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Development of Eco-Resilient Urban House Design for Sustainable City Living

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Abstract: *This study explored the principles and parameters of eco-resilient urban house design for sustainable city living in Surigao City, with emphasis on flood resilience and sustainability. Specifically, it developed and evaluated one-storey and two-storey eco-resilient urban house designs in terms of structural characteristics, architectural plans, and human comfort and health. A comparative-evaluative research design was employed. The respondents consisted of 90 stakeholders composed of residents, policy makers, environmental advocates, and urban planners. Data were analyzed using mean and standard deviation to determine the extent of perception, Kruskal–Wallis test to identify significant differences when grouped according to respondents' group, and Mann–Whitney U test to determine differences when grouped according to storey. Findings revealed that both proposed house designs were perceived very favorably and were generally rated as strongly agreeable and highly attainable. For both design options, noise reduction obtained the highest mean, while footing system received the lowest mean, although still positively evaluated. Significant differences were found in the perceptions of stakeholders when grouped according to respondents' group for both the one-storey and two-storey designs, indicating that perceptions varied across stakeholder sectors. However, no significant difference was found between the one-storey and two-storey designs when grouped according to storey. The study concluded that both designs are feasible and acceptable applications of eco-resilient housing principles and may serve as reference models for sustainable and flood-resilient housing development in Surigao City and similar urban communities. The identified parameters may also guide architects, engineers, planners, and local government units in future housing initiatives implementation.*

Keywords: eco-resilient urban house design, sustainable city living, flood resilience, structural characteristics, architectural plans, human comfort and health, stakeholder perception, Surigao City

I. INTRODUCTION

Rapid urban population growth has intensified housing demand, placing significant pressure on urban ecosystems and infrastructure, particularly in cities vulnerable to climate-related hazards such as flooding, extreme heat, and declining air quality. The United Nations (2018) reports that more than half of the global population now resides in urban areas, a proportion expected to increase further, thereby amplifying the impacts of urbanization. In the Philippines, coastal cities such as Surigao City face compounded risks due to seasonal monsoons, coastal exposure, and limitations in urban drainage systems, resulting in recurrent flooding and thermal discomfort in residential areas. These conditions highlight the urgent need for sustainable and climate-responsive housing solutions.

Eco-resilient housing has emerged as a key response to the intertwined challenges of urbanization and climate change. Ahern et al. (2014) define eco-resilient housing as design approaches that integrate flood resistance, energy efficiency, thermal comfort, and improved indoor air quality. However, inadequate urban planning and insufficient infrastructure continue to exacerbate flooding by increasing surface runoff and overburdening drainage systems (Zdunek-Wielgolaska & Grabowska, 2020). Consequently, contemporary sustainable housing design increasingly emphasizes adaptive strategies such as elevated floor levels, flood-resistant materials, and integrated water management systems to enhance long-term resilience.

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Recent studies further emphasize trends in sustainable urban housing that prioritize passive design strategies, nature-based solutions, and compact development. The urban heat island (UHI) effect—where impervious surfaces absorb and retain heat—poses a major challenge in dense urban environments by increasing ambient temperatures and energy demand for cooling. To mitigate this, modern housing designs incorporate green roofs, vegetated façades, and reflective materials that reduce heat accumulation through shading and evapotranspiration (Williams et al., 2022). Similarly, permeable pavements and rainwater infiltration systems are increasingly adopted to reduce surface runoff and improve drainage performance in flood-prone urban areas (Myint & Shafique, 2024). Beyond climate adaptation, sustainable housing trends also emphasize renewable energy integration, water conservation, and compact vertical development to reduce land consumption and carbon emissions (Zaidan, 2023).

Despite these advances, many eco-housing projects remain limited to conceptual models, isolated sustainability features, or single-building prototypes. This study differs by applying eco-resilient principles through two context-specific residential designs—a one-storey and a two-storey urban house—developed for flood-prone communities in Surigao City. The proposed designs translate sustainability concepts into concrete architectural and structural outputs, including floor plans, elevations, and material strategies, thereby moving beyond theory into practical design application.

The study further distinguishes itself through the integration of locally appropriate materials, such as bamboo–concrete composite wall systems, elevated structural bases, and climate-responsive architectural features, including large window openings, patios, and simple gable roofs. The one-storey design demonstrates how eco-resilient principles can be applied to compact and cost-efficient housing, while the two-storey design illustrates vertical adaptability as a strategy for addressing land scarcity and flood risk. This comparative design approach remains underexplored in existing eco-housing literature, particularly within the local context of Surigao City.

In addition, this study incorporates stakeholder perceptions to evaluate the performance and feasibility of the proposed designs, bridging the gap between technical design solutions and real-world applicability. By combining structural resilience, architectural planning, human comfort and health considerations, and stakeholder evaluation within a unified framework, the study offers a holistic and locally grounded contribution to eco-resilient urban housing research.

Anchored in global sustainability trends and local environmental conditions, this study examines the principles and parameters of eco-resilient urban house design for sustainable city living, with emphasis on flood resilience and overall sustainability. Building on the work of Nala (2021), the research focuses on key structural characteristics, architectural planning elements, and human comfort factors, while assessing stakeholder perceptions and comparing one-storey and two-storey housing options.

II. CONCEPTUAL FRAMEWORK

To improve urban housing, especially in flood-prone areas, this study focuses on the idea of Eco-Resilient Urban House Design for Sustainable City Living. The methodology is based on the ADDIE model (Kurt, 2017), which stands for Analysis, Design, Development, Implementation, and Evaluation. This study aims to design and develop an eco-resilient urban house by applying these phases while directly addressing the following critical variables: structural characteristics, architectural plans, and human comfort and health.

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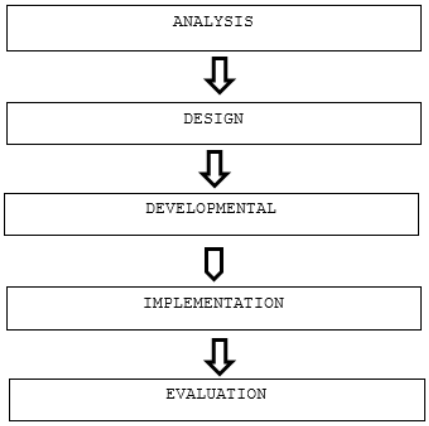

Figure 3: **The ADDIE Model Approach/Phases**

III. STATEMENT OF THE PROBLEM

This study explores the principles and parameters of eco-resilient urban house design for sustainable city living, with a particular focus on flood resilience and overall sustainability. Specifically, it seeks answers to the following questions:

1. What are the technical requirements of eco-resilient urban One and Two-Storey house designs for sustainable city living in Surigao City as to:

1.1. Architectural Plans; and

1.1.1. Maximization of Space

1.1.2. Aesthetic Value/Beauty

1.1.3. Characteristics that Define Modern Architecture

1.1.4. Cost Considerations

2, What is the perception of stakeholders on the performance and feasibility of eco-resilient urban house designs as to architectural plans?

