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**Submission date:** 10-Jan-2023 02:22PM (UTC+0700)
**Submission ID:** 1990625016
**File name:** ARTEKS_EN.pdf (1.03M)
**Word count:** 4612
**Character count:** 25599

# MAPPING OF RESIDENTIAL DUAL FACADE DESIGN IN INDONESIA

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## Abstract

This paper aims to trace and map the variety of double facades in residential designs in Indonesia. This response to issues regarding technology development, design pattern, and the role of double facades in buildings related to aesthetic, environmental, and materiality issues in design practice. A qualitative approach with a descriptive observation case study method was conducted on various modern architectural designs in the typology of residential buildings in Indonesia to illustrate how designers positioned this double facade in their design. The connection between the double facades with tectonic, geometric, aesthetic, sustainability, and environmental issues is shown in this study. This paper set the study boundaries for exploring residential designs' typology because the limited scale allowed the designer to have considerable flexibility and exploration. The findings suggest various strategies and design exploration mapping related to double facades design. The results show that it can form a new character for contemporary Indonesian architecture and become an exploratory and responsive design element in its practices.

**Keywords:** facade, second skin, indonesian architecture, contemporary design

## Introduction

This study begins with the various visual characteristics of the residential-based architectural facade in Indonesia. Indonesia's humid tropical climate is the primary context in facade architectural design, especially housing, to achieve thermal and indoor comfort. Passive ventilation and lighting systems are one of the keys to environmental sustainability (Fathia et al. 2020). Designing architectural instruments, especially the facade as the outer shell of the building, is one of the primary keys to achieving this comfort aspect. (Manubawa, Purwanto, and Ardiyanto 2020). The creativity of architects or designers in presenting visual elements of a building facade can be integrated with this comfort purpose.

Along with developing various technologies and materials, architectural façade design is expanding with multiple techniques. Using a double facade with its technology is an alternative to exploring the façade design process (Zanghirella, Perino, and Serra 2011). The principle of using a double façade is to add geometrical instrument and material composition outside the main façade layer (Joe et al. 2014). The development of materials commonly used in Indonesia, including brick, concrete, wood, and stone, which are natural materials, shifted to practical materials resulting from more varied industrial processing. Industrial materials, synthetics, and fabrications can also influence the design character of residential architecture in Indonesia. In the era of better design publications, the creativity of processed facade designs is becoming more diverse and attractive in terms of material processing and visual composition.

Apart from being attractive from an aesthetic point of view, the use of a double facade also serves to achieve better thermal comfort (Ahmed et al. 2016; Yazdi Bahri, Alier Forment, and Sanchez Riera 2021; Yazdizad, Rezaei, and Faizi 2014). The double façade acts as a filter for air and natural light to circulate passively and in a directed method to achieve good indoor comfort. Material aspects, the influence of the direction of the opening, geometric composition, and so on can be managed in the design to achieve this comfort. The double facade has the potential to become a new identity for contemporary architecture, especially for residential design in Indonesia.

The many design explorations related to this design element prompted this study to see how far the architect is developing their design thinking. The purpose of mapping the variety of multiple facades is to see the diversity of tectonics, applications, and implementation of various technologies that support the design. This mapping also seeks to see multiple architect strategies in design exploration to achieve a responsive and contextual residential facade design.

## Method

This study is a qualitative exploratory study based on thematic case studies (Creswell 2018; Groat and Wang 2013). The research problem of this study is to map the various implementations of double facades, which can be read as architectural identity characteristics and contextual design strategies of Indonesian architects. Design practice can influence the development of knowledge equivalent to research (Verbeke 2013). The case study chosen is the architectural design of contemporary Indonesian housing within the past five years. This limit is determined to be able to see the latest developments in residential architecture, as well as residential architecture, which tends to be limited in scale size, and allows broader design exploration. Design exploratory studies are carried out using literature data (internet) through direct observation (direct viewing) or indirectly (through the media). The visual content is from the design publication on popular media.

The basis for determining to map refers to aspects and variables based on literature studies. Elements and variables of this study include the category of secondary facades based on the ventilation system, geometry pattern, material tectonics, application technicality, and role in architectural design. (Mahmoudi and others 2021; Ramadhan, Estika, and Widiastuti 2021; Yazdizad, Rezaei, and Faizi 2014).

