Temporary transit architecture: Reconstruction of dynamic soundscape through moment-based adaptive spaces

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Abstract. During seasonal mass migrations such as the *Idulfitri Mudik* (an annual homecoming tradition), transit hubs experience surges in activity that overwhelm conventional infrastructure, straining operational capacity and undermining livability. This situation highlights the need for temporary transit architecture that can dynamically adapt to fluctuating demand, providing spatial configurations and sensory environments. This study addresses that challenge by developing flexible architectural design solutions to accommodate crowd surges during *Mudik*, with a key focus on dynamic soundscape engineering to create contextually attuned auditory environments. The research interweaves adaptive architecture theory with practice, employing in-situ observations at transit hubs during the Mudik period, acoustic simulations, iterative laboratory prototyping of adaptive spatial configurations, and user experience evaluations to refine design interventions that preserve everyday functionality while scaling for peak festive crowds. Findings indicate that tailoring the soundscape to the event's cultural context enables transit spaces to accommodate crowd fluctuations and maintain a sense of place even at peak occupancy. These adaptive interventions offer practical strategies for efficiently managing transit hubs during the Mudik period, and the study advances architectural theory and practice by establishing a conceptual framework for temporary transit architecture within the context of periodic mass travel events.

1 Introduction

The annual Eid al-Fitr (Idul Fitri) homecoming in Indonesia (locally known as *Mudik*) creates a unique intersection between Islamic architecture and transit infrastructure. This section introduces the article's scope, highlighting how millions travel during Eid and how public architecture – from highway rest stops to transport terminals – adapts to serve both mobility and spiritual needs. It sets the stage for examining how Islamic design elements are incorporated into transient spaces and how infrastructure is adapted for the cultural phenomenon of Mudik. Mudik and Balik as Indonesia's Eid Homecoming Tradition: Cultural Significance and Scale. Mudik refers to the mass migration of urban dwellers returning to

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their hometowns for Lebaran (Eid al-Fitr), whereas *balik* denotes the return journey back to the cities [1]. This tradition is culturally ingrained—a time for family reunions, visiting elders, and seeking forgiveness in *halal bi-halal* gatherings. It involves tens of millions of travelers each year; for example, in 2023, an estimated 123 million Indonesians took part in Mudik [2]. Notably, Mudik is observed not only by Muslims but by Indonesians of diverse backgrounds as a nationwide practice, underscoring its role in social cohesion and national identity.

Soundscape refers to the acoustic environment that characterizes a place. Sound is not only considered as part of the noise that needs to be regulated, but also as an element that can enrich the human experience of a space [3]. Soundscape affects human sensory responses in various ways, particularly in terms of perception, health, and quality of life. Perception is a dynamic process influenced by complex interactions between cognition, emotion, and temporal context. Regarding time, the moment can be a trigger in the formation of perception. A moment is a point in time with particular significance [4]. A moment is considered a turning point that can change the way a person or society views things, even though it lasts only temporarily.

The moment highlighted is Eid al-Fitr, and it will be strengthened by providing facilities to accommodate the homecoming activity, which is widely observed as part of the tradition [1,5]. Homecoming is significant because it enhances the moment, and the increased traffic density it creates also requires a solution. Based on the Ministry of Transportation's forecast, the number of homecoming travelers in 2024 is estimated at 193.6 million, equivalent to 71.7% of Indonesia's total population. Compared to the number of homecoming travelers in the previous year, which reached 123.8 million people, there was a 56.38% increase in interest in homecoming in 2024 (Ministry of Transportation of the Republic of Indonesia, 2024). Careful, proactive supervision is essential to anticipate and address potential problems [6]. Architecture should not only function as a physical container, but also as a medium for capturing and interpreting moments. By triggering dynamic soundscapes through adaptive architecture, architecture can help bring temporary moments to life. As shown in Figure 1, a relationship exists among the proposed theories. Architecture, as a fundamental theory, has many discussions about the soundscape, especially how architectural elements can shape human perception of the soundscape around them [7–9]. This is then linked to the moment as the design's goal. Eid al-Fitr, as a moment of temporary migration, is considered to provide a new perspective in the study conducted.

With the Eid homecoming moment as a context, the design is closely related to transportation needs [10]. The phenomenon of shadow terminals, which, although illegal, is often used due to high demand, can serve as an inspiration for creating more integrated and organized architectural design. Additionally, the makeshift/shadow Bus Station (*Terminal Bayangan*) and Eid Post, which serve as the Basis of the Design, can be incorporated into the design, as they are reminiscent of the homecoming period. As a means of indicating a problem, how can architectural design emphasize the experience of the ongoing moment such as the homecoming period through dynamic sound engineering that stimulates perception via adaptive elements that respond to temporary needs? The objective of this study is to create an architectural design that emphasizes the experience of the ongoing moment, such as the homecoming period, through dynamic sound engineering that stimulates perception through adaptive elements that respond to temporary needs in adaptive architecture. This design is characterized by three essential aspects: place, time, and people. In the context of place, the design focuses on transit points widely used before the homecoming moment, especially in the shadow terminal area and its surroundings, which have development potential. The relevant period is the Idulfitri homecoming, when there is a massive spike in temporary migration activity. The humans at the center of this design are the homecoming travelers themselves. Architectural design that is adaptive to a dynamic soundscape and the homecoming moment has excellent benefits, both academically and practically. In practice, this design can maximize the efficiency of urban space by optimizing the existing space's functions. Academically, this design contributes to the study of responsive architecture in response to the needs of a dynamic soundscape designed to capture the transient moment.

