SSRG International Journal of Electrical and Electronics Engineering
ISSN: 2348-8379/ https://doi.org/10.14445/23488379/IJEEE-V12I3P114

Volume 12 Issue 3, 137-144, March 2025

Original Article

Smart Home and Multimedia Panels Design Interface in Sundanese Indonesian Traditional Houses

Marvin Chandra Wijaya

Computer Engineering Department, Maranatha Christian University, West Java, Indonesia.

Corresponding Author : marvin.cw@eng.maranatha.edu

Received: 20 December 2024 Revised: 15 March 2025 Accepted: 24 March 2025 Published: 31 March 2025

Abstract *- Installing a smart home system into a conventional home would prove practical and aesthetically compatible, as well as blending modern technology into the architecture and cultural setting of the conventional house. The Sundanese traditional house, or "Rumah Adat Sunda," is an important architectural feature for the Sundanese people, who make up the largest ethnic group in West Java, Indonesia. The design of the Sundanese traditional house conveys the values of Sundanese society, its way of living and environmental adaptation. The smart house was constructed with a single living room, two bedrooms, a kitchen, and one bathroom. This design study aimed to create a functioning system. All experiments were successful in the designing of the energy-consumption greenhouse. Saving on electricity in smart houses was estimated to be 18.75%.*

Keywords *- Multimedia, Panels design, Smart home, Sundanese, Interface.*

1. Introduction

Traditional houses are an important part of cultural heritage and convey various values, beliefs, and lifestyles of communities worldwide. Normally, such houses are built of local materials, such as wood, bamboo, stone, earth, etc., and their design is appropriate for the local climate and environment. Latip mentions that traditional Malay houses, for example, are primarily built with timber due to resource availability and the material's value [1]. A good and environmentally friendly home design will greatly contribute to the harmony of neighbors in the area [2].

Several key characteristics define traditional houses:

- Vernacular Architecture: Traditional houses often exemplify vernacular architecture, meaning they are designed and built based on local needs and traditions, without the involvement of professional architects; discusses the application of Sundanese vernacular concepts to modern building design.
- Climate Responsiveness: These structures are often designed to be naturally comfortable in their respective climates.
- Cultural Significance: Traditional houses embody cultural values and practices, often incorporating symbolic elements and spatial arrangements that reflect social structures and beliefs. Latip highlights the strong cultural character of traditional Sundanese houses [1].
- Sustainable Practices: Many traditional building techniques utilize sustainable materials and methods, minimizing environmental impact, suggesting that reinventing traditional Sundanese houses could contribute to more sustainable housing design [3].

While modernization and changing lifestyles have led to a decline in the construction of traditional houses in many regions, there is a growing recognition of their value in terms of cultural preservation, sustainable building practices, and climate-responsive design [4]. Siti Halipah points out the irony of modern houses overlooking the sustainable aspects of traditional designs [3]. Efforts are being made to preserve and adapt traditional building techniques for contemporary use, blending past wisdom with present needs. The country of Indonesia, home to the world's largest archipelago-even yet the fourth most populous-and most populous among those at just 277 million (in 2022) citizens, Indonesia also occupies an important role in the bigger region of Indonesia, thus gaining formal establishment on the 17th day of 1945. Indonesian culture is very rich and diverse, with many customs and all sorts of traditional houses across the region, as shown in Figure 1.

Some of the traditional houses in Indonesia are as follows:

- “Rumah Gadang” (West Sumatra): These are traditional houses of the Minangkabau people. The house is easily recognizable because of the curved roof structure, which

looks like buffalo horns. Rumah Gadang often features intricate wood carvings, symbolizing Minangkabau culture [5].