IV. METHODS

Research Design

This study utilizes a descriptive developmental research design to explore and develop eco-resilient urban house designs for sustainable city living in Surigao City. The descriptive method will analyze current urban housing practices in Surigao City, focusing on structural characteristics (e.g., footing systems, floor heights, material requirements), architectural plans (e.g., space maximization, aesthetic value, modern architecture characteristics), and human comfort (e.g., indoor air quality, thermal comfort, noise reduction). Additionally, it will evaluate how stakeholders view the viability and efficacy of eco-resilient designs, such as those that address water management, energy efficiency, and flood resilience. Eco-resilient housing solutions will be designed, prototyped, and improved using the developmental method. Enhancing current housing and creating new designs that integrate water management, flood resilience, energy efficiency, and UHI mitigation will be the main goals of this phase. In addition to improving environmental sustainability and human comfort, it will guarantee that the designs are realistic, affordable, and suited to the needs of the people of Surigao City. Hence, this study aims to provide both a detailed understanding of the current housing landscape and actionable recommendations for future eco-resilient housing solutions in Surigao City.

Research Environment

The study will be conducted in Purok Matinabangon, Barangay Taft, Surigao City, Surigao del Norte, Mindanao, Philippines. This area was selected due to its geographical and urban characteristics, which reflect the broader

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environmental and development challenges faced by Surigao City. As a coastal and peninsula city composed of lowland, mountainous, and shoreline areas, Surigao City is particularly vulnerable to environmental issues such as flooding, increasing surface temperatures associated with urban heat island effects, and growing pressure on natural and urban resources.

Research Respondents

The respondents of this study will include residents, urban planners, developers, policymakers, and environmental organizations within Surigao City. The participants will be selected using purposive sampling, a non-random selection method that ensures that the sample represents specific characteristics required to achieve the research objectives. This method will ensure that the study gathers diverse perspectives on eco-resilient urban house designs and their feasibility in the city.

Research Instrument

A Research Made Evaluation Questionnaire (Appendix A) will be used in this study to collect opinions from stakeholders regarding eco-resilient urban home designs in Surigao City. Several important factors, such as architectural designs, human comfort and health, and structural features, will be the focus of the questionnaire. The questionnaire will evaluate opinions regarding the viability and efficacy of introducing eco-resilient housing designs in the city using five-item statements for each variable and a five-point Likert scale that goes from Strongly Agree to Disagree Strongly.

Data Analysis

The data collected in this study will be analyzed using the following statistical tools to evaluate stakeholder perceptions regarding eco-resilient urban house designs in Surigao City. These tools will help assess the performance, feasibility, and effectiveness of the design features.

Mean and Standard Deviation (SD). The mean and standard deviation will be used to measure the central tendency and variability of responses regarding structural characteristics such as footing system, floor height, enclosure below flood height level (FHL), material requirements, and utilities.

Ordinal Rank. Ordinal ranking will be employed to assess the relative importance of various architectural features, including maximization of space, aesthetic value, modern architecture characteristics, and cost considerations. Respondents will rank these features based on their perceived significance for sustainability and feasibility in Surigao City. This ranking will allow for prioritizing the most critical features for inclusion in future urban housing projects.

ANOVA (Analysis of Variance). ANOVA will be used to determine if there are significant differences in stakeholders' perceptions of eco-resilient urban house designs between one-storey and two-storey houses. This statistical test will assess how different respondent groups (e.g., residents, urban planners, policymakers) perceive the effectiveness of design features like flood resilience, space maximization, and thermal comfort based on the type of housing. ANOVA will help identify if design preferences vary significantly depending on the number of storeys in the housing design.

V. RESULTS AND DISCUSSIONS

TECHNICAL REQUIREMENTS OF ECO-RESILIENT URBAN HOUSE DESIGNS FOR SUSTAINABLE CITY LIVING IN SURIGAO CITY.

On the Architectural Plans as to Maximization of Space

One-Storey Maximization of Space. These sheets show spatial layout including living area, bedrooms, kitchen, and circulation space. The efficient use of interior space is demonstrated in A01 (Floor Plan) and A03 (Sections and Roof Plan). The floor plan illustrates the spatial arrangement of the living area, bedrooms, kitchen, and circulation spaces. The layout ensures that each room is functionally positioned to maximize accessibility and usability. Circulation pathways between spaces are clearly defined, allowing occupants to move comfortably within the house. Additionally,

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the sectional drawings provide insight into the vertical dimensions of the interior spaces, including ceiling heights and roof clearance. These design considerations contribute to an efficient and comfortable residential layout.

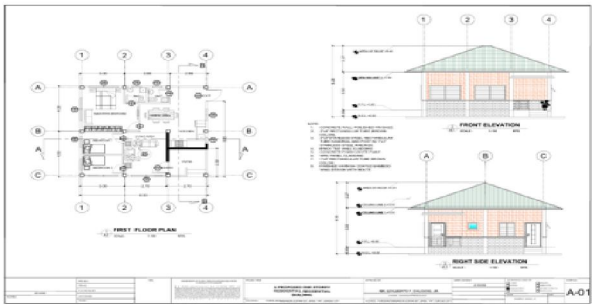

Figure 35. *One-Storey A01 – Floor Plan*

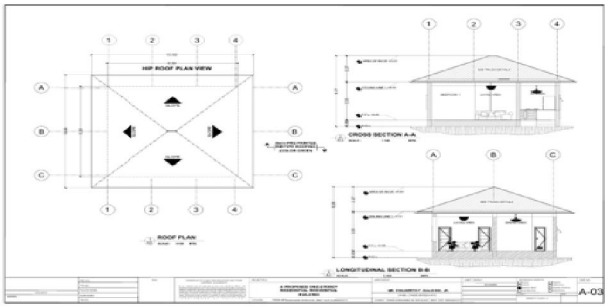

Figure 36. *One-Storey* **A03** – Sections and Roof Plan

Two-Storey Maximization of Space. These sheets show spatial layout including living area, bedrooms, kitchen, and circulation space. The efficient utilization of interior space in the two-storey residential building is illustrated in A05 (Ground Floor and Second Floor Plans).