### Secondary facade exploration

The development of facade design techniques aligns with material and construction technology developments. The definition of a double facade system (Double Façade System) is several layers that cover one or more levels of the facade separated by air pores, with a shading system and airflow that can be controlled through the spaces between the facade skins (Shameri et al. 2011; Boake et al. 2003). By implementing a double facade skin system, the innovation that can be obtained is maximizing the use of passive energy, especially ventilation, which can reduce active cooling loads, to achieve indoor thermal comfort (Zanghirella, Perino, and Serra 2011; Hosseini et al. 2019).

Another function of using this double shell is to create an intermediate space configured to separate the outer and inner areas that were initially directly connected. Its position is that this space can store heat, space cooling, and reduce noise from outside the building or acoustic comfort. (Su, Li, and Xue 2017). From this understanding, the functions of multiple skins will tend to vary, and the most basic is thermal comfort and lighting. The use of double skin, which can reduce heat in the room, functions as a shield system, which functions against the temperature, wind flow, noise level, and humidity level in the room. It has been proven quantitatively that the use of double skin is an alternative to achieving standard parameters of thermal comfort in tropical climates as a green building (Dewi et al. 2020).

Regarding the visual aesthetic factor, the use of double skin on building facades is used by many great architects in Indonesia. Generations of senior architects such as Andramatin, and Budi Pradono, generations of middle-aged architects such as Andy Rahman, Yusing to a generation of young architects such as Vidor Saputro, Yanuar Pratama, and so on. These facts show that the implementation of the double facade technique has expanded, especially in Indonesian architecture, by Indonesian architects across generations. Facade design has become one of the most explored design instruments and gives a new character to Indonesian residential architecture nowadays. (Misavan and Gultom 2014).

Design exploration is limited to specific materials, causing facade processing also to be limited. Meanwhile, nowadays, the choice of various materials makes architects free to define and have an extraordinary number of options in determining the visual character of their designs. In essence, the creation of the second skin façade should be an inseparable part of the design method and thinking, which cannot be seen as a partial element, but on the contrary, as an integrated element (Ramadhan, Estika, and Widiastuti 2021).

The material will significantly influence the second skin double facade. If other building elements are generally composed of multi-material configurations, such as walls consisting of layers of various components, the

second skin is relatively simple. The constituent elements are mostly divided into two categories, namely constructive elements, and filling elements (Dannapfel 2019). Constructive elements generally play a role in bringing together the second shell with the main facade of the building. These elements are typically composed of structural materials such as iron, aluminum, wood, etc. At the same time, the filler elements also determine the visual character of the skin of the two buildings. Infill elements can be composed of various materials, including bricks, metal plates, composite cement board (GRC) materials, ceramics, bamboo, etc (Utami, Rizki, and Jatara 2015).

In another discussion, facade technology is not only concerned with materials. The second skin configuration is detached from the first skin, allowing the facade to be configured flexibly, meaning it can move according to the user's wishes. Kinetic facade movement is generally designed to adapt to site environmental conditions, such as solar brightness, wind intensity, degree of privacy intensity, etc (Dwi, Widasari, and Arsitektur 2019).

In general, the parameters or variables that influence a double skin facade technique include (Jati, Thojib, and Amiuza 2015; Mahmoudi and others 2021) : Ventilation pattern, Geometric form, Material tectonics, Aplication technology and Role in design.

## Result and Discussion

This study's mapping and categorization will be divided into five main categories above. From the results of this mapping, a matrix and diagram are produced to reflect the development of contextual design strategies related to contemporary residential architecture in Indonesia. Another goal is that this study can become a catalogue that can assist designers in developing knowledge related to design (Karimah and Atmodiwirjo 2021).

**Ventilation pattern: Secondary facade as air and light filter**

- No Ventilation

This ventilation pattern places the second skin as forming the geometry of the building, where there is no purpose of ventilation conditioning to the space behind it. This type of design places a second skin as a massive wall covering the reverse area. This work by Gets Architects forms a multi-axis geometry through a double structural façade (Figure 1).

