live in the urban village area. Then most of the participants were Javanese (83%), the majority ethnic group in Surabaya, and had lived there for between 5 and 20 years (36%). These findings indicate that participants in the program reside in stable communities and share a common cultural background, which fosters resident participation.

The results of this study indicate that the *Kampung Hijau* program has a strong alignment with its main target group, namely low-income households in urban residential areas, especially middle-aged to elderly women who are mostly housewives. This reflects the relevance of the program to the socio-economic and cultural context in Surabaya. However, the level of participation from the younger generation and non-Javanese groups is still quite

low. This symptom indicates a gap in the inclusiveness of certain community groups and cross-generational involvement. This will have an impact on the sustainability of the program in the future (Ceptureanu et al., 2018). To address these challenges, it is recommended to develop targeted strategies, such as introducing youth-oriented activities, establishing intergenerational mentoring programs, and increasing outreach efforts to engage marginalized groups (Partanen et al., 2023; Thomas, 2019; Yarker & Buffel, 2022). In addition, the integration of income-generating components, such as urban farming or recycling projects, can empower participants economically and increase participation in the program. Tailored training and workshops for housewives and retirees can also increase their capacity and commitment, thereby ensuring the program's continued success and broader impact on the community (Baba et al., 2017).

Engagement Level

Community engagement in physical activities was notably high, while non-physical activities fell within the normal category, as figured in Table 4. The physical activity consists of plant nursery, planting, plant embroidery, fertilization, irrigation, weeding, harvesting, community meetings, counselling, and activity level. From the Figure 2, the result shows that most of the *kampungs* have the average score in range of 69-84%, and categorized as high engagement score, only *kampung* Genteng Candirejo that have average score 65,09% which categorized as normal engagement score.

Table 4. Engagement Score Category

Kampung	Physical Activity		Non-Physical Activity	
	Mean	Category	Mean	Category
Genteng Candirejo	65.09	Normal	49.09	Low
Lawas Maspati	71.95	High	64.25	Normal
Herbal Nginden	71.65	High	63.58	Normal
Jemurwonosari	74.05	High	64.33	Normal
Jambangan	72.90	High	68.33	Normal

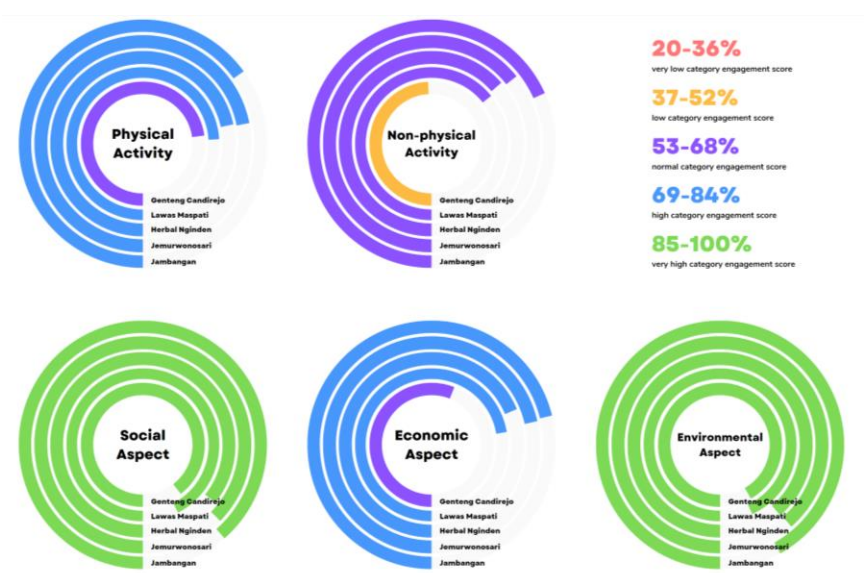

Figure 2. Engagement Level and Benefit Level of *Kampung Hijau* Program in Each *Kampung*

The similar trend also resulted on non-physical activity that consists of capital and material support, program determination, criticism, and advice, inviting other community members, and agricultural knowledge sharing. Most of the *kampungs* have the average score in range of 53-68% and categorized as normal engagement score and only *kampung* Genteng Candirejo have average score 49,09% which categorized as low category. This occurs because, as part of the development of the *Kampung Hijau* program, the majority of the green spaces in the home garden of *kampung* Genteng Candirejo residents are already quite full of plants. They now concentrate on a program for maintaining and preserving the plants in their home garden rather than expanding the green space in their *kampung*. The urban greening initiatives demonstrated very high benefits in the social and environmental aspects and high benefits in the economic aspect. These included improved nutrition, health, community solidarity, increased food supply, and enhanced environmental aesthetics.

