Traditional architecture translation of Dhurung Barn to Bawean’s Airport, East Java, Indonesia

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Abstract. The tropical architecture of island city, Bawean, has been known as a cross-cultural result. The archipelago environment is exposed to high solar radiation and wind, thermal potency and problems are accumulated with the noise problem of the building. Therefore, this study aims to provide the design proposal and analysis for the contemporary architecture with pioneer airport design as an object through re-interpreting traditional channel approach of Bawean architecture as a case. In the transformation process and its thermal interference in the design is evaluated by the Flow Design simulation program to evaluate the proposed design wind flow and a noise control evaluation. The concept of Bawean architecture, mainly the Dhurung Barn, is applied by implying its original form into the modern form without losing the conveyed meaning. The results of this airport design show the locality of shape, space, and zoning, and the formation of thermal and acoustic design integration.

Keywords: Airports design, noise control, thermal environment, tradition-based paradigm, tropical climate.

1. Introduction

In general, the implementation of the tropical architecture paradigm, tradition-based, with re-interpreting tradition channel is conducted for contemporary architecture design using a transformation of traditional translation [1]. The design conversion can be matched with the word displacement, which means the change from the original object to its invented object. Both changes that do not have or show the similarity with the original object or changes that the object is still showing clues to the original object and authentic harmonious typological of eco-cultural [2]. The development of archipelago architecture that can be done now can be done in one ethnic group by exploring the elements that exist in it. The presence of something new can be done by taking all or part of ethnicity.

Geographically, by mixing of Javanese, Madurese, Malay, Buginese, and many more other cultures, the Bawean built environment is met through temporary meaning to translate the traditional formal meaning into a newer form. The cross-cultural scheme defines the architecture performance. In line to previous study [3], a conserving architectural heritage is like the requirement of global needs in recent time. The development of Bawean Island, East Java, Indonesia is increasingly rapid, not fully able to fulfill all daily needs and tourism by using sea transportation modes. However, since the launch of the Harun Thohir Pioneer airport (Figure 1), Bawean Island has become easier to reach to meet the needs of the Bawean community and tourists. In the future, air transportation modes will develop, starting from adding flight schedules and routes, to transit places to several places. Because of this,
there is a need for the development of the Harun Thohir, Bawean Pioneer Airport. In general, the scale of building system integration is also offered in airports, between utility systems, structures, and building materials, with totally passive and active-passive hybrids as a functional consequence, energy efficiency and locality issues.

Convenience for users is considered as a factor of design transformation because each user has different sensitivity related to thermal and acoustics. The average passenger is capable of adjusting conditions than workers who are more sensitive to temperature differences. While related to acoustical comfort is also essential, the disturbing factor is noise. The continuous increase in noise levels from various activities at the airport environment can lead to noise disturbances. First, the psychological effects on human noise can shock, disrupt concentration, interfere with communication in conversation and interfere with results work and work safety. The environmental settings concern in accumulative effects even though the condition is in a low temperature and noise [4]. Secondly, the physical effects of noise can result in decreased hearing and pain abilities at a very high level. Thermal and acoustical integrates of the critical problem of the tropical urban issues, thermal and noise in the simultaneous time.

In line with similar review [5], rethinking why local traditions are frequently unrestricted and substituted by more modern ones, and attaching the lessons from traditional architecture for sustainable design, the method and emphasis of study would shift the paradigm. This research will propose the hybrid strategy on compromising method for a better living environment by conducting the tradition-based approach for contemporary commercial design. Most of the previous studies have evaluated the thermal and acoustical method for architecture design concepts only as initial investigation proposed [6, 7] , offering an integrated standard [4, 8] or conducting a separate discussion and analysis [9–11]. Therefore, this study aims the novel idea on thermal and acoustical intervention as the design tools to deliver the architectural design using tradition-based approach.

2. Methodology
Recently, many airports in Indonesia have been designed in a specific location because there needs to be a building that characterizes the identity of a region in both building and detailed forms, literally or philosophically. Because of this reason, in this research, the Harun Thohir Bawean Airport needs to display the typical architecture of Bawean. A distinctive feature of houses located on Bawean is the Dhurung Barn located in front of the house for residents who are still living on (Figure 2). This building functions as a rice storage house even though that is not all. When the lowest part of Dhurung (feet) is used as a storage place for firewood, the middle (body) is where people move and make social activities (Figure 3). The most important part, the roof (head), it has functioned as a storage area for rice. The most distinctive of its own Dhurung is its order and function. Whereas the roof is only a decoration, which can vary from each Dhurung.
In this design proposal, the transformation of the traditional Bawean architecture, namely the Dhurung Barn, which is the hallmark of the Limasan house (the traditional house) into an airport building using a re-interpreting channel. Explored related the blurred boundaries between the traditional and contemporary on architectural design, the mysterious interpretation will be the triggers of sustainable design [12]. With the transformation, the design proposal was directed to be able to show the local characteristics of Bawean Island. In researching this design proposal, the approach that fits the issue is a tropical architecture of island city. Also, it is closely related to thermal conditions and the locality of the site. The main points in consideration of designing tropical buildings are minimizing the increase in heat during the day, maximizing heat release during the night, minimizing the increase of internal heat, select sites based on micro-climate criteria, optimization of building structures, control solar radiation, and exchange air circulation.