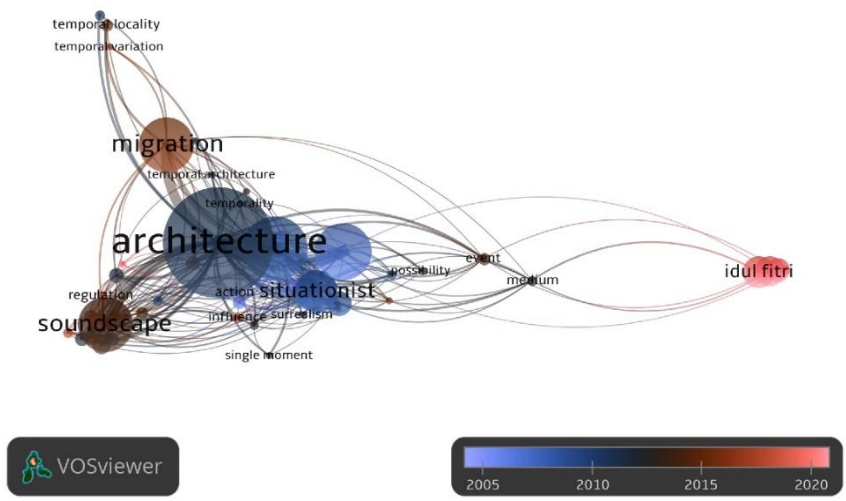


Fig 1. Research novelty analysis on VOS Viewer.

2 Methods

According to Wayne Attoe in the book Theory of Architecture, architectural theory can be understood through three main questions: What is architecture? What should architecture do? And how best to design?. These questions not only explore the essence of architecture but also discuss the goals and most effective methods in creating meaningful spaces for humans. The theory applied in this study focuses on the principle of What architecture should do?. This theory was chosen because the main idea of the design is how architecture can highlight the transience of a temporary moment. In this context, the moment becomes the primary focus of the design approach. Soundscape elements are held to influence human perception. Adaptive architecture then becomes a formal approach in design due to its ability to accommodate temporary and changing moments.

Soundscape is a term first introduced by R. Murray Schafer to describe the acoustic environment resulting from the interaction between sound and place. Schafer defines the soundscape as the totality of sounds that characterize a place, ranging from natural sounds to artificial sounds that emerge with the development of technology and urbanization [8,11,12]. The soundscape affects human sensory responses in various ways, particularly in perception, health, and quality of life. Research indicates that acoustic experiences can have a restorative effect, relieve stress, or, conversely, cause disturbance and decrease quality of life, depending on the acoustic context and the individual's perception of the sound. In urban or built environments, the soundscape is influenced by factors such as room conditions, the presence of physical elements that affect sound resonance, and the area's overall acoustic quality [13]. This is closely related to architecture; architectural elements play a role in dampening or reflecting sound, shaping a space's acoustics, and influencing user perception and comfort.

Soundscape is formed from the main elements that play a role in the acoustic experience of an environment, including [14]: a. Keynote Sounds, background sounds produced by nature (such as wind, water, and bird sounds) that are often overlooked but are essential factors in shaping the acoustic character of an area; b. Sound Signals, sounds that are intentionally heard or used as warning devices (such as bells, sirens, or vehicle horns) that become figures in the soundscape; c. Soundmarks are unique sounds considered the identity or symbol of an area (such as the sound of church bells or street vendors, typical in certain areas).

In the moment, time and rupture in modern thought, moments are understood as times that disrupt the normal flow of time [4]. Moments are not only part of the normal flow of time but also turning points that change how a person or society views the world. This is related to how humans perceive their surroundings. In psychological theory, perceptual moments—a brief period during which human perception captures reality—can be incorporated into architecture through spatial designs that invite sensory responses [15]. The context chosen for the design is the Eid al-Fitr holiday, which falls on 1 Shawwal in the Islamic calendar, as shown in Figure 2. Eid al-Fitr in Indonesia is closely related to the mudik tradition. Mudik comes from the word "udik," which means "village," so it can be translated as "going back to the village" [1,5]. As part of a public ritual, moments can create space to reaffirm social and cultural values that exist in society and interact in a larger context [16].

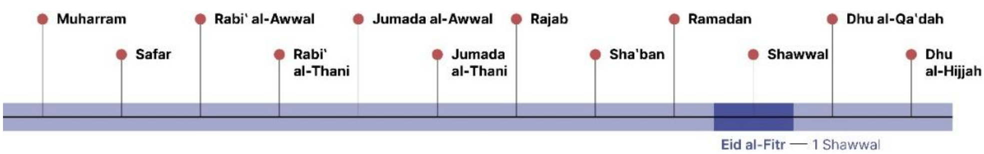


Fig. 2. Annual cycle in the Islamic calendar.