The results of the study indicate that the *Kampung Hijau* program has succeeded in encouraging high level involvement in physical activities related to urban greening, such as planting, seeding, fertilizing, watering, weeding, and harvesting. These findings demonstrate that the community is dedicated to urban greening initiative (Hughes et al., 2023). However, the low involvement in non-physical activities, such as capital and material support, program determination, offering critiques and recommendations, and disseminating agricultural knowledge, particularly in *Kampung* Genteng Candirejo, illustrates the transition of the initiatives emphasis from increasing the quantity of green space to efforts to improve management due to the current optimal condition of green space. This trend highlights the need for a more adaptive program according to the development stage of each *kampung*, emphasizing strengthening community capacity through joint decision-making, collaboration between residents, and increasing awareness of the importance of participation in non-physical aspects. The very high social and environmental benefits of this program, such as increased community solidarity, food availability, and environmental aesthetics, show its positive impact on the quality of life of urban communities (Jasrotia et al., 2024; Hartini et al., 2017; Teimouri et al., 2023; Surya et al., 2020; Alwi, 2016).

However, the high category of economic benefits indicates further development opportunities to support community welfare through sustainable initiatives. Therefore, it is recommended that the program encourage non-physical involvement by providing interesting workshops, incentives for active participation, and community-based initiatives, such as ecotourism programs or farmer markets held in several representative *Kampung Hijau* in Surabaya (Sasongko et al., 2024; Mariyono, 2019). In addition, special programs should be designed for villages with established green spaces, such as training in plant maintenance, environmental management innovation, or technical assistance. With this strategy, the *Kampung Hijau* program can strengthen cross-aspect engagement, support program sustainability, and ensure equitable benefits for all villages involved.

Implication on Urban Sustainability

Figure 3 depicts the sustainable performance of the *Kampung Hijau* program in Surabaya based on a study of the implications for urban sustainability. For the first sustainable pillar about environmental resilience and resource efficiency perspective, the average value of the performance resulted in 33.1% for land reclamation and repurposing, 33.9% for soil conservation, 37.7% for soil amendment, and 21.8% for water management. The data for the

land repurposing indicator (A1) came from the replies from the former uses of the site before the area was turned to become a green space. The answer is most of participants converting the idle land, as stated by 103 of the 193 respondents. The remaining 53 respondents used the pavement areas, and the remaining 37 respondents used the existing home garden in front of their houses. This result is in line with the actual situation in Surabaya that in densely populated areas there are limited spaces that can be utilized as green spaces so the residents repurposing idle land by getting permission from local authority and following appropriate procedures from the government.

Then the data for the soil conservation indicator (A2) came from the responses related the adoption of organic farming method such as crop rotation aimed at soil conservation. The answer from 71 respondents that never changing their crops after the harvest, 69 respondents changing the crops more than three months, while the other responses are 31 respondents changing the crops every two or three months and remaining 22 respondents are changing the types of crops after harvest in every month. From this data and the result from the interview, most gardeners are not changing the plant types aiming to conserve the soil fertility because most of the plants are ornamental plants. To maintain soil fertility, they only use fertilizers. The data for the soil amendment indicator (A3) came from the responses related to the type of fertilizers used by the residents. Most of the respondents are using environmentally friendly fertilizer including organic fertilizer, compost derived from household waste, and animal manure. However, still there are 4 respondents are using non-organic fertilizer, and 9 respondents are using chemicals fertilizer. From this result it can be inferred that most of the participants are understood to use more organic fertilizer rather than chemicals because it is safer for the environment. The data for the water management indicator (A4) came from the responses related to main water sources for the home garden. Most of the respondents are using groundwater and local grid water to fulfil the irrigation needs for the plants in their home garden. Besides groundwater and grid water, the residents also utilizing the recycled water that available from the grey water recycling system installed in their *kampung*.