- "Rumah Joglo" (Central Java): Originating from Java, particularly in Central Java and Yogyakarta, the Joglo house showcases traditional Javanese architecture. The house has a pyramid-like roof structure supported by four main wooden columns. The Joglo house represents the social status and wealth of the people from the community.
- "Rumah Panggung" (Various regions): Found across different parts of Indonesia, especially in areas prone to flooding or high humidity, the Rumah Panggung or raised houses are built on stilts. The house is raised about 1-2 meters above the ground for protection from flooding or animals.
- "Rumah Lumbung" (Bali): As a traditional Balinese rice barn, Rumah Lumbung is typical to Bali in structure: a two-story one, with rice stacked on the top level after harvest for storage. This architecture is primarily elevated to deter pests and rodents from reaching the rice stores.
- Rumah Sunda, or the "Sundanese House": A traditional house found in the West Java Province. The house designs integrate features tailored according to the ever-changing climates and lifestyles of the Sundanese community[6].

Examples of traditionally built houses in Indonesia are shown in Figure 1. This study is focused on the Sundanese traditional house called "Rumah Adat Sunda," which represents the architectural heritage of the Sundanese people, the biggest ethnic group in the West Javanese province of Indonesia. This house is designed to reflect the Sundanese community's cultural values, environmental adaptation, and lifestyle [7]. Installing smart home technology into traditional wooden houses in Minahasa brings unique opportunities and drawbacks.

Fig. 1 Examples of Indonesian traditional houses

A study suggested a conceptual design of a smart house combined with a photovoltaic (PV) rooftop solar power plant to improve energy efficiency while honoring cultural heritage by automating the management of the lighting, water, air, and security systems according to the architectonic properties of Minahasa wooden houses. With Balinese-style luxury developments rising in demand, certain developers have taken the alternative route of merging smart technologies with the traditional design approach that allows homeowners remote control over lighting, climate, security, and entertainment systems. This naturally raises the property value and offers a lifestyle of modernity while still embodying traditional attractiveness.

There is still scant evidence of integrating smart home technology with traditional Indonesian houses, especially Sundanese houses since many studies focus on modern and Western contexts. Research on smart homes tends to elaborate on functionality and convenience, but cultural preservation and environmental sustainability, which are highly imperative for keeping traditional houses as expressions of cultural identities and transitioning to climate change, are sluggishly catered for. Existing performance analysis of smart homes has paid scant attention to the particular characteristics of traditional houses, such as materials, structural designs, and energy consumption behavior. This research aims to investigate the integrators of the smart home system into the Sundanese traditional house itself, wherein the combination of modern technology is aligned with grasping cultural values and architectural aspects of that traditional dwelling. The smart home system design for Sundanese traditional houses has set out to do the following in this research:

- Harmoniously integrate modern smart home technologies.
- Enhance the functionality, energy efficiency, and convenience of the traditional house.

The research has innovatively introduced smart technology into the Sundanese traditional house while beautifully preserving the complex architecture of the house, cultural aspects, and lifestyles by granting augmented comfort, safety, and energy efficiency. Including LCA within this novel framework allows for assessing the potential environmental impact of any smart home system at every stage, from resource extraction to disposal, promoting long-term sustainability. In addition, the research can also embrace specific ID methods that could offer solutions for new vulnerabilities concerning security, privacy, and device safety in traditional homes. Maintain the aesthetic and cultural integrity of the Sundanese traditional house.

2. Sundanese Traditional House

2.1. Smart House Features and Design

The intelligent handy features wish to elevate convenience, comfort, security, and energy efficiency through some automated and interconnected gadgets. Following are

some of the most important parts and features of a smart house:

- Home Automation Systems: This type of system controls and manages any device or appliance in the house. It can be done remotely through smartphones or any other connected devices. Examples include smart thermostats, smart lighting systems, and smart locks.
- Smart Lighting: The smart homes include lighting systems, some of which have automated functions while others allow for remote control. They enable fine-tuning illumination, color, and timing, and they can even be programmed to go on or off depending on room occupancy or daylight levels.
- Home Security: Smart security systems include cameras, motion sensors, smart doorbells, and alarms that can be monitored and controlled remotely. Depending on the system, some may include facial recognition, two-way audio, and monitoring via real-time alerts on mobile apps
- Smart Appliances: Such as smart refrigerators, washing machines, ovens, and other smart appliances interconnect alongside remote monitoring. They include many features, from remote start/stop and energy consumption monitoring to maintenance notifications and alerts.
- Energy Management: Smart homes in this line include setups geared toward monitoring and managing energy usage. Smart thermostats and energy-efficient appliances thus ensure optimization in energy consumption and, therefore, savings in cost and effects on the environment.

