Exploration of artificial intelligence on building facades in the context of Indonesian regionalism

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Abstract. The campus facade building should reflect the local cultural and technological character as the basis for the character of a government-owned state institution such as the Sumatra Institute of Technology (ITERA) campus. The most appropriate approach is to display the context of the Indonesian regionalism approach that highlights local wealth that can be combined with new and modern concepts by utilizing artificial intelligence (AI). This study aims to take a regionalism approach to the application of the ITERA campus building facade appearance with the AI method by applying the criteria of Indonesian regionalism in the form of a combination of local materials and new technology, responsive to the local climate, in accordance with tradition, heritage, history, local areas, and can find the meaning of art and culture from the building. The final result obtained is the application of these criteria, including using a combination of local materials with the latest technology, especially the application of materials, openings, and the application of Sumatran cultural traditions through the representation of traditional buildings.

1 Introduction

Facade is a compromised term that contains both precise and ambiguous meanings, positive and negative, modern and backward. Most histories state that the facade was a favored surface, but it was abandoned in the 20th century due to the preoccupation with volume, space and reductive abstract aesthetics. It is also one of the most complex and multidisciplinary components of all. As the primary surface of mediation, contextualization and representation, the facade bears the greatest responsibility for containing the internal environment and facing the external world. Therefore, it is interesting to consider the main concern related to regionalism as represented through the building facade.

Regionalism in architecture emerged from the saturation of global and universal building designs. The concept of Architectural Regionalism began to emerge around the 1960s, marked by the re-emergence of regional characteristics in building designs [1]. Discussion in architectural regionalism focuses more on the discussion of the characteristics of regional and special architectural styles (specific regional) which are closely related to local culture, climate and technology. Furthermore, the basic concept of architectural regionalism in

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Indonesia can be reviewed based on 2 (two) elements, namely: (1) Local and universal values in Nusantara architecture which are manifested in form and shape and (2) Synchronic meaning and diachronic meaning in Nusantara architecture which are the philosophical basis in the design approach. Everything is always related to the local values of a region.

There are clear regulations in every region of Indonesia regarding the obligation to reflect local wisdom in every design of public/government buildings so that the value of regionalism will be clearly visible in every public building such as the campus of the Sumatra Institute of Technology (ITERA) which always prioritizes technology in its development will greatly influence the image of the building in addition to the context of human development and its environment. The context of Sumatra is indeed the main emphasis by raising local strengths that are in line with the context of regionalism. The appearance of the facade that is too modern is the main problem that needs to be explored again on the ITERA Campus facade (Figure 1). Therefore, a strong representation of Sumatra will be the appearance of the facade to show local strength and wisdom towards all activities in the ITERA Campus environment. Exploration of the ITERA Building facade in this study was carried out using the latest method, namely artificial intelligence which can generate facades to generate new ideas.

Fig. 1. ITERA campus building.

From various explanations related to the background presented. There needs to be an exploration of the facade of the ITERA campus building using the AI method with a regionalism context to represent the local facade according to ITERA's vision and mission, namely ITERA for Sumatra.

2 Literature review

2.1 Architecture regionalism

The regionalism approach is one of the developments of modern architecture that focuses on regional characteristics and usually this school of thought grows in developing countries. There are several main principles in regionalism architecture, including (1) Materials using local building materials with modern technology, (2) Responsive in overcoming climate conditions in the local area and (3) Having a local cultural context. In relation to location, architecture elevates locality as an important part of architecture, namely by using local materials, local mechanical tools, local workers, paying attention to local needs, paying attention to local culture/traditions/history, so that these can be used in the architectural process [2]. According to Suho Ozkan, regionalism architecture is divided into two, namely concrete regionalism and abstract regionalism [3]. Concrete regionalism and abstract regionalism are further divided into several (Figure 2).