Figure 1. No ventilation secondary facade
Source: https://www.archdaily.com/966914/

- Semi Ventilated

This ventilation pattern places a second skin as the outer layer of the window behind it. The purpose of this ventilation is to condition ventilation and privacy so that the window ventilation behind it can be opened freely. This ventilation takes up part of the wall behind it. Elora House's work from Studio Bertiga uses bricks that cover part of the house's front façade (Figure 2).

Figure 2. Semi ventilated secondary facade
Source: https://www.archdaily.com/956863/

- Full Ventilated

This ventilation pattern places the second skin as the 'primary' skin because there is no longer a wall but a whole opening behind it. So even though it is constructionally manifested as an additional structure outside the primary system, this facade is a single layer. It is commonly used for transitional and semi-public areas (terraces/balconies) in residential areas, such as in the Lumiere House by Studio Avana below (Figure 3).

Figure 3. Fully ventilated system facade
Source: https://www.archdaily.com/941186/

**Geometric Shape: Secondary facade as aesthetic instruments**

- Repetition

This configuration is used by repeating the material linearly, both vertically and horizontally, to achieve a second skin facade configuration. An example of this repetition configuration is The Upstairs by Wahana Architects. The vertical repetition of the woods bar and line as the outermost part of the façade (Figure 4).

Figure 4. Repetition composition of facade
Source: https://www.archdaily.com/910498/

- Abstract

This configuration is used by abstractly arranging materials as patternless as the second skin layer of the facade. The application of the abstract composition can be seen in the work of HM House by Axial Studio. The roster block configuration is arranged irregularly, enhancing the abstract impression (Figure 5).

Figure 5. Abstract pattern based facade
Source: https://www.archdaily.com/887395

- Stacking

This configuration is commonly used by stacking materials such as bricks or rosters to obtain a composition similar to a bearing wall. The cavity created results from dividing the distance between the filler materials. An example of a work with a stacked system is Rumah 12 by Studio Kita. The material used is concrete blocks which allow air and light to enter the interior of the building freely (Figure 6).

Figure 6. Stacking composition of façade material
Source: https://www.archdaily.com/925070

- Weave

This configuration works like a knit/weave. Webbing seems to emerge from wavy arrangements that bind one another. The work that uses this principle is Weave House by Wahana Architects. You can see the woven impression from the outer part of the façade (Figure 7).

Figure 7. Weave pattern of façade material
Source: https://www.archdaily.com/952254

- Organic

This configuration works like a parametric system, where the movement of each element is conditioned according to specific parameters. In this case, an example is the work of Rumah Sutorejo by Dasquadrat. The rods are arranged with a particular slope to give the impression of moving as a whole (Figure 8).

Figure 8. Organic composition on facade
Source: https://www.arsitag.com/sutorejo-house

- Perforated

This configuration utilizes regular holes in the material, which is generally plane. An example of the work is the HOS House by MONO STUDIO. This work uses a perforated pattern on the aluminum panel, the primary material. Holes like this can be adjusted to the design of the architect (Figure 9)

Figure 9. Perforated pattern and façade form
Source : https://www.archdaily.com/951495

**Material Tectonics: Secondary facade as variation demonstration**

- Tectonics of transparency

Solid : The material is solid, meaning there is no transparency in it. An open impression is obtained by arranging materials at a certain distance so that holes appear between them. An example of a work with this type of material is Andyrahman's Omah Boto which use brick as primary material (Figure 10).

Figure 10. Solid tectonics of material
Source : https://www.archdaily.com/921631

Transparent : The materials are transparent, where transparency can be at a high level or slightly opaque. The choice of material can be in the form of field material or block material. Various transparent materials include glass, polycarbonate, plastic, and so on. An example of a work using a transparent material, which is a glass block as a second skin, is RAD+ar's Refraction House (Figure 11).

Figure 11. Transparent material of facade
Source : https://www.archdaily.com/921631

- Tectonics of material configuration

Panel System: The character of this material is modular and thin. Its use usually needs to be supported by an additional framework as a basis for construction. The choice of this material is diverse, including steel panels, composite cement panels, PVC plastic panels, aluminum panels, etc. Using it as is or perforated with laser cut or CNC techniques is also possible. An example of the work is the 3500 mm house by Ago Architect, with the second skin material being polycarbonate panels (Figure 12).