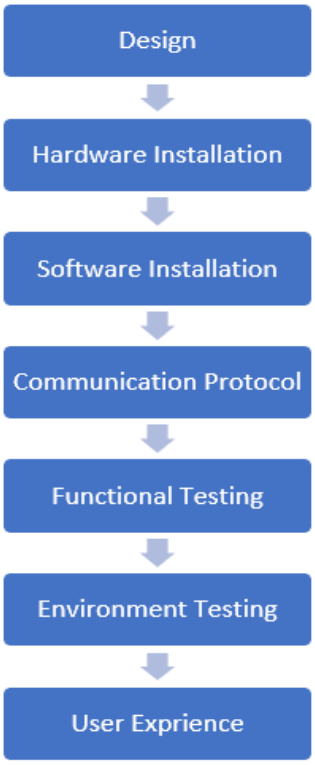

Fig. 2 Smart house design

Starting with the technology incorporation process within the traditional Sundanese houses, Figure 2 provides the development of the innovation-driven smart home system. The smart features should be designed and built into these houses without destroying their architectural and cultural integrity. Primary solutions to be built into the smart homes include ventilation created from smart, automated designs and versatile smart features such as lighting and security sensors. Hardware selection was based on energy efficiency and compatibility with construction materials, and software implementation was done using Arduino platforms. The system communicates over Wi-Fi communication protocols, with consideration for the effects of conventional building materials on signal transmission.

Figure 3 investigates the smart home feature. The smart home system components can be interconnected and controlled from a central hub like a laptop, tablet, smartphone, or game console. The devices controlled by one of these home automation systems collectively called the smart home system, include door locks, TVs, thermostats, CCTV, cameras, lighting, appliances like the refrigerator, and beyond. Smart home systems use networked devices, including smart and mobile devices. In case any installation gets done, users can manage the schedules and duration of the modifications to quickly and effectively modernize the house automation setting. Artificial intelligence is built into smart home systems, enabling them to understand a homeowner's schedule and make necessary adjustments. Multimedia modeling is widely used to display the interface of smart homes.

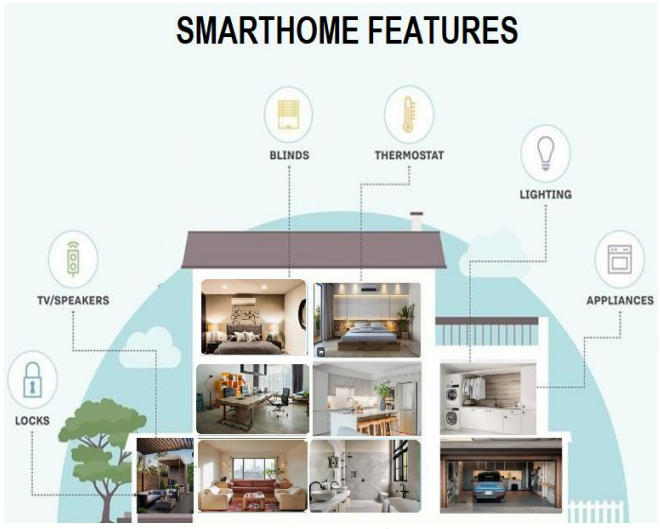

Fig. 3 Smart house features

The DS18B20 sensor is a type of Arduino-based temperature measuring device commonly used due to its waterproof capability. The design of the DS18B20 sensor is carried out in two stages: software and hardware development, as shown in Figure 4. The sensor's temperature measurement outputs are an I2C module and a 16x2 LCD display.