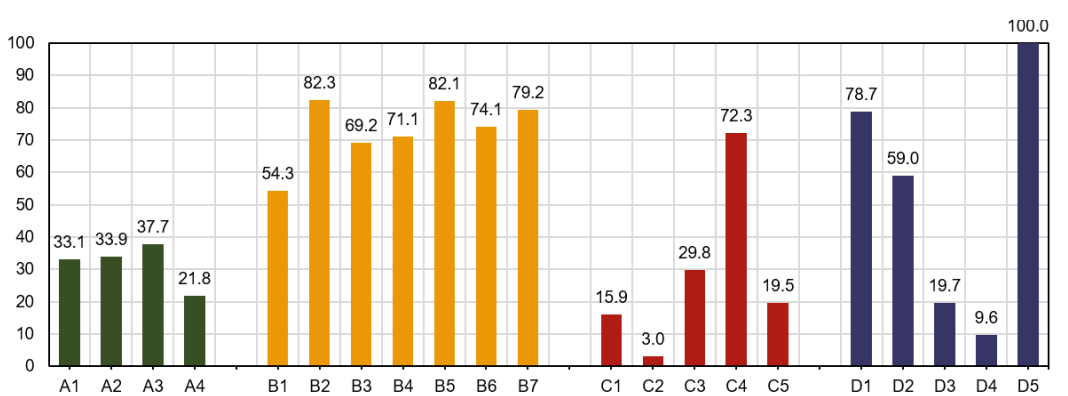

Figure 3. Sustainability Performance of *Kampung Hijau* Program in Surabaya

For the second sustainable pillar about the social inclusion perspective, the average value of the performance resulted in 54.3% for participation, 82.3% for community spirit, 69.2% for interaction, 71.1% for a new relationship, 82.1% for connection to culture, 74.1% for connection to nature, and 79.2% for environmental stewardship. The data for the participation indicator (B1) came from the responses related to the overall time spent in the home garden or community garden that could be depicted from the number and duration of the visits.

Mostly the residents are coming to the garden more than three times per week. Then from the answer, it is found that there are 46 residents doing activities in garden for less than 1 hour, 111 residents are doing about 1-2 hours, then 24 respondents are doing about 2-4 hours, while 12 respondents answer more than 4 hours. The varying activity durations are due to the different types of activities and passions of each resident. Besides that, the type of plants, the number of plants, and the stage of development of the plants planted in each garden also affect these conditions. Most of the activities that are usually carried out when coming to the garden are daily plant maintenance activities such as watering and weeding. Some *kampung* also often hold regular events so that community members can come at least once a week. Then the data for the social spirit indicator (B2) came from the responses related to the sense of community spirit that affect the resident behaviour. Mostly the respondents are considering that their neighbourhood are good place to live with the good sense of community spirit among the residents who live there. From the interview mostly the community members are answered that this feeling comes from the residents who often to helps each other. Then the data for the interaction indicator (B3) came from the responses related to the reported interaction of any kind among the members of community. Mostly the community members are very often talk each other regarding to the issues relating to the maintenance and management of the garden. This communication has existed since they participated to work together in their neighbourhood to succeed the program. With this interaction they also share their farming knowledge each other so they can garden properly and correctly to produce an optimal harvest. Then they also always share and enjoy the harvest from the home garden together. Apart from that, with residents who often spend time together during the activities, they also talk about other aspects of life such as family, health, and the education of their children. Then the data for the new relationship indicator (B4) came from the responses related to the evidence of new relationships developed through participation in the program. From the answer of the interview, mostly the respondents are made new friends through their involvement in the program. This situation is supported by events held annually by Surabaya city government to maintain and develop the networks between community members from across Surabaya. With the support of this network, people can get to know one another and assist one another, particularly regarding issues that arise in their own *kampung* or home garden.

Then data for the connection to culture indicator (B5) came from the responses related to cultural and religious expression that supported by the program. Mostly the respondents answer that the participation in community gardening activities is very important. From the interview, they could get many benefits from their participation in the program. After the COVID 19 pandemic, residents realized that it was important for them to be able to grow their own food. Besides that, from their participation in the program, they could get many friends and relations not only from their neighbourhood but also from another area in Surabaya and even from other cities. Then data for the connection to nature indicator (B6) came from the responses regarding the existence of the *Kampung Hijau* that support human-nature relationship impacted to the happiness of the residents. Mostly the residents answer that currently they happy with the existence of the green spaces around their neighbourhood. They feel happy to work together and they said that this kind of activity could affect their physical and psychological health positively. Then data for the environmental stewardship indicator (B7) came from the responses related to the environmental stewardship from the residents that promoted by the existence of the *Kampung Hijau* program. Mostly the community garden members are agreeing that their neighbourhood is improved by the program, and they feel proud with their *kampung*. Annually, Surabaya City government also holds awards to give an

appreciation to *kampungs* that can meet the assessment criteria as successful *Kampung Hijau*. This event is one of the ways from government to recognize excellence in greening efforts by residents. This event is expected to provide enthusiasm and stimulation to residents to always maintain and even innovate further to develop *Kampung Hijau* in their neighbourhood. Besides that, this event is aimed to encourage people to improve their home gardens while continuing to enjoy gardening as a fun and healthy activity.