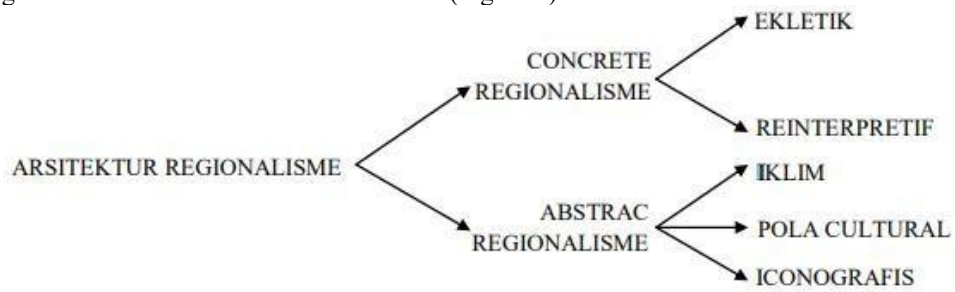


Fig. 2. Regionalism architectural type scheme.

Concrete regionalism is an approach to regional expression by emulating the greatness, parts, or all of the buildings in the area, while abstract regionalism is a type of approach that combines elements of abstract building qualities such as mass, solid and void, proportion, sense of space, lighting, and structural principles in a reprocessed form [4].

2.2 Expression of regionalism facades forms against material and climates

The facade is part of the building envelope and provides support for the external architectural features of a building where the facade has evolved throughout history from clay, stone, wood, and brick to steel and glass to meet various functional and climatic needs. The development of various materials and construction methods has led to the emergence of various architectural styles and facades. Related to climate factors, the expression of the facade and building based on the response obtained is to take advantage of the climate conditions in an effort to strengthen and shelter the function of the building or eliminate unwanted effects on the building. The expression of the facade as a climate response can be understood through simple means such as the composition of the form (Figure 3).

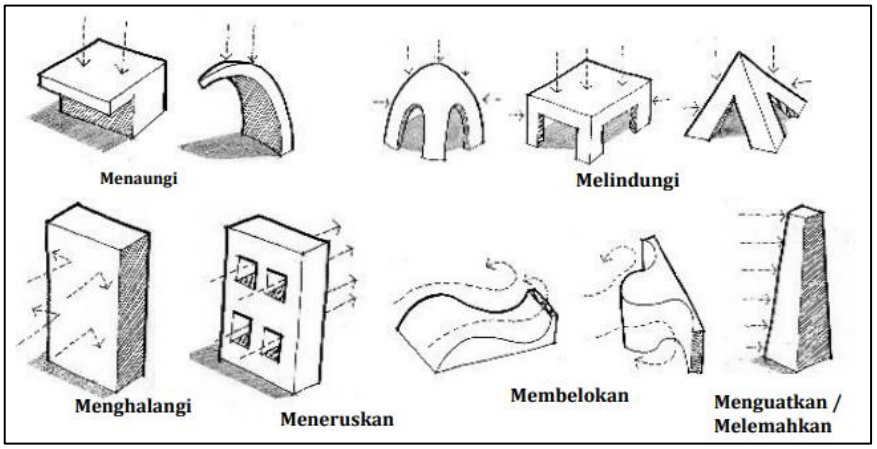


Fig. 3. Building facade expression towards climate [5].

One of the main challenges with local materials, such as bamboo, wood, or clay, is that they can be processed in such a way that they are durable and meet modern safety standards without sacrificing their sustainability [6] because the use of local materials in architectural design plays an important role in ensuring sustainability and resource efficiency. Local materials, such as wood, bamboo, natural stone and clay are generally abundant in Indonesia. In addition, these materials have the ability to adapt to local climate and geographical conditions (Table 1). The use of these materials also allows for the creation of buildings that are more resistant to local climate conditions, thereby reducing the need for energy for heating or cooling [7]. And finally, local materials are also able to produce aesthetics on the facade through color, texture, rhythm, and dimension. Meanwhile, modern architectural buildings use more modern materials such as glass, concrete, stainless steel cladding, and aluminum composite panel cladding [8] which are very different from local buildings. These materials are characteristic of modern architectural building styles, so integration between local and modern materials is needed in transforming into modern building designs through technological innovation to suit the concept of regionalism.