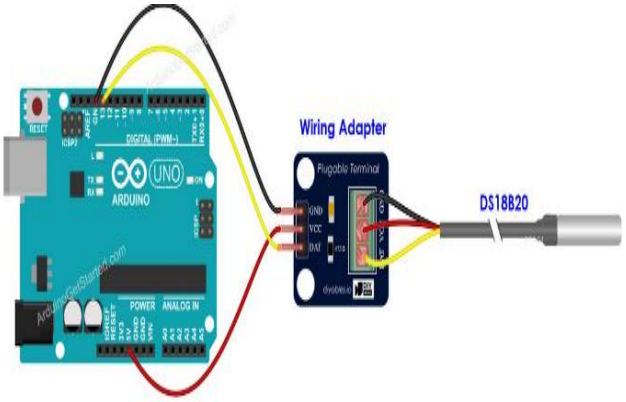

Fig. 4 Sensors with arduino

2.2. Modern Sundanese Tradional House

Indonesian traditional architecture is exceptionally heterogeneous. The architecture, functionality, significance, and philosophy vary considerably based on the different settings each was built. It is usually apparent that the Sundanese houses used a very simple sort of construction design and reused materials.

The source of the material for everything from the floor to the roof is, by ordinary visible means, bamboo, which is among the most rapidly regenerated plants. Traditional Sundanese houses, or "imah panggung", are usually built on stilts from a wooden frame with woven bamboo walls and a roof made of palm leaves to adjust for the tropical climate in West Java, Indonesia, as shown in Figure 5. Traditional Sundanese buildings fulfill one of the lightweight construction earthquake resistance aspects set by bamboo and wood building materials. Brostow mentioned some advantages of employing wood as a building construction material [8].

Fig. 5 Traditional sundanese house miniature

Bamboo is another common material used in traditional Sundanese architecture. As per Sharma, bamboo presents numerous benefits as a building material, including its rapid regenerative nature and similar mechanical qualities to wood [9]. Because bamboo fiber varies, it can be utilized for both exterior and interior construction. Paradiso said bamboo should be used as an engineering material for homes and other structures because it is a highly adaptable and readily available resource [10]. The connections are made with wooden pegs and rattan or palm fiber ties. Since it is against their ancient traditions and customs, there are no nuts, bolts, or nails (taboo). Maknun asserts that peg connections, with their 60% efficiency level, are superior to bolt connections, which have a 30% efficiency level, and nail connections, which have a 50% efficiency level [11].

3. Smart Home Device Layout Design

One living room, two bedrooms, one bath, and a kitchen are traditional Sundanese that are installed with a smart home system. The smarthome uses four multimedia display panels and four sensors, as illustrated in Figure 6.

The wiring can be installed carefully, and multimedia display panels and sensors can sit in such a way. The first procedure in wiring for a house is the installation of electrical wire to ensure the safe and effective distribution of the electrical energy inside the house. The following are the steps taken to wire a house:

- Design and Planning: This includes a complete electrical plan that maps out where outlets, switches, fixtures, and other electrical components will be before the actual wiring. Consider the electrical needs of each room, appliance, and house area.
- Gathering the Necessary Material: Gathering major materials and tools necessary for the job, such as conduits, wire connectors, outlets, switches, junction boxes, and cables and wires.
- Cable Pulling: In accordance with the conceptual electrical plan, run the electrical wires through the walls, ceilings, and floors. These wires will include other wires for the outlets, appliances, lighting circuits, etc. The cables should be secured and fastened using the appropriate attachments so they will not break and be safe.
- Install Outlets and Junction Boxes: Junction boxes should be located exactly where wires cross or there is a connection between electrical connections. Switches, outlets, and fixtures must be installed according to the electrical layout.
- Wire connections should be made to outlets, switches, circuit breakers, and fixtures by either wire connectors or terminal screws. Follow the codes or conventions of the electrical connection in order to have the right connections and avoid overloading circuits.
- Testing: Prior to turning on the circuit, the system must be tested for short circuits, overloads, or other possible trouble spots in the whole electrical system.

