Shophouse Façades on Ratchadamnoen Road in Southern Thailand: A Taxonomic Study to Produce a Dataset for AI modelling

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Abstract

Tha Wang, situated in Nakhon Si Thammarat, Thailand, is a distinctively diverse architectural hub. Beyond its array of historical edifices, it offers clues to an early human settlement. The area's primary artery, Ratchadamnoen Road, is a testament to this architectural diversity, primarily through the varied shophouses lining its path. This research delves into the ornamental relationships on shophouse façades, aiming to deduce specific shophouse characteristics, comprehend the façade patterns along the road, and semantically segment the image by the architectural features. This aims to produce a dataset that can be used as ground truth and input images to be studied by artificial intelligence models.

Data was collected from shophouse façades on Ratchadamnoen Road, spanning from Tha Sak Canal to the Wat Wang Tawan intersection. Analysis entailed discerning the shophouse façade characteristics based on ornamental relationships and identifying recurring façade patterns.

The study unveiled five distinct shophouse façade types on Ratchadamnoen Road: pre-colonial, post-colonial, eclectic, early modern, and modern. Notably, post-colonial shophouses are predominantly near Tha Sak Canal, transitioning subtly to early modern styles near the Wat Wang Tawan intersection, with the eclectic style sprinkled amidst them. This spatial arrangement suggests that human settlements in this urban expanse has evolved from canal-centric to road-focused, a shift attributed to changing transportation preferences from waterways to roads.

Keywords: Shophouse, Façade, Characteristic, Settlement, Ornament

Introduction

Tha Wang is one of the areas of the Malaya Peninsula with a connected influence of transferred styles of shophouses. From the beginning of the shophouse era in this region, during the 19th century to the early 20th century, it started with the transportation, communication, and settlement of diverse cultures and beliefs, especially those of the Chinese. The Malaya Peninsula includes Malaysia, Singapore, and Southern Thailand, especially the area of Penang, Kangtang, Phuket, Songkhla, Takuapa, Ipoh City, and Tha Wang. In the past, the main transportation of this area was the waterway. Therefore, the area of ports, "Tha" in Thai, was

the center of trading. At the beginning of the present dynasty, this area served as the palace, "Wang" in Thai, of the royal family of that era. However, in the 5th reign of the Chakri Dynasty, there was a significant change in the political terms. Thailand, Siam at the time, changed from a decentralized to a centralized reign. Therefore, Nakhon Si Thammarat area, which was the center of their district, on the one hand, saw a decline in significance. On the another hand, there were improvements in many aspects, such as the economy. The growth in many aspects was one of the factors that developed and expanded the urban area. Formerly, the Tha Wang community was developed on an apocalyptic landscape in Nakhon Si Thammarat. However, changes in transportation infrastructure led to the creation of the main road, Ratchadamneon across the waterway. After that, the linear expansion have been shifted to the road, and the development of shophouse buildings followed. Shophouses were built to serve and support the needs of people, for both residential and commercial purposes. Because of the diversity of people and the period of forming the city, Shophouses have been created at different times for different uses. Receiving the influence of many cultures and architectural innovations, shophouses show their characteristics through their façade and their type of use.
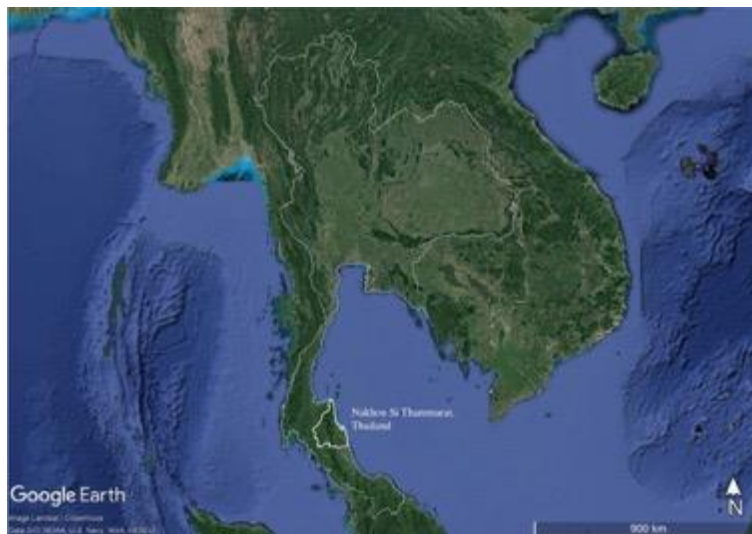
Fig. 1: Map of Nakhon Si Thammarat in Thailand
Source: Google Earth, Edited by Author, 2023

Fig. 2: Map of Mueang Nakhon Si Thammarat District in Nakhon Si Thammarat
Source: Google Earth, Edited by Author, 2023

Fig. 3: Map of Tha Wang Sub-District in Mueang Nakhon Si Thammarat District
Source: Google Earth, Edited by Author, 2023

Fig. 4: Map of Ratchadamneon Road in Tha Wang Sub-District
Source: Google Earth, Edited by Author, 2023

While Wat Phra Mahathat Woramahawihan in Tha Wang, Nakhon Si Thammarat, is recognized as a UNESCO World Heritage Site, the Tha Wang neighborhood has yet to gain recognition as a historical area in terms of vernacular architecture and shophouse buildings. These structures serve as evidence of human settlements, ways of life and historical background (Thinnakorn and Inpuntung, 2020). As a result, some buildings are still not reviewed, ruined, dismantled and not conserved.

For the sake of conservation and in order to preserve the unique atmosphere of the shophouse neighborhood along the road, the buildings, especially the façade should be redone in the specific location of the missing part. To reach that objective, there are some obstacles that need to be responded to. The lack of architectural data is the main difficulty. Some buildings have been abandoned and some have been renovated without any traceback.