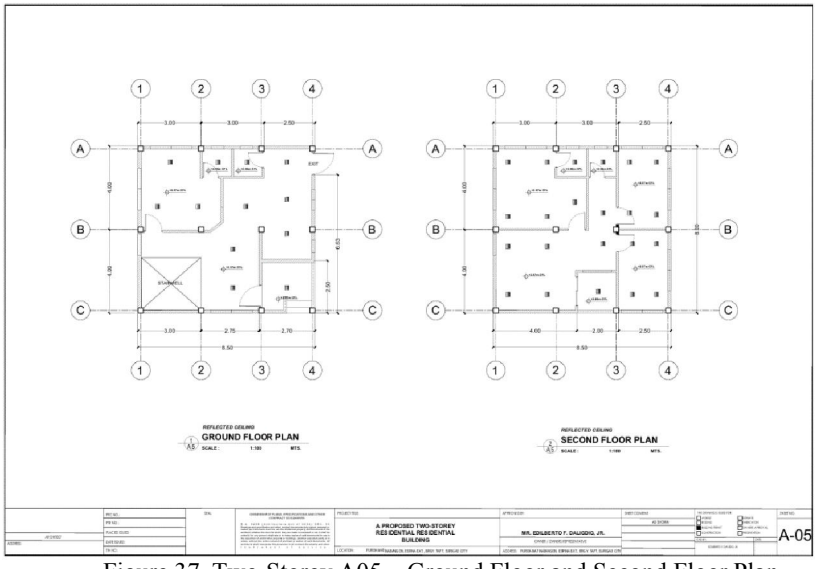

Figure 37. Two-Storey A05 – Ground Floor and Second Floor Plan

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These drawings present the spatial organization of various functional areas, including the living area, kitchen, bedrooms, and circulation spaces. The separation of living spaces across two floors allows for more efficient allocation of interior functions. The ground floor typically accommodates communal spaces such as the living room and kitchen, while private spaces such as bedrooms are located on the upper floor. This vertical organization maximizes the available floor area while maintaining functional separation between public and private zones within the house.

On the Architectural Plans as to Aesthetic Value/Beauty

One-Storey Aesthetic Value/Beauty. These architectural drawings demonstrate the overall visual design and façade treatment of the building. The aesthetic character of the proposed residential building is illustrated in A00 (Perspective View), A01 (Front and Side Elevations), and A02 (Exterior Elevations). These architectural drawings present the visual composition of the building façade, including the arrangement of windows, doors, and roof elements. The perspective view provides a three-dimensional representation of the house, highlighting the overall architectural style and exterior finishes. The elevations further emphasize the visual balance and proportion of the building. The combination of roof design, façade treatment, and exterior materials contributes to the aesthetic appeal of the structure while maintaining functional simplicity.

Figure 38. One-Storey – Perspective View

Two-Storey Aesthetic Value/Beauty. These architectural drawings demonstrate the overall visual design and façade treatment of the building. The visual design and façade treatment of the building are illustrated in A03 (Front Elevation) and A04 (Side and Rear Elevations). These architectural drawings depict the external appearance of the residential structure, including the arrangement of windows, balconies, and exterior wall finishes. The façade incorporates design elements such as brick tile cladding, wood plastic composite (WPC) panels, and stainless steel railings, which enhance the visual appeal of the building. The balanced proportions of windows and wall surfaces contribute to the aesthetic harmony of the façade. These architectural elements collectively create a modern and visually appealing residential structure.

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Figure 42. Two-Storey – Perspective View

On the Architectural Plans as to Characteristics that Define Modern Architecture

One-Storey Characteristics that Define Modern Architecture. These sheets include modern architectural elements such as aluminum windows, glass panels, and façade cladding.

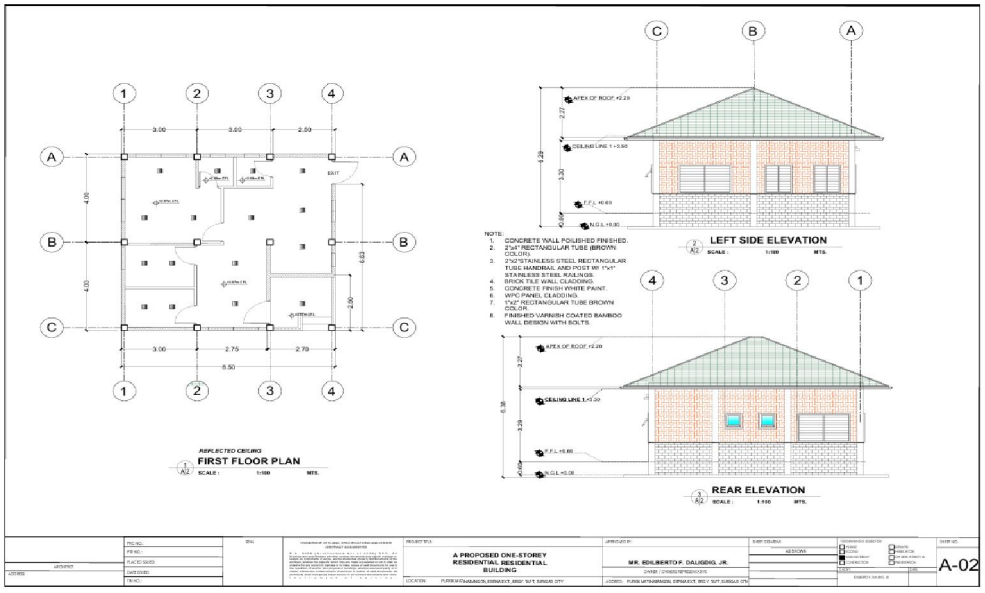

Figure 45. One-Storey A02 – Elevations and Exterior Finishes

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Modern architectural characteristics are evident in A02 (Elevations and Exterior Finishes) and A04 (Window and Door Schedule). The use of aluminum-framed windows, glass panels, and clean façade lines reflects contemporary architectural design principles. Large window openings allow natural light to enter interior spaces, enhancing visual comfort and energy efficiency. Additionally, the simple geometric forms and minimal ornamentation contribute to the modern aesthetic of the house. These architectural elements align with contemporary residential design trends that prioritize simplicity, functionality, and visual clarity.