Table 1. Expression of sheath elements with climate response.

Element	Geometric Shapes	Material	Climate Response	Expression
Roof		Wood, Shingles, Bamboo, Zinc (industrial material), Reeds, Fiber	Draining rainfall. Creating roof space volume as an insulation function. Shading the building body. Flowing air through material gaps, lattices, roof openings. Creating an outside-	Steep slope in the middle sloping at the edges, Lattice openings, windows on the roof. Prism, dome, cone shapes.

Element	Geometric Shapes	Material	Climate Response	Expression
			inside transition space. A closed roof character holds back heat.	
Walls (doors and windows)		Wood, Bamboo, Bark, Leaf sheath	Provides air circulation holes through jalousie openings. Allows the wall to breathe (air in and out through the gaps in the material). Gaps between the boards allow air to enter and exit at low speed. Inserts skylights for lighting.	Slit walls (stripe/spread pattern). Transparent walls (jalousie). Natural/organic. Inviting/open.
Floor		Wood, Bamboo and Soil	Allows the walls to breathe (air entering and exiting through the gaps in the material arrangement). Allows vertical air ventilation from floor to roof.	Stage, expression of floor gap/breathing. Natural/organic. Flexible/flexible. Footing/natural/natural hard/massive ground.
Ornament		Massive textured and hollow areas	Circulate air and control air speed through ornamental gaps. Provide skylight for natural lighting.	Symbolic. Transparent. Interactive.

2.3 Cultural and tradition context of Sumatra

The cultural and traditional context of Sumatra can be clearly reflected through its architectural context, namely the Traditional house. Traditional houses on the island of Sumatra are dominated by roof shapes with ornamental elements that become an identity and function as a form of adaptation to the climate. The existence of the legs / stage pillars is clearly seen lifting the building. There are 9 (Nine) traditional buildings such as Omah Aceh, Toba Batak House, Karo Batak House, North Nias House, South Nias House, Lontik House, Gadang House, Tuha House and Kenali House, most of which are already well known to the wider community.

Fig. 4. Sumatran regionalism building.

2.4 Artificial intelligence as stable diffusion of image generator

AI image generator through stable diffusion is a tool for converting text into images, objects, or scenes that are close to accurate and realistic based on the user's imagination [9]. Its implementation is in the form of images to text such as coding using GPT chat or other similar tools. Creating a text-to-image program is the opposite of creating images to text. This latest program answers the needs of today's work that requires a more integrated framework modeling [10]. Text-to-image synthesis is a step forward in realizing and expanding human imagination which continues to be developed today. Image generators can also be used from image to image while still using text assistance. Seeing the power of technology offered by AI image generators to make significant changes in creating images in terms of exterior, interior, and furniture details in this study [11].

3 Material and method

This study uses a qualitative method by describing the understanding of Indonesian regionalism architecture and then continued with an experimental method by utilizing artificial intelligence tools to explore the facade of the Sumatra Institute of Technology campus to become a building that is in accordance with the concept of regionalism. The first stage is to collect image datasets, namely images of the ITERA Building and traditional buildings. Then conduct a study of the context of regionalism in the Sumatra region as a basis for AI prompts such as: materials, the influence of facades and building forms on climate and cultural traditions of the community based on traditional buildings. The last is to use AI tools to generate facades into new forms.

4 Result and discussion

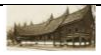
The selected building is Building A, the Rectorate of the Sumatra Institute of Technology, serving as the main building. It is expected to symbolize the architectural style of other structures. For traditional buildings, nine model structures from the Sumatra region have been chosen to reflect regionalism, including Omah Aceh, Toba Batak House, Karo Batak House, North Nias House, South Nias House, Lontik House, Gadang House, Tuha House, and Kenali House.