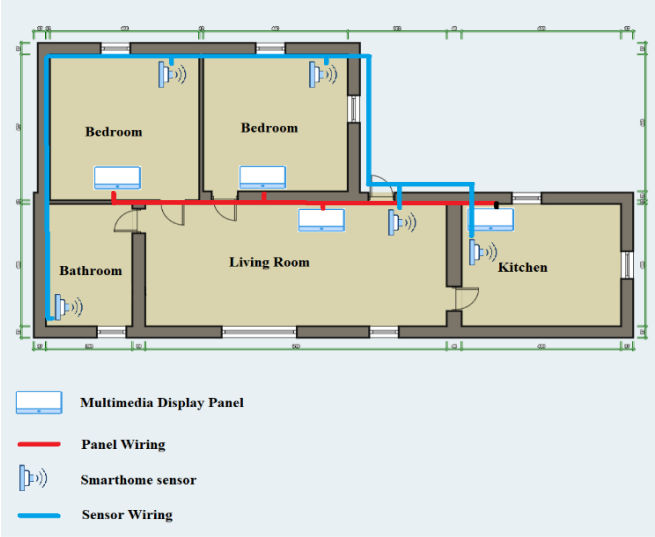

Fig. 6 Wired design of smart home for sundanese house

4. Smart Home Interface Design

The Smart Home System for the Sundanese house uses four multimedia display panels as its main control interface for all the home functions. The interface shall be designed and animated to present an appealing and interactive view. The interface has:

1. Functionality And Layout:
   - Dashboard view. Each display panel may build an interactive dashboard to show information about temperature, energy monitoring, security, notifications, etc.
   - Zone control: Interface sections may be dedicated to controlling devices in certain house zones (e.g., living room, kitchen, bedrooms). Thus, the system can control things like lighting, appliances, and other devices in each area.
   - Scene setting: Scene controls will be activated that bring the specific zone into mono settings as required for a scenario, such as “Movie Night” (dim lights, blinds down, and entertainment system turned on) or “Away Mode” (activating security, thermostats adjusted).
   - Device management: An interface for managing devices individually allows users to change settings on one device, see the status of a machine, and pinpoint the source of problems.
2. User experience design:
   - Intuitive navigation: Keyboard shortcuts are highly recommended because they create easy usage. Understandable navigation boards, icons, and labels will replace the most complex menus. There might be a touchscreen for directly pushing the items.
   - Provide feedback in kind: After any action is taken by the user, some visible feedback could be provided, such as the button changing its color upon being pressed or a message confirming the action.
   - Personalization: Set up the interface for users’ preferences, from GUI themes to arranging widgets/settings in default values.
   - Accessibility: Considerations for those with disabilities include wider font size, a monochrome color scheme, and a speaking assistant (talking commands).
3. Integration and Connectivity:
   - Device Integration: Seamless integration with all smart home devices enabled for users so that they can control and monitor their devices from a central interface.
   - Remote Access: Allow remote access from anywhere via a mobile app or web interface to control their smart home system
   - Voice Control: Voice control enabled for hands-free functionality and increased convenience
4. Performance and Security:
   - Responsiveness: The interface should be optimized for light-speed responsiveness to promote a smooth and seamless user experience. Responsiveness measurements are good performance indicators of about 75-85ms for display panels and 50-56ms for sensors in smart home setups.
   - Security: Instill solid security features in the smart home system and protect it from potential unauthorized access.

5. Resilient Design Strategies

Resilient design provides a path to creating sustainable, cost-effective housing. Clean technologies using Life Cycle Analysis (LCA) are a must in this regard [12]. It is in the domain of how LCA influences the resilient strategies of affordable housing design:

1. Material Selection: LCA looks into the environmental effects of various building materials over their entire life cycle, including extraction, manufacture, use, and eventual disposal [13]. This will inform the selection based on low embodied carbon, low natural resource depletion, and low waste emission. This implicitly means that durable, low-maintenance materials that guarantee lower long-term costs will be selected for affordable housing [14].
2. Construction Practices: LCA can assess the environmental footprint of various construction practices. This encourages efficient construction practices in resource use and curtailing waste arising from their operation [15].
3. Building Performance: The energy efficiency of a building during its operation can be analyzed with the support of LCA. Informed design decisions for affordable housing reduce their utility costs through operational energy use management during the entire lifespan of the facility: passive heating/cooling design methods, optimizing insulation, and using efficient lighting systems [16].