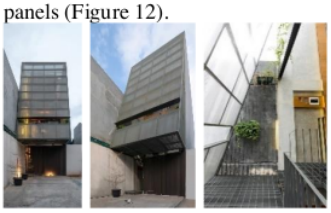

Figure 12. Panel system of facade
Source : https://www.archdaily.com/921631

Strip System : Strip or line-based material is generally a material with extended properties, such as iron bamboo wood, which is then arranged horizontally and vertically with a repetition system. An example of a work made of stem material is Parhuis House by Aaksen Studio. The material used is wood with a vertical configuration (Figure 13).

Figure 13. Façade system with repetitive strip
Source : https://www.archdaily.com/959889

Block System : Block material is a material whose unit is in the form of small units. These units can be arranged in such a way as to obtain a particular configuration. Examples of this material are bricks, roster, and so on. An example of a block material is Flick House by Delution (Figure 14).

Figure 14. Block system on facade
Source : https://www.archdaily.com/913723

- Tectonics of material source

Natural : The variety of materials sourced from nature includes bamboo, wood, stone, rattan, etc. This material is generally used with minimal processing so that the original shape of the material is still maintained. An example of a work with natural materials as a second skin is Wahana Architect's House in Nursery

which utilizes bamboo stems as its material (Figure 15).

Figure 15. Natural material (bamboo) of facade
Source : https://www.archdaily.com/109391

Industrial : Artificial or industrial materials are all materials that have been processed at the factory. Examples are PVC material, plastic, metal, aluminum, etc. An example of a work with fabricated materials is Ivan Priatman's JJ House which utilizes wire mesh as the outer shell of the building (Figure 16).

Figure 16. Industrial modular material of façade
Source : https://www.archdaily.com/926851

- Tectonics of material texture

Material has texture as a visual image as well as forming its character. Based on the surface, second-skin materials such as aluminum, glass, polycarbonate, and so on can be smooth textured. However, the texture can also be rough, such as brick, rooster, adobe, wood, rattan, etc (Figure 17 & 18).

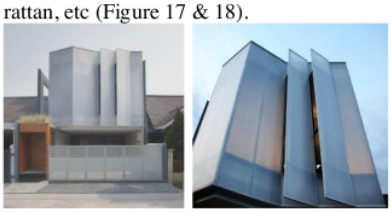

Figure 17. Smooth surface on facade texture
Source : https://www.archdaily.com/940497

Figure 18. Rough surface on facade texture
Source : https://www.archdaily.com/965874

**Application & Technology: Secondary facade as technology and design integration**

- Kynetic system

This technology is a mechanical technology that supports the facade to be moved as needed. This movement adjusts the intensity of environmental variables related to indoor comforts, such as the intensity of sunlight, wind, and visual comfort, such as the degree of privacy. An example of a recent work that uses both kinetic facades is Andramatin's Awrawikara House. The opening and closing mechanisms are combined with rattan woven material so that the space behind the facade can be conditioned according to the occupants' needs at certain times and conditions (Figure 19).

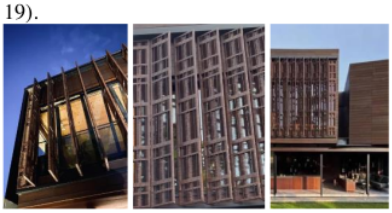

Figure 19. Manual kinetic system of facade
Source :
https://www.instagram.com/woodlamindonesia

- CNC Technology

This technology functions to form a pattern on the second facade plane, with a computational technique that controls the drilling according to the desired way. This CNC drill technique can be used on thick materials such as GRC, wood, etc. This technique allows the wide plane to have patterns with three-dimensional depth. lAn example of a work with perforated material using the CNC technique on its double façade is Rumah VM by Axial Studio. The material used is a PVC panel with CNC punching technique (Figure 20).