Two-Storey Characteristics that Define Modern Architecture. These sheets include modern architectural elements such as aluminum windows, glass panels, and façade cladding. Modern architectural characteristics of the two-storey residential building are evident in A02 (Roof Plan), A03 (Elevations), and A04 (Elevations). These drawings highlight design features such as the hip roof configuration, large window openings, balcony structures, and clean geometric façade lines. The use of large windows enhances natural lighting and improves the visual connection between interior and exterior spaces. The simple yet elegant façade design reflects contemporary architectural principles that emphasize functionality, minimalism, and aesthetic clarity.

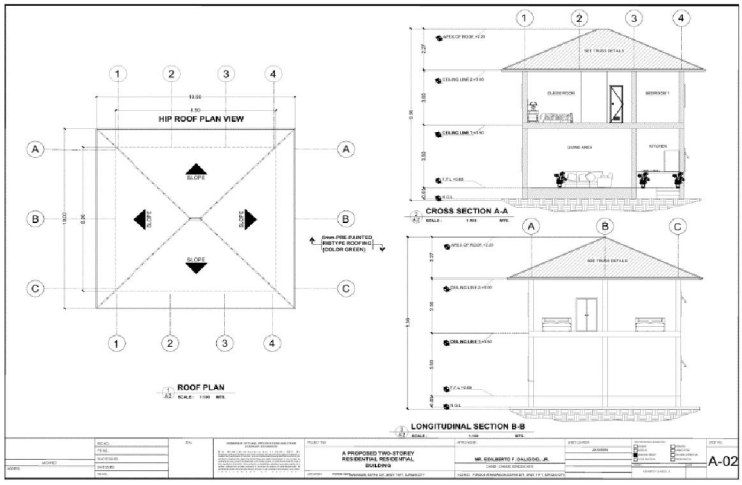

Figure 47. Two-Storey A02 – Roof Plan

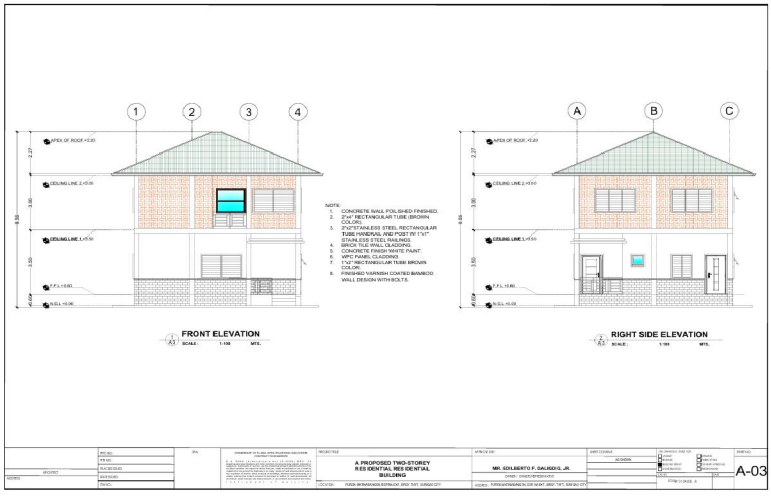

Figure 48. Two-Storey A03 – Elevations

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On the Architectural Plans as to Cost Considerations

One-Storey Cost Considerations. These plans determine the materials, structural system, and utilities, which are major factors in estimating construction cost. The cost considerations of the proposed one-storey residential building can be analyzed through the combined structural, architectural, electrical, and plumbing plans. Structural drawings S01–S06 determine the quantity and specifications of concrete, reinforcement bars, and other structural materials required for construction. Architectural drawings A01–A04 define the building layout, finishes, and components that influence construction expenses. Similarly, electrical sheets E01–E02 and plumbing drawings P01–P03 identify the materials and installation requirements for utility systems. These drawings collectively provide the basis for estimating construction costs, including labor, materials, and installation processes. Accurate cost estimation is essential for ensuring that the building design remains economically feasible while maintaining structural integrity and functionality.

Two-Storey Cost Considerations. These plans determine the materials, structural system, and utilities, which are major factors in estimating construction cost. Construction cost considerations can be analyzed through the technical specifications and material requirements outlined in S01 (Structural Materials and Standards) and A06 (Schedule of Doors and Windows). The structural drawings determine the quantities of concrete, reinforcement bars, and other structural materials required for construction. Meanwhile, the door and window schedule identifies the types, dimensions, and materials used for building openings. These components significantly influence construction costs, as they determine both material expenses and installation requirements. Accurate cost estimation based on these technical drawings ensures that the building design remains economically feasible while maintaining structural safety and architectural quality.

PERCEPTION OF STAKEHOLDERS ON THE PERFORMANCE AND FEASIBILITY OF ECO-RESILIENT URBAN HOUSE DESIGNS

Table 1 presents the extent of the perception of stakeholders on the performance and feasibility of a one-storey eco-resilient urban house design on its Architectural Plans in terms of Maximization of Space, Aesthetic Value/Beauty, Characteristics that Define Modern Architecture, and Cost Considerations.

Table 5: Extent of the perception of stakeholders on the performance and feasibility of one-storey eco-resilient urban house designs on their Architectural Plans.

Statements	Mean	Std. Deviation	VI	QD
Maximization of Space				
The design of eco-resilient urban houses maximizes usable space through efficient layouts and multi-functional rooms.	4.42	0.79	SA	HA
The space inside eco-resilient urban houses is optimized for both residential use and environmental sustainability.	4.24	0.85	SA	HA
Vertical design elements (e.g., multi-story houses) are used effectively to maximize the use of available land.	4.73	0.47	SA	HA
Eco-resilient house designs include flexible spaces that can be adapted to meet the changing needs of the occupants.	4.77	0.45	SA	HA
The architectural design efficiently balances functional space with sustainability, ensuring a comfortable and productive living environment.	4.79	0.44	SA	HA
Average	4.59	0.43	SA	HA
Aesthetic Value/ Beauty				
The aesthetic design of eco-resilient urban houses enhances the visual appeal of the community while adhering to sustainable principles.	4.42	0.78	SA	HA