The movement pattern of travelers shows a significant increase in the seven days leading up to Eid al-Fitr. In contrast, for the return flow, the number of travelers returning to the city tends to decrease in the seven days after Eid al-Fitr. The volume of travelers increases again, approaching the end of the leave period or joint holiday. For moments, temporary architecture is closely related to designs that respond to changes in the cycle of time and human activity. Temporary architecture is not only seen in terms of static space but also as part of an experience that changes with specific moments and times. Eid al-Fitr triggers homecoming, which brings significant changes in the use of space in urban areas, especially related to transportation. Architecture can enrich the user experience during this brief period by incorporating significant architectural elements.

Adaptive architecture is a design approach that allows buildings to adapt to changes in human needs and the surrounding environment. Through adaptive architecture, a building is designed with flexibility in mind to accommodate various functions and facilitate structural changes over time [17]. As shown in Figure 3, there are six main types of adaptability based on the kinds of changes that can occur in a building.

The thinking process in this design is based on the method developed by Plowright in Revealing Architectural Design: Methods, Frameworks and Tools. Figure 4 shows the interaction among the framework, design approach, design method, and design tools as interconnected components at each stage of the design process. The framework serves as a foundation for exploring ideas, for example, through pattern-based, force-based, or concept-based approaches [18]. This forms a belief filter that shapes how one views the problem to be solved. The chosen design approach is connected to the belief filter, reflecting the values and assumptions that shape the priorities to be taken. The design's priority determines the method used. This method is then implemented using design tools. The result is a design proposal that reflects the entire process.

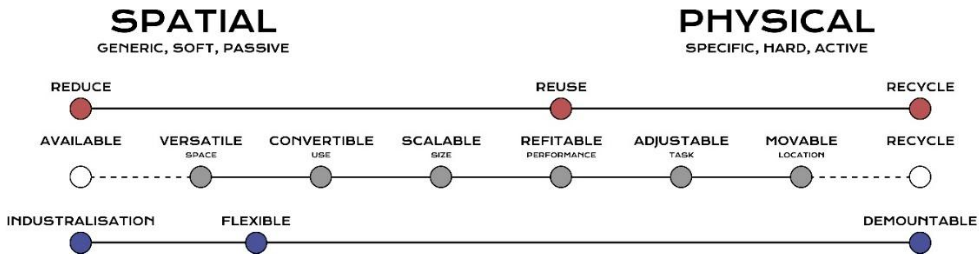


Fig. 3. Adaptability types in architecture.

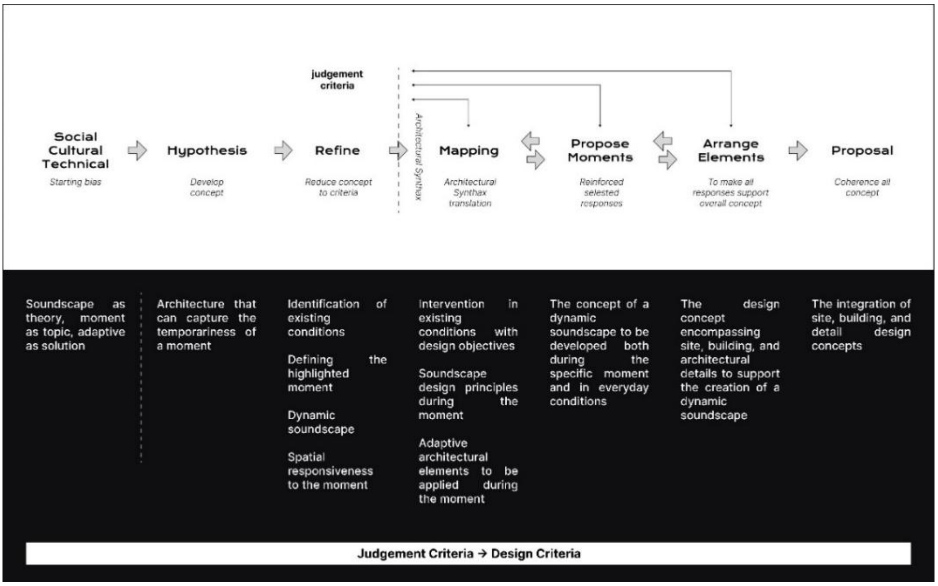


Fig. 4. Design framework.

In the design process, design tools serve as a medium for developing ideas and ensuring that the designs created can be communicated effectively and efficiently. Design tools are practical instruments or technologies that assist in the implementation of design methods. The following are the tools and materials used in this design process: a. Data Analysis, including understanding the context, location, and environmental factors that influence the design. This tool ensures that the design is responsive to external factors, such as climate, topography, and urban context, thereby optimizing building performance. b. Diagrams are simple representations of complex ideas or systems in architecture. Diagrams break down complex relationships, making it easier to communicate the design concept framework. c. Collage, exploring visual styles, materials, and contextual relationships. This tool helps reference real-world elements and combine various visual inspirations to create a design. d. Computational tools, such as CAD and 3D modeling software, facilitate precision in designing complex forms. These tools expand the architect's ability to model and manipulate forms, thereby increasing efficiency and accuracy during the design process.