Then, for the third sustainability pillar about food security and income generation perspective, the average value of the performance resulted in 15.9% for the stability of the production of food, 3.0% for the accessibility of the production of food, 29.8% for preparedness for food sovereignty, 72.3% for the financial resilience of households, and 19.5% for the financial resilience of the urban agriculture initiative. The data for the production of food stability indicator (C1) came from the responses for the predictability in the vegetables production from the home garden. Most of the respondents are response that they could not predict the vegetable harvest. Then for the production of food accessibility indicator (C2) came from the responses for the accessibility or household consumption to the vegetables that harvested from the garden. Most respondents stated that they only obtain a portion of their needs from the garden. They continue to primarily purchase the vegetables from the market to meet their needs for food. The reason behind the results of C1 and C2 indicator is because the residents mostly are not really concern about the total amount of the harvest from the home garden. They place more emphasis on gardening activities and the enjoyment they derive from taking part in the *Kampung Hijau* program. The data for the preparedness for food sovereignty indicator (C3) came from the replies related to the participation of the residents in the formal and informal agriculture education schemes to gain knowledge for vegetable production practices. From the interview, the residents could gain gardening knowledge from various resources. Mostly they carry out self-learning based on available resources such as social media and YouTube. Moreover, they could learn from each other among the residents from their *kampung* that will be voluntary to share their gardening knowledge. The data for the financial resilience of household's indicator (C4) came from the responses regarding the total amount spent by the participants for garden activities. Based on the interview, 21 respondents did not spend money for the gardening activities, 91 respondents spend less than Rp 200.000 annually, 72 respondents spend between Rp 200.000 to Rp 1.000.000, 5 respondents spend Rp 1.000.000 to Rp 2.000.000, 1 respondent spends Rp 2.000.000 to Rp 4.000.000, and there are 3 respondents that spend more than Rp 4.000.000 per year. Mostly, they spend the funds to purchase garden maintenance materials such as fertilizer, seed packs, seedlings, or new plants. They are willing to spend some funding because they also benefit from their activities in the garden. The data for the financial resilience of the urban agriculture initiatives indicator (C5) came from the responses related the income generated from the home garden. Most of the respondents are answer that they did not get any income from the home garden. According to the interviews, they received intangible advantages like happiness with their neighbours and health because they perceive the program as social and exercise activities.

For the last sustainability pillar about sustainable urban design perspective, the average value of performance resulted in 78.7% for perceived private utility, 59.0% for perceived public utility, 19.7% for land access and tenure, 9.8% for civil steering, and 100.0% for accessibility. The data for the private utility indicator (D1) came from the responses related to the garden allocation from privately owned available spaces. From the results, in average

more than 78% of the home garden are planted by various types of plants by the residents. The data for the public utility indicator (D2) came from the responses related to the type of land as a location for the community garden. Mostly the answer from respondents is the type of the land that used as green spaces is the transitional spaces between the private and public land. Apart from that, the existence of a green spaces can also improve the beauty of the environment around the residential area. The data for the land access and tenure indicator (D3) came from the responses related to the secure access to the land of the green spaces granted to the residents via formal documents released by the authorities. Most of the answer from respondents that the land is public with no formal agreement. The local authorities give permission to the community as long as it is used for the success of the *Kampung Hijau* program. The data for the civil steering indicator (D4) came from the responses related to the type of role of civil society organizations in driving *Kampung Hijau* initiatives. Mostly, the answer from the respondents is they do not have partnerships with both public and private stakeholders. In implementing the *Kampung Hijau* program, the community relies on their own resources without any help from outside parties. Public stakeholders such as the Surabaya city government only provide support when their *kampung* is included in the winning category. The data for the garden accessibility indicator (D5) came from the responses related to transportation and travel time to reach the garden. All the respondents said that they can reach the green spaces by walking, with the time spent being less than 10 minutes. These results are in line with the fact that, as mentioned before, most of the green spaces are home garden or community garden that located in their neighbourhood, so it is easy to reach by residents. Based on these results, it can be inferred that the *Kampung Hijau* program shows high performance implications, especially in the social pillar. This is related to the fact that *kampung* inhabitants view this program as a community-based program aimed at the benefit of the residents themselves. The analysis also reveals that the implemented programs still have low average ratings on the economic and environmental pillars. This can serve as a reference for all stakeholders involved, particularly the government as the program organizer for program improvement, which will be held continuously in the following years. The program that will be held can take more consideration and focus on improvements to environmental and economic pillars.

Integrated Synthesis of Community Dynamics and Urban Sustainability

The first subsection (household characteristics) establishes the demographic and socio-economic foundations of the *Kampung Hijau* program, revealing that the initiative is largely driven by women, particularly housewives, and by a significant proportion of elderly or post-productive residents. The stability of these subgroups and shared cultural backgrounds fosters a strong sense of community and participation in the community. The second subsection (engagement level) provides insight into how residents actively participate in physical activities (e.g., planting, weeding, and harvesting) and non-physical activities (such as decision-making, financial support, and knowledge sharing). While physical engagement is high in most villages, non-physical participation tends to be moderate, with notable exceptions such as *Kampung* Genteng Candirejo, where a focus on maintenance rather than expansion has resulted in lower engagement scores. The third subsection (implications for urban sustainability) evaluates the impact of the program by assessing performance on environmental resilience, social inclusion, economic stability, and sustainable urban design. Based on the findings of this study, it shows that the high scores are in the social and design aspects, while the assessment results in the economic and environmental aspects are still