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The use of natural, eco-friendly materials contributes positively to the aesthetic beauty of eco-resilient houses.	4.37	0.77	SA	HA
The architectural design of eco-resilient houses respects local cultural styles while incorporating modern, sustainable features.	4.66	0.48	SA	HA
Eco-resilient houses are designed to blend harmoniously with their natural surroundings, enhancing both aesthetics and environmental integration.	4.42	0.78	SA	HA
The overall aesthetic of eco-resilient houses contributes to the overall attractiveness of urban areas, fostering a positive sense of place.	4.57	0.72	SA	HA
Average	4.49	0.49	SA	HA
Characteristics that Define Modern Architecture				
Eco-resilient urban houses incorporate modern architectural elements such as clean lines, open spaces, and minimalism.	4.66	0.64	SA	HA
The use of energy-efficient systems and green technologies (e.g., solar panels, green roofs) defines the modern architectural style of eco-resilient houses.	4.34	0.80	SA	HA
Modern architecture characteristics in eco-resilient urban houses prioritize sustainability, comfort, and functionality, balancing aesthetic value with performance.	4.49	0.72	SA	HA
Design flexibility is a key characteristic of modern architecture in eco-resilient houses, allowing adaptation to various environmental and social needs.	4.79	0.41	SA	HA
Modern architectural solutions in eco-resilient urban housing reduce the ecological footprint while enhancing the urban landscape's appeal.	4.47	0.78	SA	HA
Average	4.55	0.42	SA	HA
Cost Considerations				
The construction costs of eco-resilient urban houses are competitive with traditional housing, considering long-term savings in energy and maintenance.	4.84	0.36	SA	HA
The initial investment for eco-resilient housing is offset by the reduced operational costs over time due to energy and water efficiency features.	4.42	0.78	SA	HA
Eco-resilient houses are priced in a way that makes them affordable for middle-income families, especially with long-term savings in energy consumption.	4.37	0.77	SA	HA
Government incentives (e.g., tax breaks, subsidies) significantly contribute to making eco-resilient housing financially viable.	4.80	0.40	SA	HA
Despite the higher upfront costs, the value proposition of eco-resilient housing, in terms of sustainability and long-term benefits, makes it a worthwhile investment.	4.86	0.35	SA	HA
Average	4.66	0.36	SA	HA

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Scale	Parameter	Verbal Interpretation	Qualitative Description
5	4.21–5.00	Strongly Agree (SA)	Highly attainable
4	3.41–4.20	Agree (A)	Attainable
3	2.61–3.40	Neutral (N)	Moderately attainable
2	1.81–2.60	Disagree (D)	Less attainable
1	1.00–1.80	Strongly Disagree (SD)	Not attainable at all

Table 5 presents the extent of the perception of stakeholders on the performance and feasibility of the one-storey eco-resilient urban house design in terms of architectural plans, specifically in maximization of space, aesthetic value/beauty, characteristics that define modern architecture, and cost considerations. Overall, all four variables obtained mean ratings within the range of Strongly Agree and were qualitatively described as Highly Attainable, which indicates that stakeholders viewed the architectural planning of the one-storey eco-resilient urban house as highly feasible, attractive, and responsive to sustainable city living. This supports the study's view that the one-storey design applies eco-resilient principles through concrete architectural outputs and demonstrates a compact and cost-efficient housing option suited to local urban conditions. According to the study, eco-resilient housing design should combine sustainability, architectural planning, and stakeholder acceptability to ensure real-world applicability.

Maximization of Space. The highest-rated item under maximization of space was Item 5, "The architectural design efficiently balances functional space with sustainability, ensuring a comfortable and productive living environment," with a mean of 4.79, verbally interpreted as Strongly Agree and qualitatively described as Highly Attainable. This indicates that stakeholders strongly perceived the one-storey eco-resilient house as capable of balancing efficient space use with sustainability. This suggests that respondents appreciated the practicality of the design, particularly its ability to create a comfortable living environment without sacrificing environmental responsiveness. According to Sengers, Späth, and Raven (2018), eco-resilient homes should maximize usable space through open-plan layouts, multipurpose design strategies, and flexibility so residents can adapt spaces to changing needs and conditions. This idea is also consistent with the study's description of the one-storey design as a compact and cost-efficient housing solution.

The lowest-rated item was Item 2, "The space inside eco-resilient urban houses is optimized for both residential use and environmental sustainability," with a mean of 4.24, which is still interpreted as Strongly Agree and Highly Attainable. Although this was the lowest in the group, it still reflects a very favorable evaluation. This may suggest that while stakeholders strongly accepted the spatial planning, some were slightly more cautious about how fully residential use and environmental sustainability were optimized at the same time. In other words, respondents may have recognized the design's functionality, but some may still have seen room for further improvement in balancing space efficiency and sustainability. According to Sengers, Späth, and Raven (2018), maximizing space in eco-resilient housing requires not only efficient layout planning but also flexibility and adaptability to environmental circumstances, which supports this interpretation.

The average mean for maximization of space was 4.59, interpreted as Strongly Agree and Highly Attainable. This shows that stakeholders had a very positive overall perception of the one-storey house design in terms of spatial efficiency. It indicates that the architectural layout was seen as highly feasible for urban living, where space is often limited and flexibility is important. This aligns with Sengers, Späth, and Raven (2018), who emphasize that open layouts, vertical or strategic design elements, and flexible spaces are important in maximizing the usability of eco-resilient homes in urban settings.

Aesthetic Value / Beauty. The highest-rated item under aesthetic value/beauty was Item 3, "The architectural design of eco-resilient houses respects local cultural styles while incorporating modern, sustainable features," with a mean of 4.66, interpreted as Strongly Agree and Highly Attainable. This indicates that stakeholders strongly appreciated the ability of the one-storey design to combine local character with modern sustainable features. This suggests that the design was not only accepted for its functionality but was also valued for preserving cultural relevance while remaining contemporary. According to William et al. (2022), eco-resilient homes can combine beauty and function using locally

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sourced natural materials and design features that strengthen the building's connection to its environment while enhancing its visual appeal.

The lowest-rated item was Item 2, "The use of natural, eco-friendly materials contributes positively to the aesthetic beauty of eco-resilient houses," with a mean of 4.37, which is still interpreted as Strongly Agree and Highly Attainable. Although this item received the lowest rating in the category, it still shows that stakeholders positively perceived the visual contribution of natural and eco-friendly materials. The slightly lower mean may imply that while respondents accepted the use of such materials, some may have been less certain about their aesthetic appeal compared with broader design features such as cultural integration or overall urban attractiveness. Still, William et al. (2022) explain that natural and locally sourced materials can strengthen both the environmental connection and beauty of eco-resilient homes, especially when paired with modern sustainable elements such as vertical gardens or green roofs.

The average mean for aesthetic value/beauty was 4.49, interpreted as Strongly Agree and Highly Attainable. This indicates that stakeholders viewed the one-storey eco-resilient house design as aesthetically pleasing and capable of contributing positively to the appearance of the community. It suggests that beauty was not sacrificed in favor of sustainability; instead, both were perceived to work together in the design. This supports William et al. (2022), who note that eco-resilient housing can successfully integrate aesthetic appeal and environmental function without compromising either.