Figure 5 illustrates the design implementation method employed, which begins by collecting data on moment specifications, soundscapes, and adaptive architectural types. This is followed by an analysis to determine the needs and design principles that support the objectives of the engineered acoustic environment. The results of this analysis are then synthesized into technical criteria and concepts that are applied to the design. The iteration process is carried out in conjunction with the design to refine it, ensuring it meets all needs and remains responsive to temporary moments in its use.

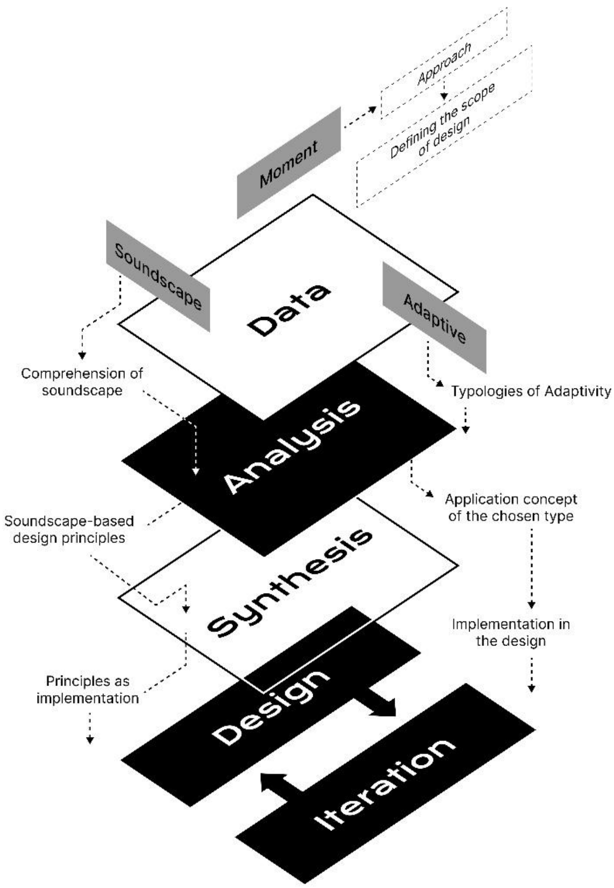


Fig. 5. Design flows.

3 Results and discussion

3.1 Description of temporary transit architecture site

The design is expected to have a significant impact. Research was conducted to identify terminals with relatively high activity levels, so that the provision of temporary transit architecture during the homecoming period can support the main terminal. It was found that the Purabaya Terminal is the busiest in Southeast Asia [19]. The shadow terminal of the Purabaya Terminal is in the Medaeng area, and an analysis was conducted throughout that area. The selected land was either empty, had a related function, or was considered suitable for further utilization. It illustrates the presence of numerous bus parking lots, several empty lots, buildings with associated functions, and several informal buildings that can be adapted. From these potential lands, the choice was narrowed to those optimized for design purposes. The choice fell to four lands outlined in red. The separate lands are planned to be connected by a connector to improve their integration, as shown in Figure 6.

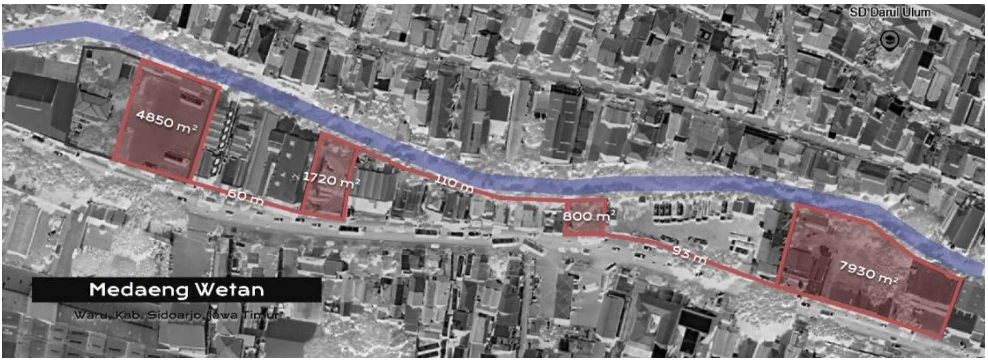


Fig. 6. Site location.

3.2 Proposal for reconstruction of dynamic soundscape through temporary transit architecture

The dynamic soundscape is the first concept discussed, ensuring that the design elements displayed will continue to complement and truly accommodate the targeted dynamic soundscape. The design concept begins by detailing the atmosphere to be created for the relevant users. The details of this atmosphere include how the dynamic soundscape will be made in the moment and how it contrasts with a typical day. The explanation related to this is presented in Figure 7.