relatively underdeveloped, indicating that there are potential areas that need to be improved. In general, the relationship between these three subsections forms a continuous cycle where demographic characteristics and a stable community base (first subsection) directly influence the level and nature of engagement (second subsection), which in turn drives sustainability outcomes (third subsection). High physical engagement reinforces tangible community benefits, such as improved environmental aesthetics and social cohesion, while moderate non-physical engagement indicates that the strategic and financial aspects of the program are not fully optimized. These sustainability outcomes then play a role in influencing future community engagement; strong social and design impacts can motivate further participation, but deficiencies in the economic and environmental pillars have the potential to dampen long-term enthusiasm. The key finding is that a balanced and mutually reinforcing cycle where each element supports and reinforces the others, become the key to the success and sustainability of the *Kampung Hijau* program as a whole.

To reinforce the cycle, it is critical to implement targeted recommendations addressing the identified deficiencies. Increasing non-physical engagement through structured capacity-enhancement initiatives such as leadership development, regular community forums/meetings, and specialized training can amplify involvement from the community members in decision-making and financial planning, favourably influencing economic and ecological performance. Additionally, strengthening partnerships with local governments, private sector stakeholders, and academic institutions will provide the support and resources needed to formalize the state of the space used in the program and incentivize sustainable practices. By integrating these steps with participatory governance models and effective communication strategies, the program can strengthen the cycle of community engagement, increase participation, and improve sustainability outcomes, ensuring long-term resilience and success of the *Kampung Hijau* Program.

CONCLUSION

The *Kampung Hijau* program constitutes one of the strategies that can be implemented as a measure to achieve urban sustainability within the city of Surabaya. However, the stability of execution in the long term is significantly dependent upon cooperative collaboration from diverse stakeholders, the presence of incentives that possess economic value, and support from strategic policies of the city government. The stability of the program can be attained if a variety of stakeholders are actively engaged with the community in the program execution. These stakeholders include city government, the private sector, non-governmental organizations, and also academic institutions. This engagement may manifest in forms of support such as guidance and monitoring, knowledge dissemination from specialists, or financial funding for the sustainability of the program. The integration of the initiative with micro-enterprises by leveraging the resources accessible within each *kampung* can support the program in financial sustainability. This can stimulate the long-term involvement of the community as the principal agent in the execution of the *Kampung Hijau* program, given that the program is relatively economically viable. In addition, strategic policy support from the government such as granting formal status, providing technical assistance, and awards for villages that successfully implement this program well is also very important for the stability

of the program. These three components together form a comprehensive framework that aims to address the sustainability of the program in the social and economic dimensions.

A combination of increasing public awareness, economic incentive strategies to encourage active participation, and increasing technical and regulatory support from authorities are needed to enhance the program to be more substantial. To foster a sense of ownership and responsibility for the program, community empowerment can be achieved by implementing a participatory governance framework. To give the motivation to the community to participate in the program in the long term, a reward-based system and structured financial incentives can be implemented. In addition, program promotion through social media can also increase visibility, attract external support, and have the potential to encourage participation from wider community groups. By integrating these actions strategically and systematically, the *Kampung Hijau* program in Surabaya can be develop into a resilient model to achieve urban sustainability and serve as a pilot model for other similar types of programs both in Indonesia and beyond.

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THE EFFECT OF THE EXISTENCE OF SUSTAINABLE GREEN OPEN SPACE ON THE COMMUNITY'S ECONOMY IN BIG CITIES

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Abstract
Urbanization in Indonesia is characterized by high population density in big cities. So far, urban areas in Indonesia tend to experience typical problems due to urbanization, namely, the use of green open space functions still seems to have a complementary meaning for urban areas, so that land use for green open space is considered as an addition to environmental aesthetics. Errors in mindset often arise regarding public open spaces which are considered a reserve for future land use, resulting in the emergence of a paradigm that, at any time, green open spaces could be replaced with other uses that are felt to be more profitable economically. This study aims to examine the variables related to green open spaces and determine their influence on the economic conditions of the community. This study uses a quantitative method called multivariable linear regression. Data collection used an online questionnaire, focusing on people who had visited green open spaces in five big cities, namely Jakarta, Bandung, Yogyakarta, Semarang, and Surabaya. The results of the multivariable linear regression analysis indicated that the existence of a quality green open space for an area is considered economically profitable, both direct and indirect.