Characteristics that Define Modern Architecture. The highest-rated item under this variable was Item 4, "Design flexibility is a key characteristic of modern architecture in eco-resilient houses, allowing adaptation to various environmental and social needs," with a mean of 4.79, interpreted as Strongly Agree and Highly Attainable. This indicates that stakeholders strongly believed that design flexibility is one of the most important modern architectural strengths of the one-storey eco-resilient house. This suggests that respondents recognized adaptability as central to modern and sustainable housing, especially in environments exposed to changing climatic and social conditions. According to Vélez-Duque and Arteaga-Morales (2022), contemporary eco-resilient designs should emphasize practical adaptation to environmental conditions and improved performance through sustainable architectural strategies. Likewise, Sengers, Späth, and Raven (2018) stress the importance of flexibility so that spaces can respond to changing user and environmental needs.

The lowest-rated item was Item 2, "The use of energy-efficient systems and green technologies (e.g., solar panels, green roofs) defines the modern architectural style of eco-resilient houses," with a mean of 4.34, which is still interpreted as Strongly Agree and Highly Attainable. Although still highly rated, this lower mean may indicate that stakeholders were somewhat more cautious about associating modern architecture mainly with green technologies compared with more visible design features like flexibility, open space, or simplicity. Still, the result remains positive and supports the idea that energy-efficient systems are accepted as part of modern eco-resilient design. According to Vélez-Duque and Arteaga-Morales (2022), contemporary eco-resilient homes emphasize performance-enhancing design solutions, while Zaidan (2022) also identifies green infrastructure features such as green roofs and related sustainable systems as essential components of eco-resilient development.

The average mean for characteristics that define modern architecture was 4.55, interpreted as Strongly Agree and Highly Attainable. This shows that stakeholders had a highly favorable overall perception of the one-storey design as a modern architectural solution. It implies that the house design was seen as embodying key modern features such as flexibility, simplicity, sustainability, and functional performance. This agrees with Vélez-Duque and Arteaga-Morales (2022), who describe contemporary eco-resilient architecture as combining environmental responsiveness, modern planning strategies, and improved urban performance.

Cost Considerations. The highest-rated item under cost considerations was Item 5, "Despite the higher upfront costs, the value proposition of eco-resilient housing, in terms of sustainability and long-term benefits, makes it a worthwhile investment," with a mean of 4.86, interpreted as Strongly Agree and Highly Attainable. This is also the highest individual mean in Table 4, which indicates that stakeholders most strongly valued the long-term investment potential of the one-storey eco-resilient house design. This suggests that respondents clearly understood that even if eco-resilient

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housing may require greater initial cost, its sustainability, durability, and long-term benefits justify the investment. According to Zaidan (2023), eco-resilient homes may be more expensive at the start because of specialized materials and technologies, but they reduce maintenance needs, save energy over time, and remain financially viable in the long run.

The lowest-rated item was Item 3, "Eco-resilient houses are priced in a way that makes them affordable for middle-income families, especially with long-term savings in energy consumption," with a mean of 4.37, still interpreted as Strongly Agree and Highly Attainable. Even though this was the lowest in the category, the result still shows a positive perception of affordability. The slightly lower mean may indicate that while stakeholders acknowledged long-term savings, some may still have concerns about the immediate affordability of eco-resilient housing for middle-income households. This is understandable because affordability is often assessed not only by long-term returns but also by actual upfront access. According to Zaidan (2023), the cost of eco-resilient homes may initially be higher due to specialized materials and technologies, even though long-term savings in energy and maintenance improve financial viability over time.

The average mean for cost considerations was 4.66, interpreted as Strongly Agree and Highly Attainable. This indicates that stakeholders had a very strong overall perception of the one-storey eco-resilient urban house as financially feasible and worthwhile. It suggests that the design was seen not merely as an environmentally sound option but also as a practical economic choice in the long term. This is consistent with Zaidan (2023), who explains that eco-resilient housing becomes financially beneficial over time through reduced operational and maintenance costs, despite higher initial investment.

Overall, Table 5 shows that stakeholders had a very favorable perception of the architectural plans of the one-storey eco-resilient urban house design. Among the four variables, Cost Considerations obtained the highest average mean (4.66), followed by Maximization of Space (4.59), Characteristics that Define Modern Architecture (4.55), and Aesthetic Value/Beauty (4.49). All variables were interpreted as Strongly Agree and Highly Attainable. These findings indicate that the one-storey eco-resilient urban house was widely viewed as architecturally feasible, visually acceptable, spatially efficient, modern, and economically worthwhile. According to the study, the one-storey design demonstrates how eco-resilient principles can be translated into a compact and cost-efficient housing solution, while stakeholder evaluation helps confirm that the design is both technically sound and socially acceptable.

Table 2 presents the extent of the perception of stakeholders on the performance and feasibility of a two-storey eco-resilient urban house design on its Architectural Plans in terms of Maximization of Space, Aesthetic Value/Beauty, Characteristics that Define Modern Architecture, and Cost Considerations.

Table 6: Extent of the perception of stakeholders on the performance and feasibility of two-storey eco-resilient urban house designs on their Architectural Plans.

Statements	Mean	Std. Deviation	VI	QD
Maximization of Space				
The design of eco-resilient urban houses maximizes usable space through efficient layouts and multi-functional rooms.	4.60	0.65	SA	HA
The space inside eco-resilient urban houses is optimized for both residential use and environmental sustainability.	4.39	0.82	SA	HA
Vertical design elements (e.g., multi-story houses) are used effectively to maximize the use of available land.	4.70	0.55	SA	HA
Eco-resilient house designs include flexible spaces that can be adapted to meet the changing needs of the occupants.	4.76	0.55	SA	HA
The architectural design efficiently balances functional space with sustainability, ensuring a comfortable and productive living environment.	4.93	0.25	SA	HA
Average	4.68	0.40	SA	HA