4. Durability and Adaptability: A resilient design aims to build structures that can deal with and adjust to the different environmental conditions and accompanying natural disaster scenarios. LCA occurs with measurements of how durable or poorly durable the material and building system are across time so that the house would remain in its long-term livable space [15].
5. Waste Management and Reduction of End-of-Life: LCA looks at the end-of-life diameter of building materials and recommends strategies for deconstruction, reuse, and recyclability. This way, less material accumulates in landfills, corresponding to less environmental damage during demolition.

6. Performance Analysis

An important performance trait is assessing the efficiency and success of smart home systems. Smart home performance This process evaluates connected devices, the data taken from the system, and all changes made to improve the whole smart home experience and its successful function. Assess each smart device's functionality and integration within the home ecosystem and how it works as an integrated entity. Also, the devices should be checked to see if they perform their assigned functions effectively. Additional verification of a multimedia model may also provide accuracy and insight into the performance of the complete smart home system. Testing can be performed on components' response time, reliability, and interoperability in an integrated smart home solution.

Table 1. Device functionality

	Number	Functionality	Responsiveness (ms)
Multi media Panel	1	Good	79
	2	Good	75
	3	Good	85
	4	Good	83
Sensor	1	Good	50
	2	Good	51
	3	Good	56
	4	Good	52

Table 1 is the result of experiments to measure the function of each component in a smart home. Based on the experimental results, all multimedia display panels and sensors functioned well. All sensors (sensor in bedroom 1, sensor in bedroom 2, sensor in the living room, sensor in kitchen) and multimedia panels (multimedia in bedroom 1, multimedia in bedroom 2, multimedia in living room, and multimedia in kitchen) are working properly.

Other performance measurements include collecting information about smart home energy usage, device response, connectivity issues, system outages, and user behavior trends [17]. The smart home system measures energy consumption using a watt meter. Figure 7 shows the energy consumption of a smart home, and the measurement shows that energy consumption at night is greater than energy consumption during the day. There is also a slight increase in energy consumption in the morning.

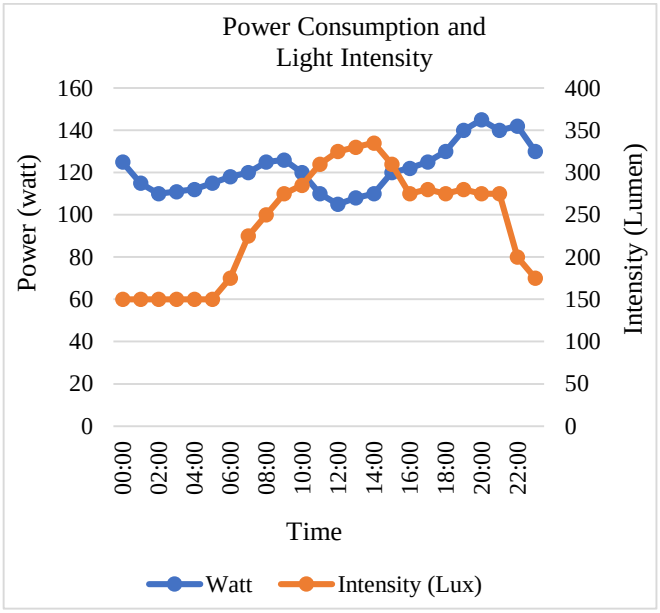

Fig. 7 Energy usage analysis

Using a smart home can save electricity by:

Electricity Saving = (160 - 130) / 130 x 100% = 18.75%

The responsiveness of each smart home device is measured using software. Multimedia display panels have responsiveness ranging from 75-85 ms. The sensors installed in the smart home have a responsiveness of around 50-56 ms, as shown in Figure 8.