The first exploration is to try to see the combination of two different building contexts (two images) between the Rectorate Building and the Traditional building in the context of local culture/tradition (Sumatra region), material technology and climate response as a representation of regionalism (Table 2).

Table 2. Traditional and modern in regionalism.

Campus Building Data Image	Modern Campus Building Materials	Image Data Traditional Buildings (Sumatran Cultural Traditions)	Local Materials of Traditional Sumatran Buildings	Expression on Climate	Running Results (From Modern to Traditional)	Running Results (From Traditional to Modern)
 Rectorate Building	Concrete, glass, stainless steel	 Omah Aceh	Wood	Steep slope in the middle sloping towards the edges, Prism shape, Gap walls (line/spread pattern), Stage, Gap/breathing floor expression.		
 Rectorate Building	Concrete, glass, stainless steel	 Batak Toba House	Wood, bamboo, palm fiber	Steep slope in the middle sloping at the edges, Lattice openings, windows on the roof, Prism shape, Slotted walls (line/spread pattern). Stage, slotted/breathing floor expression.		

Campus Building Data Image	Modern Campus Building Materials	Image Data Traditional Buildings (Sumatran Cultural Traditions)	Local Materials of Traditional Sumatran Buildings	Expression on Climate	Running Results (From Modern to Traditional)	Running Results (From Traditional to Modern)
 Rectorate Building	Concrete, glass, stainless steel	 Batak Karo House	Wood, bamboo, palm fiber	Steep slope in the middle sloping at the edges, Lattice openings, windows on the roof, Prism shape, Gap walls (line/spread pattern). Transparent walls (jalousie), Stage, Gap/breathing floor expression.		
 Rectorate Building	Concrete, glass, stainless steel	 North Nias House	Wood, stone	Steep slope in the middle sloping at the edges, Lattice openings, windows on the roof, Prism shape, Slit walls (line/spread pattern). Transparent walls (jalousie), Stage, Slit/breathing floor expression.		
 Rectorate Building	Concrete, glass, stainless steel	 South Nias House	Wood	Steep slope in the middle sloping at the edges, Lattice openings, windows on the roof. Prism shape, Slotted walls (line/spread pattern), Stage, slotted/breathing floor expression.		
 Rectorate Building	Concrete, glass, stainless steel	 Lontik House	Wood	Steep slope in the middle sloping towards the edges, Prism shape, Cracked walls (line/spread pattern), Stage, crack/breathi		

Campus Building Data Image	Modern Campus Building Materials	Image Data Traditional Buildings (Sumatran Cultural Traditions)	Local Materials of Traditional Sumatran Buildings	Expression on Climate	Running Results (From Modern to Traditional)	Running Results (From Traditional to Modern)
				ng floor expression.		
 Rectorate Building	Concrete, glass, stainless steel	 Gadang House	Wood, palm fiber	Steep slope in the middle sloping towards the edges, Prism shape, Cracked walls (line/spread pattern), Stage, crack/breathing floor expression.		
 Rectorate Building	Concrete, glass, stainless steel	 Tuha House (Lampung)	Wood	Steep slope in the middle sloping towards the edges, Prism shape Gap walls (line/spread pattern), Stage, Gap/breathing floor expression.		
 Rectorate Building	Concrete, glass, stainless steel	 Kenali House (Lampung)	Wood, bamboo, palm fiber	Steep slope in the middle sloping towards the edges, Prism shape, Gap walls (line/spread pattern), Stage, Gap/breathing floor expression.		

Source : Author, 2025

The second exploration is trying to translate the form of the Rectorate Building directly with the AI prompt to produce a Rectorate building with a regionalism context (Table 3). Significant changes can be seen in the shape of the roof and wall materials. The concrete roof becomes a gable roof and shield to reflect Sumatran culture while the concrete and glass walls get the addition of local materials, namely wood.

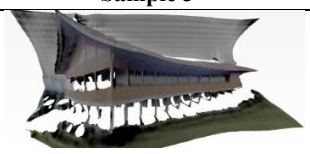
Table 3. Exploring the rectorate building with prompt.