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Aesthetic Value/ Beauty				
The aesthetic design of eco-resilient urban houses enhances the visual appeal of the community while adhering to sustainable principles.	4.68	0.56	SA	HA
The use of natural, eco-friendly materials contributes positively to the aesthetic beauty of eco-resilient houses.	4.40	0.79	SA	HA
The architectural design of eco-resilient houses respects local cultural styles while incorporating modern, sustainable features.	4.69	0.51	SA	HA
Eco-resilient houses are designed to blend harmoniously with their natural surroundings, enhancing both aesthetics and environmental integration.	4.32	0.76	SA	HA
The overall aesthetic of eco-resilient houses contributes to the overall attractiveness of urban areas, fostering a positive sense of place.	4.58	0.78	SA	HA
Average	4.53	0.46	SA	HA
Characteristics that Define Modern Architecture				
Eco-resilient urban houses incorporate modern architectural elements such as clean lines, open spaces, and minimalism.	4.76	0.61	SA	HA
The use of energy-efficient systems and green technologies (e.g., solar panels, green roofs) defines the modern architectural style of eco-resilient houses.	4.26	0.84	SA	HA
Modern architecture characteristics in eco-resilient urban houses prioritize sustainability, comfort, and functionality, balancing aesthetic value with performance.	4.34	0.81	SA	HA
Design flexibility is a key characteristic of modern architecture in eco-resilient houses, allowing adaptation to various environmental and social needs.	4.83	0.43	SA	HA
Modern architectural solutions in eco-resilient urban housing reduce the ecological footprint while enhancing the urban landscape's appeal.	4.60	0.73	SA	HA
Average	4.56	0.52	SA	HA
Cost Considerations				
The construction costs of eco-resilient urban houses are competitive with traditional housing, considering long-term savings in energy and maintenance.	4.82	0.38	SA	HA
The initial investment for eco-resilient housing is offset by the reduced operational costs over time due to energy and water efficiency features.	4.53	0.72	SA	HA
Eco-resilient houses are priced in a way that makes them affordable for middle-income families, especially with long-term savings in energy consumption.	4.23	0.89	SA	HA
Government incentives (e.g., tax breaks, subsidies) significantly contribute to making eco-resilient housing financially viable.	4.92	0.31	SA	HA
Despite the higher upfront costs, the value proposition of eco-resilient housing, in terms of sustainability and long-term benefits, makes it a worthwhile investment.	4.87	0.37	SA	HA
Average	4.68	0.37	SA	HA

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Scale	Parameter	Verbal Interpretation	Qualitative Description
5	4.21–5.00	Strongly Agree (SA)	Highly attainable
4	3.41–4.20	Agree (A)	Attainable
3	2.61–3.40	Neutral (N)	Moderately attainable
2	1.81–2.60	Disagree (D)	Less attainable
1	1.00–1.80	Strongly Disagree (SD)	Not attainable at all

Table 6 presents the extent of the perception of stakeholders on the performance and feasibility of the two-storey eco-resilient urban house design in terms of architectural plans, specifically in maximization of space, aesthetic value/beauty, characteristics that define modern architecture, and cost considerations. Overall, all four variables obtained mean ratings interpreted as Strongly Agree and qualitatively described as Highly Attainable, showing that stakeholders had a very favorable perception of the architectural planning of the two-storey eco-resilient urban house. This suggests that the proposed two-storey design was viewed as spatially efficient, visually acceptable, modern, and economically worthwhile for sustainable city living. This supports the study's claim that the two-storey design illustrates vertical adaptability as a strategy for addressing land scarcity and flood risk, while stakeholder evaluation helps confirm its real-world feasibility and acceptability.

Maximization of Space. The highest-rated item under maximization of space was Item 5, "The architectural design efficiently balances functional space with sustainability, ensuring a comfortable and productive living environment," with a mean of 4.93, verbally interpreted as Strongly Agree and qualitatively described as Highly Attainable. This is also the highest individual mean in Table 5, indicating that stakeholders most strongly valued the ability of the two-storey eco-resilient house to provide both functionality and sustainability. This suggests that respondents clearly appreciated the architectural efficiency of the design, especially its ability to use vertical planning to create a comfortable living environment while still supporting sustainability goals. According to Sengers, Späth, and Raven (2018), maximizing usable space in eco-resilient homes requires innovative strategies such as open-plan layouts, vertical design elements, multipurpose features, and flexibility to respond to changing residential and environmental needs. This also agrees with the study's statement that the two-storey design demonstrates vertical adaptability for land-scarce urban areas.

The lowest-rated item was Item 2, "The space inside eco-resilient urban houses is optimized for both residential use and environmental sustainability," with a mean of 4.39, which is still interpreted as Strongly Agree and Highly Attainable. Although this was the lowest in the group, the rating remains highly favorable. This may imply that while stakeholders strongly agreed that the two-storey house maximizes space, some were slightly more cautious about how fully residential function and environmental sustainability are optimized at the same time. In other words, the design was clearly accepted, but some respondents may still perceive room for improvement in balancing daily usability and sustainability features. According to Sengers, Späth, and Raven (2018), space maximization in eco-resilient housing is most effective when design flexibility allows occupants to adjust room use as needs and conditions change.

The average mean for maximization of space was 4.68, interpreted as Strongly Agree and Highly Attainable. This shows that stakeholders had a very strong overall perception of the two-storey design in terms of spatial planning. It indicates that the architectural layout was seen as highly effective in making the most of limited urban land while maintaining comfort and sustainability. This aligns with Sengers, Späth, and Raven (2018), who emphasize that vertical development, flexible spaces, and multipurpose layouts are essential planning strategies in eco-resilient urban homes.

Aesthetic Value / Beauty. The highest-rated item under aesthetic value/beauty was Item 3, "The architectural design of eco-resilient houses respects local cultural styles while incorporating modern, sustainable features," with a mean of 4.69, interpreted as Strongly Agree and Highly Attainable. This indicates that stakeholders strongly appreciated the design's ability to preserve cultural relevance while still incorporating sustainability and modernity. This suggests that the two-storey eco-resilient house was not only accepted as functional but also seen as visually meaningful within the local context. According to William et al. (2022), the aesthetic value of eco-resilient homes can be enhanced through

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the use of locally sourced natural materials and modern sustainable features, allowing beauty and functionality to coexist without sacrificing either.

The lowest-rated item was Item 4, "Eco-resilient houses are designed to blend harmoniously with their natural surroundings, enhancing both aesthetics and environmental integration," with a mean of 4.32, which is still interpreted as Strongly Agree and Highly Attainable. Even if it ranked lowest in the category, the result remains clearly positive. This may indicate that some stakeholders were slightly less certain about how well the two-storey design blends with the natural environment compared with other aesthetic indicators such as cultural style or community visual appeal. This is understandable, since harmony with surroundings can be influenced by actual site context and landscape treatment. Still, William et al. (2022) explain that eco-resilient homes may improve both aesthetic quality and environmental integration through natural materials and green design elements such as vertical gardens and green roofs.

The average mean for aesthetic value/beauty was 4.53, interpreted as Strongly Agree and Highly Attainable. This indicates that stakeholders generally viewed the two-storey eco-resilient urban house as visually appealing and suitable for enhancing the urban environment. It suggests that the design's sustainability features did not lessen its beauty; rather, they were perceived as contributing to its overall attractiveness. This supports William et al. (2022), who emphasize that eco-resilient housing can successfully integrate environmental function with aesthetic appeal.