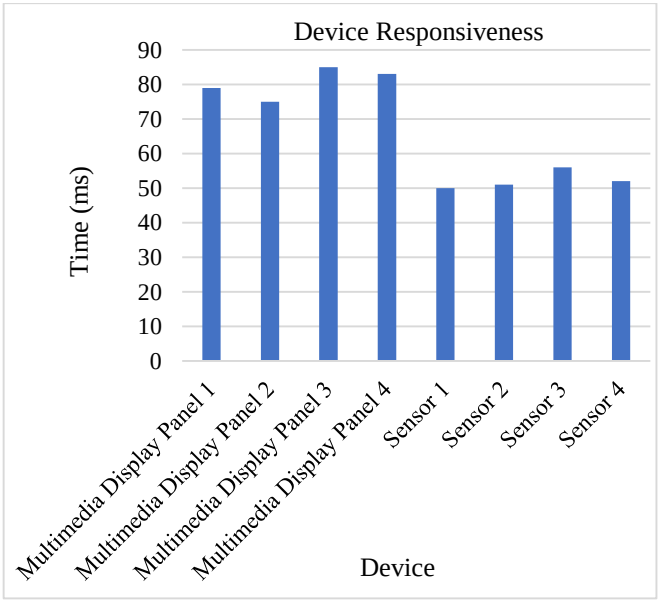

Fig. 8 Device responsiveness analysis

7. Conclusion

A traditional house does not mean it cannot be given a modern touch. Traditional Sundanese houses can be equipped with multimedia display panels and sensors to make the house a smart home. Based on the experimental results, all devices function properly. Energy consumption used by a smart home is greater at night than energy consumption during the day. The use of smart homes has electricity savings of 18.75%. Multimedia display panels have responsiveness ranging from 75-85 ms. The sensors installed in the smart home have a responsiveness of around 50-56 ms.

This response time is sufficient for a smart home system. Some advantages can be provided by putting smart home technology into conventional Sundanese houses, such as comfort, security, and energy threshold enhancement. Nevertheless, traditional houses' unique cultural and architectural elements need to be resorted to when persuading their roles to ensure that their implementations smoothly blend with the design that is lived and conserved within the cultural heritage. The output of this study can provide a framework for further studies and development in integrating smart home technology into traditional houses in Indonesia, particularly the Sundanese style.

7.1. Future Direction

Future developments in smart home technology and the multimedia panel design of Sundanese houses must combine modern technology with cultural aesthetics such as local traditional wisdom. Implementing Sundanese script and motifs onto user interfaces, allowing voice assistants to communicate in Sundanese, and automatically controlling traditional windows and bamboo ventilation, equating to enhanced comfort, would be a projection for upcoming developments. Sustainable ecology would be guaranteed through the adaptation of the Sundanese roofing system for applications such as solar panels, usage of LED lights along traditional colors, and the application of smart water management systems. In sequence, multimedia panels could have gesture-based controls taking inspiration from wayang movements and an AI-voice assistant modeled on the traditional Sinden singers. Complemented by AI surveillance to ensure that safety and culture could still exist together

Acknowledgment

The author would like to thank Maranatha Christian University for supporting this study. Thanks to Andrew Sebastian Lehman, Maranatha Christian University, for assisting with this research.

References

[1] N. Abdul Latip et al., "Identification of Timber Material Defect Using VIA on Selected Traditional Malay House: Case Study on Tuan Hj Hashim Itam (Kerani) Historical House at Penang, Malaysia," *2nd International Conference on Materials Engineering & Science*, Baghdad, Iraq , vol. 2213, no. 1, 2020. [CrossRef] [Google Scholar] [Publisher Link]

[2] Husam R. Husain, and Omar Salem, "The Role of Tactical-Ism and Community Engagement in Shaping Decent Neighbourhoods: Cairo Case Study," *New Design Ideas*, vol. 8, no. Special Issue, pp. 106-130, 2024. [CrossRef] [Google Scholar] [Publisher Link]

[3] Siti Halipah Ibrahim, "Reinventing Traditional Malay House for Sustainable Housing Design: Obstacle and Solution," *Technology Journal*, vol. 72, no. 1, pp. 97-102, 2015. [CrossRef] [Google Scholar] [Publisher Link]