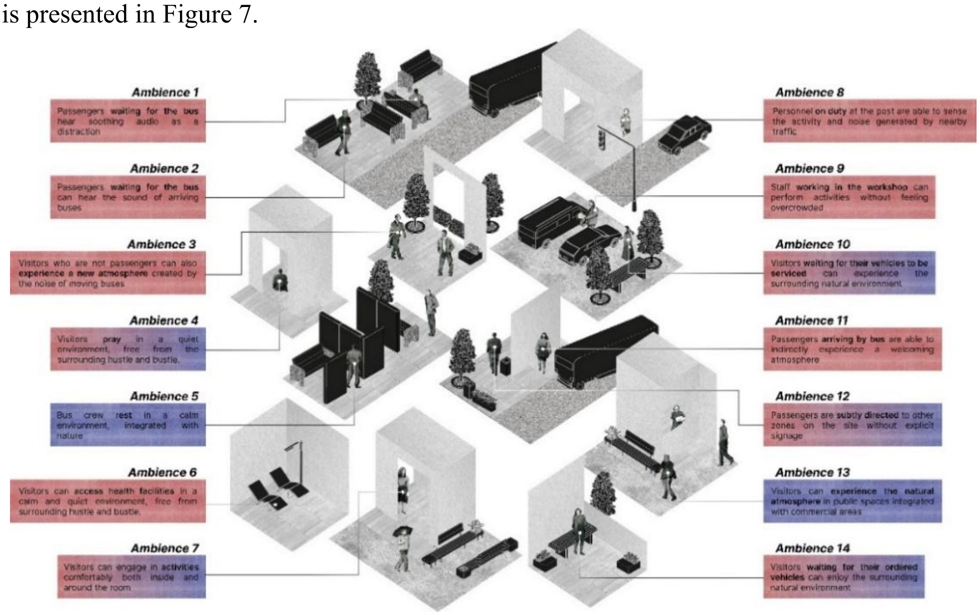
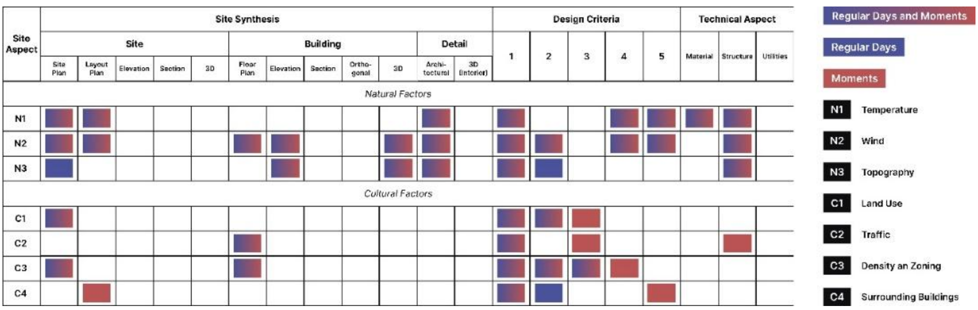


Fig. 7. Dynamic soundscape atmosphere concept.

After mapping the dynamic soundscape design for each land, the concept development for design elements can begin. To ensure focus and alignment with the topic, a scenario table is used, as presented in Table 1. The design scenario ensures that every design decision made is the result of a synthesis of site conditions and still meets the design criteria. Concept exploration for design decisions is based on precedents. Precedents can be designs that have been built or theories about the systematics of how something works that have been proven to exist. Concept exploration begins by describing the findings from the precedent and then linking them to existing site conditions, based on the innovative idea to be implemented. The chart explaining the concept is divided into three sections: site design concept, building design concept, and detailed design concept. The exploration flow of each design element presented in Figures 8-12 consists of mass and vegetation arrangement, orientation concept, bus transit area, temporary structure concept for Eid post, and responsive element concept. Among all dynamic soundscape concepts, these ideas have been the representative of the scenario stated in Table 1.

Table 1. Reconstruction scenario.