Original Image	Prompt	Simulation Result 1	Simulation Result 2	Simulation Result 3
	Steep slope in the middle sloping towards the edges, Prism shape, Gap walls (line/spread pattern), Stage, Gap/breathing floor expression, wood material, traditional Sumatra house, Sumatra ornament			

Source : Author, 2025

Exploration 3 (three) is by looking at the image changes from 2D to 3D. . The image shows that the building adapts to the climate with long eaves, numerous openings, and a play of light and shadow. It also reflects Sumatran culture through traditional gable roofs, stilt structures, and the use of wood, glass, and concrete, which can be integrated with modern technology (Table 4).

Table 4. 2D to 3D image exploration (STL file).

Sample 1	Sample 2	Sample 3
		

Source : Author, 2025

5 Conclusion

The final result of this research is to produce a new form without leaving the essence of its basic form. The first result (exploration 1) of the modern building facade (Rectorate Building) into a traditional building by producing changes in facade materials and changes in facade elements such as roofs and windows. While the traditional building facade into a modern building changes several facade elements such as glass material, the addition of openings and changes in material from wood to concrete. The second result (exploration 2) is the change in the modern building facade (Rectorate Building) into a Traditional building with changes in concrete material to wood and a roof that changes significantly. The final experiment (exploration 3) involves converting 2D images into 3D to analyze the depth, structural differences, construction techniques, and materials. This allows the regional context, including climate and cultural values, to be clearly visible.

Ultimately, this research is an attempt to see the impact of the use of artificial intelligence in exploring the context of regionalism so that it becomes an alternative new technology that can be used to see how far modern buildings have changed to traditional buildings or traditional buildings to modern buildings.

References

1. M. I. Hidayatun, J. Prijotomo, and M. Rachmawati, Regionality and regionalism in architectural views, Journal of Basic and Applied Scientific Research, **2**(7), 7147 (2012). https://doi.org/10.24002/jars.v11i5.1293.
2. M. Rachmawati and J. Prijotomo, Pelestarian alam dalam arsitektur: masalah dan usulan pemecahannya, Jurnal Bumi Lestari, **10**(2), 341–351 (2010).
3. S. Ozkan, Regionalism within modernism, in Regionalism in Architecture (1985).
4. L. S. Ulfa, H. Hardiyati, and A. Dianingrum, Penerapan pendekatan regionalisme pada konsep tampilan pusat seni dan budaya Jawa di Kota Surakarta, Jurnal Ilmiah Mahasiswa Arsitektur Senthong, **6**(3), 963–970 (2023).
5. Y. H. Prasetyo and S. Astuti, Ekspresi bentuk klimatik tropis arsitektur tradisional Nusantara dalam regionalisme, Jurnal Permukiman, **12**(2), 80–93 (2017).
6. M. Setiawan and R. Fadillah, Integrasi arsitektur vernakular dalam desain permukiman modern, Jurnal Lingkungan Berkelanjutan, **5**(2), 78–89 (2020).
7. A. Rachman, Arsitektur vernakular sebagai solusi keberlanjutan, Jurnal Tata Kota, **8**(3), 114–126 (2020).
8. H. M. Furqon and G. P. Verlialdi, Aplikasi material pada bangunan modern ditinjau dari estetika fasade, Jurnal Reka Karsa, **3**(3), 1–13 (2015).
9. S. A. Bankar and S. Ket, An analysis of text-to-image synthesis, in International Conference on Smart Data Intelligence (ICSMDI) (2021).
10. M. G. Gunagama and N. F. Lathifa, Automatictecture: otomatisasi penuh dalam arsitektur masa depan, NALARs, **16**(1), 43–60 (2017). https://doi.org/10.24853/nalars.16.1.43-60
11. M. C. Florian, Can artificial intelligence systems like DALL-E or Midjourney perform creative tasks?, ArchDaily (2022). Available online.