Keywords: *Multivariate regression; green open space; sustainability; economic aspects*

INTRODUCTION

Currently, more than half of the global population lives in urban areas because of the advantages and opportunities to obtain jobs, and better facilities (Amegnaglo, 2018; Brockerhoff & Nations, 1998; Sodri & Garniwa, 2016). In Indonesia alone, by 2025, 60% of the population is predicted to live in urban areas. Urbanization in Indonesia is characterized by high population density in big cities, especially on the island of Java. The pattern of urbanization is also accompanied by inter-city disparities between big cities and small towns (Rustiadi et al., 2021).

Urbanization causes the unplanned and uncontrolled expansion of cities, which results in the continuous displacement of open spaces, vegetation, and water bodies (Kumari et al., 2019), thereby affecting the city microclimate (Meshram et al., n.d.). So far, urban areas in Indonesia tend to experience typical problems, namely, the utilization of green open space functions still seems to have a complementary meaning for urban areas, so land use for green open space is considered as an addition to environmental aesthetics. Even worse, there are many misconceptions regarding public open spaces that are considered reserves for future

land use (*Problematika Pembangunan Ruang Terbuka Hijau | Dinas Lingkungan Hidup Dan Kehutanan DIY*, n.d.). This has resulted in the emergence of a paradigm wherein green open spaces are perceived as replaceable with other uses deemed more economically profitable.

According to experts, green open spaces yield positive effects on the economy of urban communities. Among them is the image of green open space. This open space image supports the success of city branding by considering the position of green open spaces on regional, national, and international scales (Bruni & Porta, 2016; Žlender & Gemin, 2020). To improve the quality and suitability of the green open space theme, the public needs to understand the theme of the green open space (Gertner & Kotler, 2004; Kotler Haider, Donald H., Rein, Irving J., 1993). The suitability of the theme of green open space that is trying to be formed with the reality of green open space that has to be made simply, not making it up and not being forced, makes visitors want to come back (Kotler, 2000, 2004). Unique green open spaces in the form of things that are not found in other green open spaces have visual symbols that are the main characteristics of green open spaces and are part of a cultural heritage. By developing an image that can adapt to the green open space theme that is trying to be promoted and able to communicate, it can strengthen the position of green open spaces to attract visitors (Carmona et al., 2003).

The next factor with a positive effect on the economy of urban communities is the management of green open space. The key to the success of green open space management is measured using the Key Performance Index regularly. The management of green open spaces aims to empower the community through community participation in managing green open spaces (Noguera & Riera, 2021; Rasoolimanesh et al., 2019). This participation has the goal of empowering residents and actively involving all stakeholders in decision-making throughout the design, planning, and maintenance of open spaces (Yoong et al., 2017). Government participation plays a crucial role in the management of green open space. With the participation of the government, accountability processes from local governments regarding procurement, publication, and dissemination of policies, plans, etc., can enhance inclusive policies from local governments (Cohen et al., 2019; Steiniger et al., 2020). The delivery of information that is effective, clear, targeted, and delivered in the most effective manner could enable horizontal channels of communication between the key actors of the urban planning process ("Planning and Design Strategies for Sustainable Urban Development," 2015; Serdar, 2019; Vollmer et al., 2018). The utilization of the private sector is also a crucial part of the management of green open spaces. With the participation of the private sector in the management of green open spaces, a bottom-linked approach will be established to foster the collaboration between government and stakeholders/ private sectors (Rasoolimanesh et al., 2019; Vollmer et al., 2018). In addition, there is collaboration between the two regarding development funding and the management of green open spaces (Victoria, 2017).

The next factor that positively affects the economy of urban communities is informal activity. The informal sector also creates jobs for people who need them, so it is necessary to maintain the quality of informal activities in green open spaces. Among them are providing locations for the development of the informal business sector and street vendors in areas with limitations in terms of both area and time and maintaining the quality of goods and services from informal activities with regular checks (Geppert & Colini, 2015).

Many studies have mentioned aspects of green open spaces that have an economic impact on society, either directly or indirectly. However, no research has discussed how significant this influence is on the community's economy. This study aims to examine the variables associated with green open spaces such as: appropriate green open space design with the city's slogan, clarity of public open space theme/design concept, unique public open space, government's active role in maintaining or improving the quality of green open space, the active role of the community in maintaining or improving the quality of green open space, public open space is fairly well maintained, orderliness in informal activities in public open space, and knowing how much influence these variables have on community economic conditions. Data were collected using an online questionnaire. The distribution of the questionnaire focused on people who had visited green open spaces in five big cities on Java Island with different typologies: Jakarta, Bandung, Yogyakarta, Semarang, and Surabaya. Primary data were collected through public perceptions. The results can be presented to decision makers, planners, and other professionals related to area design for further action or corporate into development plans, as well as to evaluate existing areas.