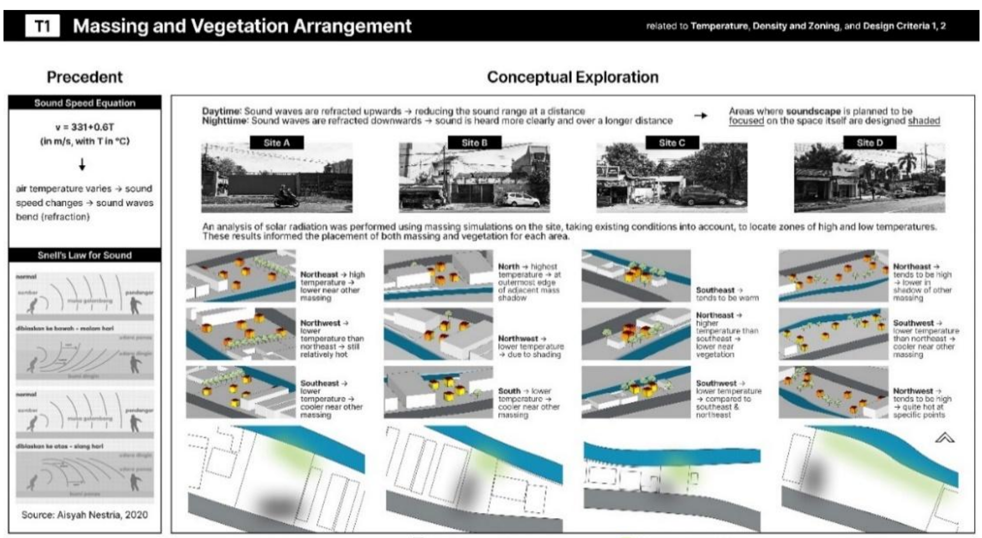


Fig. 8. Mass and vegetation arrangement.

Figures 8 and 9 illustrate that the plan's implementation centers on reducing noise through the use of natural or passive techniques [20–22]. Additionally, the concept of mass organization and direction is illustrated by these figures, which are a demonstration of the concept. As an additional point of interest, the idea of the bus transit area, which is illustrated in Figure 10, is now being created in order to concentrate the auditory presence within the terminal. The establishment of the dynamic soundscape is done with the intention of serving as an essential notion for the construction of the environment of sound. The execution of the 14 ambiance techniques, which are depicted in Figure 7, is carried out in this manner. The utilization of all of the structural technical method state components that are shown in Figure 11 as well as the specific response components that are illustrated throughout Figure 12, has been proven to be an efficient means of accomplishing this purpose.

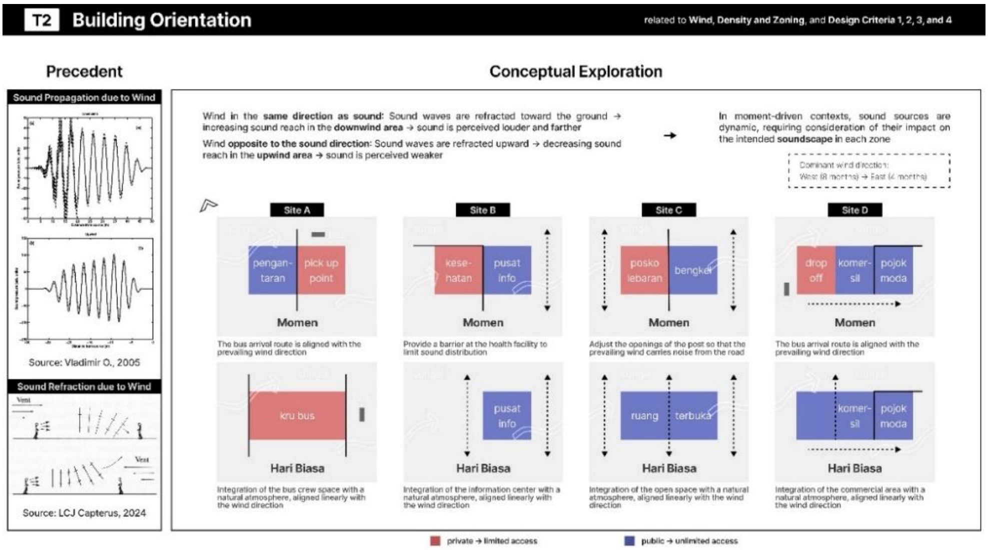


Fig. 9. Building orientation concept.

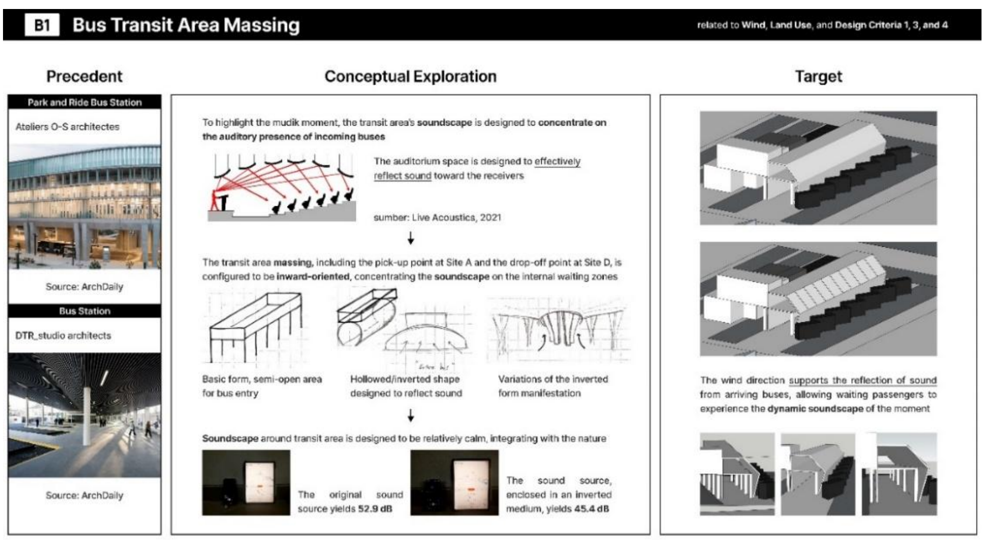


Fig. 10. Bus transit area.