The Dhurung Barn formal transformation is used to translate the contemporary meaning for Harun Thohir Airport building. This process involves several aspects, both physical and non-physical. Therefore, in this transformation, it does not need to move the physical aspects only, but also what is related to thermal and acoustical aspects as a control variable. All the considerations chosen in the transformation process will be adjusted to those environmental issues. As shown in Figure 4, the tradition-based method is analyzed through finding the scale of design principles (physical or social-
cultural), rethinking of symbolic language (low or high), and how modern or tradition will the design go. The re-interpreting will also be compared to the other traditional based channels (reinvigorating, reinventing, and extending paradigms).

3. Results and discussion

3.1. Formatting the title

The concept of space is personalized to the requirement of its users (Table 1). For designs related to thermal and acoustical comfort, it will be adjusted according to user, activity, and time of use. The detailed design presents the impression of the Dhurung Barn created through how users interact directly with the details of buildings that resemble Dhurung. The concept of forms and facades uses forms that describe the identity of the place. With the transformation of the Dhurung Barn to become an airport, it conveys the impression that this airport is the first greeter before heading to Bawean Island. With the transformation of the Dhurung Barn shape, it is also possible to integrate with thermal and acoustic aspects. For example, the roof with an angle of 60° and has the best performance cavity. A typical high sloped roof could be the possible building performance due to the angle, area, and cavities. The zoning concept for design objects is adapted to the technical aspects of airport standards, wind direction, and distance with airside facilities. Natural ventilation generating the wind used for passive cooling while the noise can be attenuated. This acoustics simulation results for transmission lost due to increased distance and material change. In line to preceding discussion [7], the noise propagation is reduced by considering the ground reflectance, diffraction of the site and building elements, and atmosphere intervention.

| Name             | User                  | Activity               | Duration | Cooling Method | Concept |
|------------------|-----------------------|------------------------|----------|----------------|---------|
| Check-in Room    | Passengers            | Light Working (check-in)| 15 min   | P              | O       |
| Waiting Room     | Passengers            | Resting (waiting for departure) | 1 h to 2 h | A              | C       |
| Employee Office  | Airport Operational Unit | Working               | 8 h      | A              | C       |
| Airline Office   | Airline Employee      | Working                | 8 h      | A              | C       |

Notes: A = Active; P : Passive; O = Opened design wall (high Window to Wall Ratio = WWR); C = Closed design wall (low Window to Wall Ratio = WWR)

3.2. Design transformation

The transformation process begins through sorting the architectural elements that will be transformed, ranging from images, functions, to building details (Table 2). All design process results in the final design (Figure 5).

| Element          | Existing Design (Dhurung) | Final Design (Airport) |
|------------------|---------------------------|------------------------|
| Image            | i. The roof’s angle of 60° | i. The roof’s angle of 60° |
|                  | ii. Palm leaves material as roof cover (not transparent) | ii. The material of concrete and glass shingles as roof cover (mixed) |
|                  | iii. Jelapang (Dhurung’s column element) | iii. Jelapang |
| Function         | i. Receiving guests | - Receiving people first entering Bawean |
|                  | ii. Activity: Afternoon: weaving /Night: rest | Changed activities |

Table 2 continued on the next page
Table 2. Continued

| Element       | Existing Design (*Dhurung*) | Final Design (Airport) |
|---------------|-----------------------------|------------------------|
| Construction  | i. Stilt structure          | i. Airport             |
|               | ii. Wood construction       | ii. Stilt structure    |
|               | iii. Overlap connection/joint| iii. The mixture of laminated wood, concrete, and steel |
|               | iv. Four columns            | iv. Connections/joint are piled up |
| Thermal       | i. No-wall at level 1 (crossing) | i. A concept of ‘minimal walls’ |
|               | ii. Shading due to the roof | ii. Shading due to the roof |
| Acoustics     | i. Comfort from noise even without protecting the wall | i. Noisy can be ‘enjoyed’ |

As shown in Figure 6, the airport design transformation process could be illustrated as follows:

i. Starting from a *Dhurung* with an elongated ratio, then transformed by way of translation of maintaining the original ratio of the building,
ii. copying to the West, by giving a distance to give space so that the wind can pass through space,
iii. designing an evaporative pool to reduce temperature and regulate humidity,
iv. implementing the concept of ‘minimal walls’ to allow wind crossing (Figure 7 and Figure 8). Also, the concept of ‘minimal wall’ also allows outside noise to enter so that it can be used as a guide,
v. column placing process, affecting the ratio will be extended and the formation of a new column is designed due to the relation of one or two or four columns,
vi. installation of beams arranged overlapping,
vii. second floor as ‘connecting’ to the apron,
viii. designing the rooms and floors according to space requirements and standards, and
ix. different building height and distance between buildings, causing shadow due to other buildings.