RESEARCH METHODS

This study was conducted from October 2020 to October 2022. This research was conducted in five major cities on the island of Java: Jakarta, Bandung, Semarang, Yogyakarta, and Surabaya. This study uses the quantitative multivariate regression method, which is a method used to test certain theories by examining the causal relationships between variables (Creswell, 2016). Multivariable linear regression analysis is a method used to measure the causal effect between one variable and another and aims to determine the form of a cause-and-effect relationship between variables from known data, where there is more than one causal variable (Yarnold & Grimm, 2017).

Data were obtained from the results of a questionnaire survey distributed online to the public. The questions in the questionnaire use closed questions to collect public opinion regarding the positive influence of the existence of green open space on the community's economy. The questionnaire results were completed by 371 respondents, with an age range of 17-69 years. From this age range, it is expected to be able to provide various answers and be able to provide more objective answers to the positive impact of the existence of green open spaces on the economy of urban communities represented by the cities of Jakarta, Bandung, Yogyakarta, Semarang, and Surabaya. The respondents' backgrounds were predominantly composed of students and employees who regularly visited public open spaces.

The data collected were analysed using Analysis of Variance (ANOVA). ANOVA is a statistical technique for analysing variations in response variables (continuous random variables) measured under conditions determined by discrete factors (classified variables, often with nominal levels) (Larson, 2008). At this stage, the ANOVA aims to determine the significant effect between the variables.

The next step was to perform a regression analysis. Regression analysis describes the relationship between the dependent and independent variables about how the dependent variable changes when one or more independent variables change due to factors (Schneider et al., 2010). In many cases, the contribution of one independent variable alone is inadequate to explain the dependent variable Y. If so, multivariable linear regression can be performed

to study the effect of several variables on the dependent variable. In the multivariable regression model, the dependent variable is described as a linear function of the independent variable Xi, as follows:

$$Y = a + b1 \times X1 + b2 \times X2 + \ldots + bn \times Xn \text{ (Schneider et al., 2010)}$$

The main purpose of this analysis was to determine the relationship between dependent and independent variables. Several independent variables were selected to help predict the dependent variable. In addition, it helps validate whether the predictor variable is good enough to predict dependent variables. Where Y represents the positive effect of the existence of green open space on the community's economy. The Y is the dependent variable; X1: Appropriate green open space design with the city's slogan; X2: Clarity of public open space theme/design concept; X3: Unique public open space; X4: Government's active role in maintaining/improving the quality of green open space; X5: The active role of the community in maintaining/improving the quality of green open space; X6: public open space is fairly well maintained; X7: Orderliness in informal activities in public open space. X1, X2, X3, X4, X5, X6, and X7 are the independent variables. The purpose of the statistical analysis is to determine which factors influence the dependent variable. The art of statistical evaluation lies in identifying the variable that best explains the dependent variable.

RESULT AND DISCUSSION

In the questionnaire, respondents were asked to decide whether they agreed, disagreed, or abstained from some statements. These statements represent the parameters that were analysed using multivariable linear regression. Statements responded to 'agree' by each respondent were worth 5 (five), statements responded to 'disagree' by each respondent were worth 0 (zero), statements responded to 'abstain' by each respondent were worth 1 (one). The following is a summary of the output of the regression statistics.

Table 1. Summary Output

Regression Statistics	
Multiple R	0,24657
R Square	0,060797
Adjusted R Square	0,042685
Standard Error	1,991749
Observations	371

From the display shown in Table 1, ‘Multiple R’ is the correlation value between the positive effect of the existence of green open space on the community's economy and other parameters, falling within the low category. The ‘R squared’ is a number that ranges from 0 to 1, which indicates the magnitude of the combination of independent variables that together affect the value of the dependent variable. R squared adjusted calculates each additional variable and estimates the R squared value of the additional variable. If the addition of the new pattern improves the regression results model better than the estimate, the addition of these variables will increase the adjusted R-squared value. 'observations' is the number of respondents.

The collected data were initially analysed using ANOVA. At this stage, the ANOVA aims to determine the significant effect between the positive effect of the existence of green open space on the community's economy and other parameters. The following is a table of ANOVA results.

Table 2. ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	7	93,2173	13,31676	3,356829	0,001757
Residual	363	1440,044	3,967064		
Total	370	1533,261			

From the display in Table 2, 'df' is the degree of freedom. 'SS' is the sum of squares. 'MS' is the mean squares. 'F' is ANOVA coefficient. Based on the results of the ANOVA analysis, the 'significance value of F' is 0,001757 (<alpha=0.05). It can be concluded that there is a significant influence between the positive effect of the existence of green open space on the community's economy and other parameters.

Once it is known that there is a significant influence between the positive effect of the existence of green open spaces on the community's economy and other parameters, the next step is to perform a multivariable linear regression analysis. The following table shows the results of the multivariate linear regression analysis.