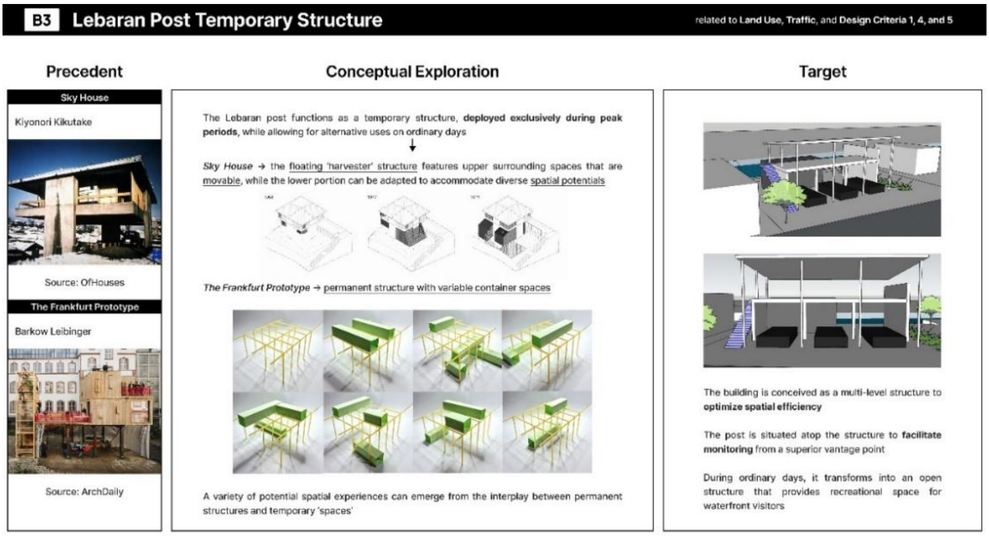


Fig. 11. Temporary structure concept for Eid post.

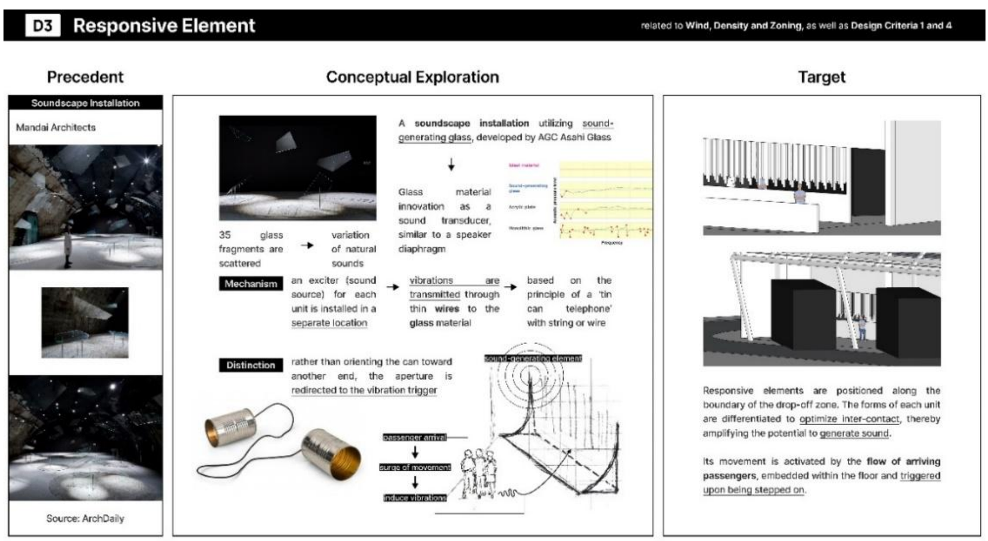


Fig. 12. Responsive element concept.

3.3 Reflective discussion: Transportation hubs and religious needs

In Muslim-majority contexts, transit architecture is not just about moving people, but also about accommodating spiritual practices. This subsection highlights how major transportation hubs provide facilities for worship, recognizing that many travelers will need to pray during their journey. Airports around the world, including in Asia, now routinely include multifaith prayer rooms or dedicated Muslim prayer halls, so that passengers need not resort to praying in corridors or public areas [23,24]. We will discuss standards for these facilities, such as proper ablution areas and orientation toward Mecca, and how they are seamlessly incorporated into the designs. In Indonesia, train stations and bus terminals commonly feature a *mosque* (small mosque) on site. Providing such spaces in terminals during Mudik is crucial, as it allows travelers to fulfill their religious obligations end route. This section uses examples, such as the mosque and prayer rooms at Soekarno–Hatta International Airport and Jakarta's rail stations, to illustrate how transit hubs balance functionality with faith, particularly during the Eid rush, when these facilities see peak usage.