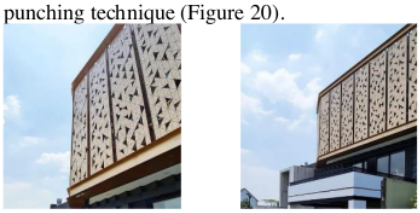

Figure 20. CNC system on forming a façade pattern
Source :
https://www.instagram.com/p/CN_9E--HNnp/

- Laser Cutting Technology

This technology is more refined than CNC because it uses a laser to form a cavity pattern on a plane. Materials that can be used for this

technology are aluminum panels, PVC panels, steel panels, and so on. This technology has a higher level of precision than CNC technology. An example of a work with a double facade that utilizes laser cutting is the RR House by Rakta Studio. Aluminum panels are laser cut with a particular pattern to be used as a second double facade covering (Figure 21).

Figure 21. Laser cutting on façade surface
Source :
https://www.instagram.com/p/CN_9E--HNnp/

**Role in design: Secondary façade as functional design instrument**

- Building Science (Thermal, Accoustic, Ventilation, Lighting)

The first comfort that can be obtained is the convenience related to building science. Building science deals with environmental variables such as light, wind, heat, etc. The second skin plays a role in controlling and reducing the intensity of the various variables so that the comfort of the inner space can be achieved better. This role is beneficial for tropical climate conditions. With sufficient spacing, the distance between the second skin break and the main facade of the building can act as a kind of trap that reduces excessive heat and glare. In ventilation, using a second skin that is dominantly perforated can facilitate natural air circulation into the building. On the other hand, acoustic comfort can be achieved by using solid and thick materials on the outside of the building (Figure 22).

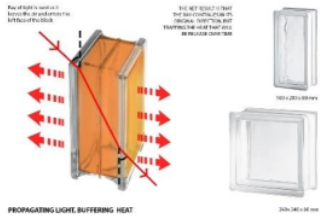


Figure 22. Insulasi panas pada fasade ganda
Source : https://www.archdaily.com/964603

- Visual and Spatial Character

Architecture cannot be separated from technical and artistic collaboration. Viewed from an artistic aspect, the second double skin can be used to form a visual character that influences the aesthetics of the building. This function is especially useful in the exterior aspects of the building, while in the interior, beauty can radiate because of the light that falls. It is conditioned by design because the light penetrates through the gaps of the pants of the second skin. The impression varies, can form shadows, strengthen the color in the interior, and so on (Figure 23).

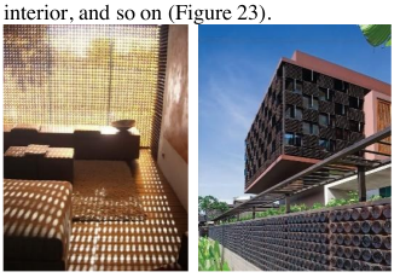

Figure 23. Color and spatial ambience formed by secondary facade
Source : https://www.archdaily.com/964603

- Spatial Experience (Privacy and Identity)

Double facades or second skins can also strongly define a building's identity (Vioveta, Santosa, and Iyati 2017). The automatic inner space experience is also formed with the second skin, especially the spaces directly adjacent to the large openings behind the second skin. The area will simultaneously have personal feelings and privacy and remain open with sufficient distance in the second skin. One of the works of the FFFAAARRR consulting firm, a boarding house in the Haji Baun area of Lebak Bulus, utilizes bricks to shape the character of the building from the exterior powerfully. The building looks solid with the dominance of brick material, but from the inside, you get a good level of privacy while still considering ventilation and natural lighting (Figure 24).

Figure 24. Facade as experience instrument
Source : https://www.archdaily.com/985237/

Based on the various explorations of multiple facades in residential architecture above, a

categorization diagram can be produced as follows (Figure 25):

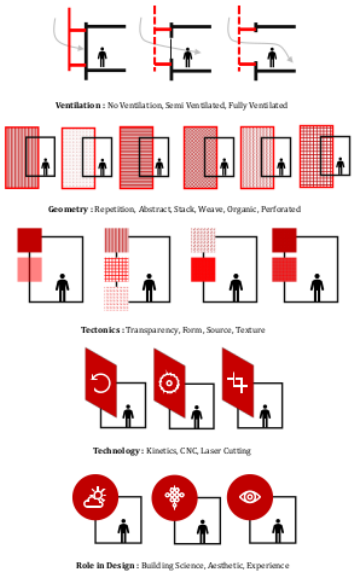


Figure 25. Diagram of categorization
Source : Author

Based on the possible uses, double facades in buildings can be mapped with the following possible matrix:

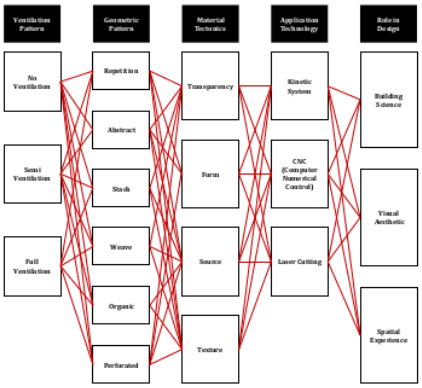


Figure 26. Matrix of possibility
Source : Author

## Conclusion

The use of the second skin is a design trend that has many benefits, both externally (identity, aesthetics) and internally (comfort, environmental science, privacy, and so on). The range of materials and configurations applied in design is vast, so the designer can define the characteristics of solving the design problem with the most contextual choices. This study presents the categorization and the possibility of using a variation of secondary façade. It also demonstrates that a secondary façade can reflect the designer's thinking in achieving a particular goal in the design process.

The possibility for the future is that more technologies can be utilized to support the application of this double facade. Using and implementing the double facade in architectural design is considered very contextual to the humid tropical climate conditions because environmental parameters can be adjusted to achieve better spatial comfort. In addition, the discourse on this double facade system has broad dynamic potential due to the development of technology, construction engineering, creativity in design processing, and material and tectonic developments.

This study is limited to observation (direct and digital literature) and occupancy typology. Follow-up studies can be carried out in various other architectural typologies and other regions with different climates. This study can help with mapping, classification, and triggers for further exploration of the recombination of design variants by architects in the future.

## References

Ahmed, Mostafa M S, Ali K Abel-Rahman, Ahmed Hamza H Ali, and M Suzuki. 2016. "Double Skin Façade: The State of Art on Building Energy Efficiency." *Journal of Clean Energy Technologies* 4 (1): 84–89.

Boake, T M, K Harrison, D Collins, A Chatham, and R Lee. 2003. "Understanding the Principles of the Double Façade System Terri Meyer Boake BES B. Arch M." *No. November*, 1–18.

Creswell, John. 2018. *Qualitative Inquiry & Research Design : Choosing among Five Approaches*. Thousand Oaks, California: SAGE.

Dannapfel, Verena. 2019. "The Plug-n-Harvest Façade: A Second Skin with Active and Passive Components." *Journal of Facade Design and Engineering* 7 (1): 101–14.

Dewi, Euis Puspita, Ari Wijaya, Siti Sujatini, Dena Rahmana, Chris Mandela, and Frank Gulit. 2020. "Penerapan Double Skin Facade Pada Daerah Iklim Tropis." *IKRAITH-TEKNOLOGI VOL 4 No 2 Juli 2020* 4 (2): 1–7.

Dwi, Gendis, Rahma Widasari, and Jurusan Arsitektur. 2019. "Penerapan Desain Fasad Yang Menyesuaikan Iklim Dan Cuaca Setempat Pada Perancangan The Hills Resort Lembang" IV (2): 1–13.

Fathia, Zahra, I G Oka Sindhu Pribadi, Laksmi Utami, Mahasiswa Program, Studi Arsitektur, and Universitas Trisakti. 2020. "Dengan Penggunaan Kayu Sebagai Double Skin Facade Application of Green Architecture in Apartment Buildings Using Wood As Double Skin Facade" 18 (2): 92–98.

Groat, L N, and D Wang. 2013. *Architectural Research Methods*. Architectural Research Methods. Wiley. https://books.google.co.id/books?id=0jADDQAAQBAJ.

Hosseini, Seyed Morteza, Masi Mohammadi, Alexander Rosemann, Torsten Schröder, and Jos Lichtenberg. 2019. "A Morphological Approach for Kinetic Façade Design Process to Improve Visual and Thermal Comfort." *Building and Environment* 153: 186–204.