Table 3. Multivariable Linear Regression

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 95,0%	Upper 95,0%
Y	1,828496	0,398613	4,587151	6,2E-06	1,044616	2,612376	1,044616	2,612376
X1	0,0501	0,054484	0,919519	0,358435	-0,05705	0,157244	-0,05705	0,157244
X2	0,091863	0,054032	1,700163	0,089957	-0,01439	0,198118	-0,01439	0,198118
X3	0,050713	0,057352	0,884253	0,377145	-0,06207	0,163496	-0,06207	0,163496
X4	0,108366	0,06494	1,668711	0,096037	-0,01934	0,236073	-0,01934	0,236073
X5	0,095708	0,054323	1,761821	0,078941	-0,01112	0,202536	-0,01112	0,202536
X6	0,029117	0,070304	0,414159	0,679003	-0,10914	0,167371	-0,10914	0,167371
X7	0,011667	0,053777	0,216947	0,828372	-0,09409	0,117421	-0,09409	0,117421

The multivariable linear regression in Table 3 can be formulated into a multivariable linear regression equation as follows:

$$Y = 1{,}83 + 0{,}05\ X1 + 0{,}09\ X2 + 0{,}05\ X3 + 0{,}11\ X4 + 0{,}1\ X5 + 0{,}03\ X6 + 0{,}01\ X7$$

Based on the equation above, if the value of the variable X1 to X7 is 0, then the magnitude of the Y value (the positive influence of the existence of green open space on the community's economy) is 1.83. Every time X1 (appropriate green open space design with the city's slogan) variable increases by 1%, the positive influence of the existence of green open space on the community's economy will increase by 0.05 (by 5%) or vice versa. Every time the X2 (clarity of public open space theme/design concept) variable increases by 1%, the positive influence of the existence of green open space on the community's economy will increase by 0.09 (by 9%) or vice versa. Every time there is an increase in the X3 (unique public open space) variable by 1%, the positive influence of the existence of green open space on the community's economy will increase by 0.05 (by 5%) or vice versa. Every time there is an increase in the

X4 (government's active role in maintaining or improving the quality of green open space) variable by 1%, the positive influence of the presence of green open space on the community's economy will increase by 0.11 (by 11%) or vice versa. Every time there is an increase in the X5 (the active role of the community in maintaining or improving the quality of green open space) variable by 1%, the positive influence of the existence of green open space on the community's economy will increase by 0.1 (by 10%) or vice versa. Every time there is an increase in the X6 (public open space is fairly well maintained) variable by 1%, the positive influence of the presence of green open space on the community's economy will increase by 0.03 (by 3%) or vice versa. Every time there is an increase in the X7 (orderliness in informal activities in public open space) variable by 1%, the positive influence of the presence of green open space on the community's economy will increase by 0.01 (by 1%) or vice versa. From the equation above, it can be concluded that X1 (appropriate green open space design with the city's slogan), X2 (clarity of public open space theme/design concept), X3 (unique public open space), X4 (government's active role in maintaining/improving the quality of green open space), X5 (the active role of the community in maintaining/improving the quality of green open space), X6 (public open space is fairly well maintained), and X7 (orderliness in informal activities in public open space) have an effect on the Y value (the positive influence of the existence of green open space on the community's economy).

CONCLUSION

The existence of green open spaces plays a crucial role in the community. This research examines the influence of green open spaces on the community's economy. This study was divided into 2 (two) main stages: analysis using ANOVA which aims to determine the significant effect between variables, followed by multivariable linear regression analysis which aims to determine the relationship between the dependent and independent variables. Based on the results of the research and discussion of multiple linear regression analysis, it can be concluded that aspects such as the suitability of green open space designs with city slogans, the clarity of the green open space design theme or concept, the uniqueness of green open space, the government's active role in maintaining or improving the quality of green open spaces, the active role of the community in maintaining or improving the quality of green open spaces, well maintained green open spaces, and orderly informal activities in green open spaces have a significant relationship with the positive influence of the existence of green open spaces on the community's economy. This can be seen from the results of the ANOVA, with a significance value of F = 0.01757. Therefore, the provision of green open spaces for an area is considered economically beneficial, with both direct and indirect benefits. Unfortunately, the regression equation with R = 0.06 is not a good regression equation. This equation can cause deviations when applied to real-world situations.

This multivariable linear regression analysis for a set of dependent and independent variables proves that the independent variable is not a good predictor of the dependent variable, because the value of the coefficient of determination can be neglected. In this case, it is necessary to search for other predictor variables to predict the dependent variable in the regression analysis. This study suggests that a regression equation can be developed by adding other variables originating from social and environmental aspects so that a more valid equation is obtained with a larger regression coefficient value.

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CONFLICT OF INTEREST

The authors declare no conflicts of interest. Funders had no role in the research design, collection, analysis, or interpretation of data; in the writing of the manuscript; and in the decision to publish the results.

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