3.4 Toward a conceptual framework for spiritually resonant transit architecture

Building on the above insights, we propose a conceptual framework for designing public transit architecture (such as rest stops and temporary prayer facilities) that integrates practical functionality with Islamic sacred cosmology**.** The framework is organized into key principles: Unity and Purposeful Design. All design elements should stem from the principle of unity, unifying people (community), aligning with the One God (orientation), and harmonizing with the environment. This means that every aspect of the architecture serves a dual purpose: both functional and symbolic. For instance, a roof can provide shelter and simultaneously symbolize the celestial dome of heaven; structural patterns can support the building and echo infinite geometric motifs of Islamic art, reminding users of the divine unity that underlies diversity [25]. By keeping the unity at the core, architects ensure that the space naturally invites a unified experience of the material and spiritual (as Ardalan would advocate [26].

The deeper dimensions of Islamic architecture – its metaphysical underpinnings, symbolic language of geometry and light, and Sufi-inspired focus on experiential spirituality – provide a rich source of guidance for designing transit spaces during Mudik and similar collective journeys. By viewing Mudik as not merely a logistical phenomenon but *as* an expression of spiritual movement (a physical enactment of returning to one's origins, echoing the ultimate return to the Creator), architects and planners can transform mundane rest stops into sacred waystations**.** The outline above proposes that through intentional design principles, even temporary, adaptive architectures can embody sacred cosmology**:** the unity of God reflected in harmonious forms, the journey of the soul mirrored in spatial sequences, and the rhythm of the cosmos felt in patterns and sounds along the road [27,28].

3.5 Dynamic soundscapes for spiritual comfort during mudik travel: Cultural and emotional responses to sound

Mudik – the homecoming exodus during Eid – challenges Muslim travelers to maintain spiritual focus amid noisy highways, bus terminals, and airports**.** Dynamic soundscapes can transform transient prayer spaces (e.g., rest-area mosques or airport prayer rooms) into sanctuaries of calm. This report examines how carefully curated sounds (adhan, Qur'anic recitation, ambient nature) and acoustic strategies reinforce a sense of the sacred in chaotic environments. It also explores practical design measures (spatial zoning, acoustic materials, directional audio, sound masking), the cultural/emotional impact of different sounds, relevant case studies, and theoretical foundations from Islamic aesthetics, soundscape studies, environmental psychology, and architectural acoustics [24,29–32]. The goal is a comprehensive understanding of how sound can enhance the spiritual experience of Muslim travelers in transit. Designing the soundscape of a prayer area goes hand in hand with architectural acoustics and layout. In noisy transit settings, the goal is twofold*:* block or mitigate intrusive noise from outside and enhance desired sounds within.

The strategic use of sound in these spaces is not just functional but profoundly emotive. Ritual Islamic sounds reinforce identity and peace, while natural sounds contribute to serenity and focus. Reducing unwanted noise prevents stress and distraction. For Muslim travelers, a prayer space that "sounds right" is as important as how it looks – it can mean the difference between a hurried, distracted prayer and a deeply felt spiritual moment on the journey.

4 Conclusion

This architectural design is formulated as a response to the transient nature of a moment felt by humans, with a focus on dynamic soundscapes engineering as the main element. The synthesis of site analysis, literature review, precedent study, and regulatory standards produces an adaptive space design that can respond to the dynamics of the soundscape. This approach incorporates the use of flexible, modular elements, integration with the existing site, and the application of acoustic design strategies to enhance user comfort. By prioritizing spatial flexibility and adaptability to temporary moments, this design not only offers a functional solution during the homecoming period but also contributes to the overall quality of urban space by increasing the effectiveness of the main terminal during the moment. Soundscapes will undergo improvements. Ensuring that additional simulations related to the soundscape can test the performance of the designed adaptive space, especially in the moment. In addition, the development of design details. Deepening the technical aspects of adaptive design, integrated with acoustic intervention elements.

During the frenetic journey of Mudik, a thoughtfully designed soundscape can create a transient prayer space that feels as sacred and soothing as one's home mosque. By blending Islamic acoustic traditions (a clear call to prayer, soothing Quranic recitation) with modern design tactics (noise-control materials, sound zoning, and adaptive audio systems), even a small rest-area *mosque* or airport prayer room can become a bastion of tranquility. Key soundscape elements, such as the adhan, act as beacons of divine reminder amid chaos, while ambient sounds of nature or water impart calm and mask the din. Practical measures – from arranging a quiet corner to installing beam-steered speakers and acoustic panels – ensure that desired sounds are heard with clarity and unwanted noise is hushed. The emotional payoff for Muslim travelers is significant: better concentration, comfort, and a deeper spiritual immersion in their worship, which in turn reduces travel fatigue and stress. Dynamic soundscape design acknowledges that a space's holiness is experienced in its hush and harmonious sounds. As the Muslim poet Rumi wrote, "Silence is the language of God, all else is poor translation." In the context of Mudik, creating moments of silence and sacred sound for travelers is a gift that resonates deeply. By applying interdisciplinary insights and engaging with cultural sensitivities, architects and planners can ensure that even on the loudest of journeys, the spiritual heart finds a place to rest, enveloped in an oasis of peace and reverence, one prayer at once.

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