Jati, Razqyan Mas Bimatyugra, Jusuf Thojib, and Chairil Budiarto Amiuza. 2015. "Secondary Skin Motif Batik Jawa Timur Pada Hotel Di Surabaya." *Jurnal Mahasiswa Jurusan Arsitektur* 3 (1): 1–14. http://arsitektur.studentjournal.ub.ac.id/index.php/jma/article/view/74.

Joe, Jaewan, Wonjun Choi, Younghoon Kwak, and Jung-Ho Huh. 2014. "Optimal Design of a Multi-Story Double Skin Facade." *Energy and Buildings* 76: 143–50.

Karimah, Afifah, and Paramita Atmodiwirjo. 2021. "Catalogue Drawing: A Framing Device for Design Thinking." *Arsnet* 1 (1): 74–87. https://doi.org/10.7454/arsnet.v1i1.6.

Mahmoudi, Shayan, and others. 2021. "Study on Using Double-Skin Facade and Its Effects on Urban Landscape Aesthetic." *Turkish Journal of Computer and Mathematics Education (TURCOMAT)* 12 (13): 4739–50.

Manubawa, A E, L M F Purwanto, and A Ardiyanto. 2020. "Measuring the Quality of Natural Lighting in a Building with Double Skin Façade (DSF)." *International Journal of Architecture and Urban Development* 10 (2): 5–12.

Misavan, Derry Feriyan, and Bontor Jumaylinda Gultom. 2014. "Pengaruh Pembaruan Fasad Bangunan Terhadap Karakter Visual Kawasan, Studi Kasus: Jalan Tanjungpra Pontianak." *Langkau Betang: Jurnal Arsitektur* 1 (2): 1–16. https://doi.org/10.26418/lantang.v1i2.18796.

Ramadhan, Try, Nita Dwi Estika, and Indah Widiastuti. 2021. "The Characteristics of Secondary Skin Facade of Contemporary House by Indonesian Architects." *IOP Conference Series: Earth and Environmental Science* 738 (1). https://doi.org/10.1088/1755-1315/738/1/012022.

Shameri, M A, M A Alghoul, K Sopian, M Fauzi M Zain, and Omkalthum Elayeb. 2011. "Perspectives of Double Skin Façade Systems in Buildings and Energy Saving." *Renewable and Sustainable Energy Reviews* 15 (3): 1468–75. https://doi.org/https://doi.org/10.1016/j.rser.2010.10.016.

Su, Ziyi, Xiaofeng Li, and Fei Xue. 2017. "Double-Skin Façade Optimization Design for Different Climate Zones in China." *Solar Energy* 155: 281–90. https://doi.org/https://doi.org/10.1016/j.solener.2017.06.042.

Utami, Mamiek N U R, Kamal Rizki, and Sandi Jatara. 2015. "Sistem Pemasangan Dan Pemeliharaan Selubung Kulit Bangunan Keramik Pada Daerah Tropis" 3 (1): 1–10.

Verbeke, Johan. 2013. "This Is Research by Design." In *Design Research in Architecture*, 137–60. Routledge.

Vioveta, L, H Santosa, and W Iyati. 2017. "Eksplorasi Fasade Yang Dinamis Dengan Material Alumunium Composite Panel Pada Bangunan MOG Di Malang." *Jurnal …*. http://arsitektur.studentjournal.ub.ac.id/index.php/jma/article/view/328.

Yazdi Bahri, Seyedehsara, Marc Alier Forment, and Albert Sanchez Riera. 2021. "Thermal Comfort Improvement by Applying Parametric Design Panel as a Second Skin on the Facade in Building Refurbishment in Moderate Climate." In *Ninth International Conference on Technological Ecosystems for Enhancing Multiculturality (TEEM'21)*, 763–67.

Yazdizad, Arash, Firooze Rezaei, and Foad Faizi. 2014. “Classification of Double Skin Façade and Their Function to Reduce Energy Consumption and Create Sustainability in Buildings.” In *2nd International Congress on Structure, Architecture and Urban Development, Tabriz, Iran*.

Zanghirella, Fabio, Marco Perino, and Valentina Serra. 2011. “A Numerical Model to Evaluate the Thermal Behaviour of Active Transparent Façades.” *Energy and Buildings* 43 (5): 1123–38. https://doi.org/https://doi.org/10.1016/j.enbuild.2010.08.031.

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