[4] Shi Linfeng, Yang Wanyi, and Norsidah Ujang, "A Systematic Literature Review of Place Attachment in Environments, Cities and Landscapes," *New Design Ideas*, vol. 8, no. 2, pp. 389-411, 2024. [CrossRef] [Google Scholar] [Publisher Link]

[5] Dina Fatimah, "Implementation Overview of Minangkabau Society's life Philosophy on the Custom House Interior Plan," *Proceedings of the International Conference on Business, Economic, Social Science and Humanities*, pp. 147-151, 2018. [CrossRef] [Google Scholar] [Publisher Link]

[6] Purnama Salura, Stephanie Clarissa, and Reginaldo Christophori Lake, "The Application of Sundanese Vernacular Concept to The Design of Modern Building-Case Study: Aula Barat (West Hall) of Bandung Institute of Technology, West Java, Indonesia," *Journal of Design and Built Environment*, vol. 20, no. 1, pp. 1-12, 2020. [CrossRef] [Google Scholar] [Publisher Link]

[7] Zhang Jingling, "A Study on the Change of Functions of Kinari Village's Rumah Gadang," *Andalas International Journal of Socio-Humanities*, vol. 1, no. 1, pp. 18-24, 2019. [Google Scholar] [Publisher Link]

[8] Witold Brostow, Madhuri Dutta, and Piotr Rusek, "Modified Epoxy Coatings on Mild Steel: Tribology and Surface Energy," *European Polymer Journal*, vol. 46, no. 11, pp. 2181-2189, 2010. [CrossRef] [Google Scholar] [Publisher Link]

[9] Bhavna Sharma et al., "Engineered Bamboo for Structural Applications," *Construction and Building Materials*, vol. 81, pp. 66-73, 2015. [CrossRef] [Google Scholar] [Publisher Link]

[10] Michele Paradiso et al., "Usage of Bamboo Powder as an Additive in Adobe Bricks and Bamboo Canes Frame for the Reinforcement of Adobe Structure," *M Magazine*, vol. 15, pp. 70-79, 2019. [Google Scholar]

[11] J. Maknun, T. Busono, and Nuryanto, "Disaster-Friendly Sundanese Traditional Building Construction," *IOP Conference Series: Materials Science and Engineering, International Conference on Innovation in Engineering and Vocational Education*, Bandung, Indonesia, vol. 128, no. 1, pp. 1-9, 2016. [CrossRef] [Google Scholar] [Publisher Link]

[12] Rolando-Arturo Cubillos-González et al., "Design of Resilient Affordable Housing Prototypes for Latin American Cities," *New Design Ideas*, vol. 8, no. 2, pp. 300-312, 2024. [CrossRef] [Google Scholar] [Publisher Link]

[13] Haley M. Gardner et al., "Whole Building Life Cycle Assessment of a Living Building," *Journal of Architectural Engineering*, vol. 26, no. 4, 2020. [CrossRef] [Google Scholar] [Publisher Link]

[14] Yong Han Ahn et al., "The Greening of Affordable Housing Through Public and Private Partnerships: Development of a Model for Green Affordable Housing," *Journal of Green Building*, vol. 9, no. 1, pp. 93-112, 2014. [CrossRef] [Google Scholar] [Publisher Link]

[15] C.K. Chau et al., "Evaluation of the Impacts of End-Of-Life Management Strategies for Deconstruction of a High-Rise Concrete Framed Office Building," *Applied Energy*, vol. 185, no. 2, pp. 1595-1603, 2016. [CrossRef] [Google Scholar] [Publisher Link]

[16] Vaclav Hasik et al., "Comparative Whole Building Life Cycle Assessment of Renovation and New Construction," *Building and Environment*, vol. 161, no. 10, 2019. [CrossRef] [Google Scholar] [Publisher Link]

[17] Ameer Hamza Y, and Shravankumar Venumula, "Implementation of the Control System for Energy-Efficient Electrical Devices on IoT," *International Innovative Research Journal of Engineering and Technology*, vol. 9, no. 2, pp. 1-8, 2023. [CrossRef] [Google Scholar] [Publisher Link]