Meanwhile, as shown in Figure 9, the following explanation is the process of transforming roof designs:

i. The roof with a slope of 60° to inhibit the heat radiation received, copied according to the needs of existing buildings,
ii. distinguished by its material to provide light openings,
iii. extended in the west,
iv. divided according to needs, and differentiated to provide cavities and wind vents and the heat trapped inside can come out.

Figure 6. Transformation process.

Figure 7. Noise control (Matlab analysis).
3.3. Final translation
As previously explained, the existing standard will be given a special outcome. This is related to users, activities, and time can be seen from several rooms, such as the check-in area as shown in Figure 10a, according to Table 1. It is preferred that passengers who report themselves no more than 15 min. Therefore, it allows the area to use passive cooling. However, the result of passive cooling causes incoming noise concentrations. According to previous study [7], the openings in tropical walls do affect passive cooling. On the other hand, they will also include noise in the same direction as the
wind vectors. Because people tend not to be there long, it will be ignored. Moreover, the suitability of the Dhurung Barn does not have a wall so that the concept of minimal walls appears.

The waiting room, usually passengers, are there in 1 h to 2 h. This is longer than the short self-report time. Thus, there needs to be active cooling in the room and also causes the walls to tend to be closed (Figure 10b). So that it will minimize noise because the Dhurung Barn has a storage function at the top level due to air control. Finally, the placement position of the waiting room is on the second floor. The design of rooms related to airport operations; existing employees tend to spend a long time each day, and they are more sensitive to the quality of comfort temperature. For this reason, these spaces use the hybrid method of active and closed cooling. This is closely related to the effectiveness of work.

![Figure 10. Check-in (a) dan waiting (b) rooms design.](image)

The facade of the building is formed from the Dhurung Barn transformation process which is adapted to the thermal and acoustic aspects, and it is designed just displaying the form. Overall, Figure 11 illustrates that this building has similarities, namely: i). Has the same roof shape but different material; ii). Stage-shaped buildings; iii). Level 1 has a minimal wall concept; iv). level 2 is closed; v). Column material from glulam wood; vi). It is expected that with the form that has similarities with the Dhurung Barn, it describes the same function, as the first greeter before entering the inner area.

The building zoning is based on standards and technical requirement of the terminal building, the airport operations office located near the apron (Figure 12). As a result, there are noisy consequences obtained. However, it can be minimized by giving distance, level differences, and material selection. For orientation, the building does not block the wind and can put wind in the building while the lodging building is located far from the apron. The existence of long distances and barriers in the form of other buildings causing noise can be more minimized. The arrangement is expected to be able to pass through the building.

![Figure 11. Roof attic of Dhurung (a) and proposed final design (b).](image)

![Figure 12. Axonometric of the final design.](image)
3.4. Rethinking of tradition-based channels of tropical architecture

Since the contemporary architecture proposed by the architect, the idea has been generated by thinking their regional and contextual richness. The scale on borrowing the tradition for contemporary tropical architecture is broader from adoption in reinvigorating to the idea of reinterpreting as proposed by this study. Calling back of tradition-based analysis (Figure 4), the principles of reinterpreting walk harmonically to the current and nowadays trend and user perception (see Figure 13). In addition to prior reports [13, 14], the tropical architecture has been and remains to be, an everchanging constructed object, from traditional (Dhurung) to the contemporary meaning of airport.

Figure 13. Indication of the tropical tradition-based channel.

The physical principles dominate the design transformation compared to the socio-cultural dimension. The high-sloped roof shows that as the representative of formal aspect and the space movement for the new function of contemporary architecture is implemented based on the environmental consideration and standards taken from the characteristic’s similarity of Dhurung, more than socio-cultural understanding. The same of thoroughly modern translation compared to the traditional option is the characteristic of a contemporary channel of reinterpreting approach. Meanwhile, the figure of the tradition-based channel is still recognized by half of the symbolic meaning of the traditional expression. The mid-level of the symbol is the representative of all tradition-based channels. In general, when the identical Western trope for the term of the “otherness” of the “tropical” state well-known by previous research [15], this research exhibits the power of tradition-based as the roots of tropical itself by involving the symbolic meaning in addition to the principles and translation design.

4. Conclusion

The airport development is proposed to be able to meet the needs of flight activities. Thermal comfort and acoustics are maintained in quality so that users feel more comfortable than the existing. The new concept offered is the integration between thermal and acoustical aspects. In addition, it is expected that this airport can show its role as a gateway that represents the Dhurung Barn for each house on Bawean, by giving an impression on the shape of the building and the details. Re-thinking on traditional-based channels will return the architect to the native richness, their traditional expression. The mid-level of a symbol is the representative of all tradition-based channels. The contemporary translation represented by airport design demonstrates the formal and spatial locality
integrated with the environmental issues of the island city. Moreover, the transculturation idea in the tropics this study of the tropics needs to figure out on the idea of transculturation as illustrated on island city characteristics, looking at the encouragement the local architecture on the systematic and so continuously.

Acknowledgments
This research is part of Excellent Primary Research of Higher Education, Penelitian Dasar Unggulan Perguruan Tinggi No. 877/PKS/ITS/2019. The authors gratefully acknowledge this financial and technical support.

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