Characteristics that Define Modern Architecture. The highest-rated item under this variable was Item 4, "Design flexibility is a key characteristic of modern architecture in eco-resilient houses, allowing adaptation to various environmental and social needs," with a mean of 4.83, interpreted as Strongly Agree and Highly Attainable. This indicates that stakeholders strongly recognized flexibility as one of the defining architectural strengths of the two-storey eco-resilient house. This suggests that respondents associated modern architecture not merely with appearance but with the capacity to adapt to changing environmental and social needs. According to Vélez-Duque and Arteaga-Morales (2022), contemporary eco-resilient architecture focuses on practical adaptation, improved environmental performance, and planning strategies that respond to current urban challenges. This is also consistent with Sengers, Späth, and Raven (2018), who identify flexibility as an important design consideration in sustainable housing.

The lowest-rated item was Item 2, "The use of energy-efficient systems and green technologies (e.g., solar panels, green roofs) defines the modern architectural style of eco-resilient houses," with a mean of 4.26, which is still interpreted as Strongly Agree and Highly Attainable. Although still favorable, this lower mean may indicate that stakeholders were somewhat more cautious about identifying modern architecture mainly through green technologies compared with more visible or spatial qualities such as flexibility, clean lines, and open spaces. Still, the positive rating shows that respondents accepted energy-efficient systems and green technologies as important components of modern eco-resilient design. According to Vélez-Duque and Arteaga-Morales (2022), modern eco-resilient housing emphasizes performance and environmental responsiveness, while Zaidan (2022) highlights green infrastructure such as green roofs and related systems as central components of eco-resilient development.

The average mean for characteristics that define modern architecture was 4.56, interpreted as Strongly Agree and Highly Attainable. This indicates that stakeholders had a very favorable overall perception of the two-storey design as a modern architectural solution. It implies that the proposed house was seen as combining flexibility, clean modern form, sustainability, and practical performance. This agrees with Vélez-Duque and Arteaga-Morales (2022), who describe contemporary eco-resilient architecture as modern design that improves functionality and environmental performance in urban settings.

Cost Considerations. The highest-rated item under cost considerations was Item 4, "Government incentives (e.g., tax breaks, subsidies) significantly contribute to making eco-resilient housing financially viable," with a mean of 4.92, interpreted as Strongly Agree and Highly Attainable. This indicates that stakeholders strongly believed that policy support and incentives are important in making two-storey eco-resilient housing economically feasible. This suggests that respondents recognized that although the design may involve higher initial costs, external financial support can greatly improve affordability and encourage adoption. According to Zaidan (2023), eco-resilient buildings may require higher upfront investment due to specialized technologies and materials, but they remain financially viable in the long

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term because of lower maintenance and energy costs. The strong support for incentives may therefore reflect stakeholder awareness that affordability can be improved when long-term benefits are paired with enabling policy measures.

The lowest-rated item was Item 3, "Eco-resilient houses are priced in a way that makes them affordable for middle-income families, especially with long-term savings in energy consumption," with a mean of 4.23, still interpreted as Strongly Agree and Highly Attainable. Although this is the lowest mean under cost considerations, it is still positive. This may indicate that some stakeholders were slightly more cautious about the immediate affordability of the two-storey eco-resilient house for middle-income households, even if they acknowledged the long-term savings. This finding is understandable because affordability is often influenced by upfront cost, not just by future operational savings. According to Zaidan (2023), eco-resilient homes may cost more initially because of specialized materials and technologies, even though they become economically beneficial over time due to reduced energy and maintenance expenses.

The average mean for cost considerations was 4.68, interpreted as Strongly Agree and Highly Attainable. This shows that stakeholders had a very strong overall perception of the two-storey eco-resilient urban house as a financially worthwhile and feasible housing option. It indicates that the design was viewed as economically justifiable, especially when long-term benefits and possible government support are considered. This aligns with Zaidan (2023), who explains that eco-resilient housing remains financially viable over the long term despite higher initial investment.

Overall, Table 6 shows that stakeholders had a very favorable perception of the architectural plans of the two-storey eco-resilient urban house design. Among the four variables, Maximization of Space and Cost Considerations both obtained the highest average mean (4.68), followed by Characteristics that Define Modern Architecture (4.56) and Aesthetic Value/Beauty (4.53). All variables were interpreted as Strongly Agree and Highly Attainable. These findings indicate that the two-storey eco-resilient urban house was widely viewed as spatially efficient, architecturally modern, visually acceptable, and financially worthwhile. This supports the study's position that the two-storey design offers vertical adaptability for land-scarce and flood-prone urban areas, while stakeholder perception remains essential in confirming whether eco-resilient designs are seen as beneficial, realistic, and socially acceptable. According to Zaidan (2023) and Syazsa (2023), community support and stakeholder involvement are critical in ensuring that eco-resilient housing solutions are both technically feasible and acceptable to the people who will use them.

VI. CONCLUSIONS

1. The study concludes that eco-resilient urban house designs for sustainable city living in Surigao City must integrate appropriate structural characteristics, architectural plans, and human comfort and health provisions. These technical requirements serve as essential design parameters in ensuring that proposed housing designs are resilient, sustainable, and suitable for flood-prone urban communities.
2. The study concludes that both the one-storey and two-storey eco-resilient urban house designs are generally feasible, acceptable, and highly attainable based on stakeholder evaluation. Since both designs received highly favorable ratings, they may be considered practical housing options for promoting flood resilience and sustainable city living.

VII. RECOMMENDATIONS

1. It is recommended that future eco-resilient urban house designs in Surigao City and similar flood-prone areas should consistently incorporate the identified technical requirements under structural characteristics, architectural plans, and human comfort and health. Designers, engineers, architects, and planners should use these parameters as a guide in developing housing models that are resilient, sustainable, and responsive to local environmental conditions.
2. It is recommended that the proposed one-storey and two-storey eco-resilient urban house designs be considered for further development, validation, or pilot implementation since both were perceived as feasible and highly attainable. Local government units, housing planners, and private developers may use these proposed designs as reference models for sustainable housing projects in flood-prone communities.

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3. It is recommended that both one-storey and two-storey eco-resilient urban house designs be considered as viable options for sustainable housing, with the final choice depending on site condition, land availability, budget, and user needs. Since both designs were viewed as similarly feasible and acceptable, decision-makers may adopt either design based on practical considerations in the target community.

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