Drawing from the linear development theory, there is a belief that in the human settlements, location, concentration, and typology of the buildings are interrelated. Therefore, urban settlement patterns would be able to predict the characteristics of the buildings based on their location and the surroundings. This research aims to throw light on the nature of these settlement patterns.

Its objectives are to find the relationships of ornaments on shophouse façades to identify the characteristics of the shophouses, to recognize the pattern of façade characteristics through the street, and to use the data as the input for image segmentation.

History and Previous Studies of Shophouses

A shophouse is a building that has a commercial part, a store or "shop", and a residential part, a "house", mostly seen on the sideway in Southeast Asia for both living and trading purposes. The styles of the shophouse façade are related to the time when it was built. For the areas of the Malay peninsula and southern Thailand, the time of shophouse building started around the 1890s when the roads became the more important ways of communication and transportation than the rivers or canals. However, in Tha Wang, Nakhon Si Thammarat, Thailand, shophouses were built later with the influence of Britain colonization and other cultures. Consequently, the shophouses in Tha Wang exhibit a mélange of styles, shaped by the era of their construction, cultural influences, intended functionalities, and subsequent renovations.

Previous research in classifying the historical building façades (Vozniak and Butyrin, 2019) shows that the classification of the details on a façade can be separated by the ornaments, which horizontal segmentation, vertical segmentation, wall surface elements, top elements of the wall, windows, doors, and balconies and their elements. However, the study from Vozniak and Butyrin in 2019 was only focused on the classical theory which has a different ornament relationship and order from the Malaya Peninsula shophouses. According to Wongpradit, Kirdsiri, and Chapman in 2022, the research used 6 ornaments in shophouses to classify the difference between shophouses in study areas, Penang, Kantang, Phuket, and Takuapa. The ornaments that were been used are the roof, upper and lower façade, window/air ventilation, door/air ventilation, arcade, and material/structure. Thus, air ventilation, in both the attached window and door, is the important ornament which is in contrast to the classical ornament theory that were used in the research from Vozniak and Butyrin in 2019. Because of the tropical climate, there is an architectural innovation that was adapted to be consistent. Air ventilation became the important ornament in this type of shophouse. The research on the typology of shophouse façades by Ali, Hadi, and Rizallindalshak (2015), suggests the classification of the architectural style of shophouse buildings in the core zone of Ipoh City, Malaysia where the influences of Britain architecture are spread as well as in Tha Wang neighborhood, Nakhon Si Thammarat, Thailand. This research classified the shophouse in that area into 6 characteristics and definitions, neo-classical, transition, eclectic, art deco, early modern, and modern, based on their features. However, the buildings along Ratchadamnoen Road are slightly different from other parts of Britain influence shophouses. Therefore, the classification of shophouses in the study area will be adapted based on the different classify by relationship between ornaments.

In the realm of architectural classification, human cognition has always leaned towards systematisation. Tracing back to the 19th century, façade analysis has been pivotal in architecturally categorising cases, laying the foundations for taxonomic research. Gottfried Semper (2004), through codifying the order and arrangement patterns of various architectural façade elements (e.g., A-B-A, A-B-B-A-B), conceptualised the idea of "style". He perceived a building's form as a comprehensive output, amalgamating aspects of culture, time, function, technology, and other factors. Formal analysts in mid-late twentieth century expanded on these mathematical insights, incorporating tools common to rationalism, like geometric analysis, and those rooted in Gestalt theory (Eisenman, 2006; Krier, 2009; Rowe, 1982). Between the 1960s and 1990s, numerous attempts to grasp the deep structures of form or space rendered architectural representation and taxonomy "computable" (Stiny and Mitchell,1978; March, 2010).

However, with the rapid advancements in deep generative models in the 2010s (Isola, 2017), particularly conditional generative models, much of the limitations inherent in traditional research methodologies, specifically in the realm of prior knowledge, have been removed for architectural style analysis and style-based design creation (Huang, 2021; Meng, 2021; Bolojan, 2022; Huang et al., 2023). The advancement in methodology signifies a

paradigmatic transition in the comprehension and categorisation of architectural styles, rooted in computational formal analyses, notably façade analysis employing emergent AI techniques. In this context, a model-specified dataset is imperative for the taxonomic examination of Shophouse Façades in Tha Wang, aiming to discern the historical influences on architectural design.

Research Methodology

This research is divided into 2 parts, classification of the shophouse façades based on the buildings and creation of ground truth and input images for taxonomic study in AI modelling. The article focuses on data collection for the conservation of historical buildings and vernacular settlements. Therefore, an image segmentation method is used to predict the missing façades to maintain the atmosphere of the road for conservational purposes.

Data was collected by measuring and collecting pictures of the shophouse façades at the selected site, along the Ratchadamneon Road from Tha Sak Canal to the Wat Wang Tawan intersection. There are around 95 shophouse buildings along the road that are selected and separated into 6 parts, based on the road and alley separation, A01, A02, A03, A04, A05, and A06. From the beginning, the A01 section is the part that is close to the Wat Wang Tawan intersection, the combination of Buddhist temples and mostly commercial shophouses with the same style of building. In the A02 section, moving closer to the canal, the buildings are dramatically smaller, and more styles of architecture are found. The A03 section is the closest part to the Tha Sak canal. This sector also has different characteristics of shophouses and even smaller buildings. In the opposite part of the road, the A04 section is almost the same as the sector A03 but with slightly taller buildings. However, in the A05 part, the style of the building is changed but with the same building height. Lastly, in the A06 section, on the opposite side of the temple, repetition of the shophouse buildings occur. In each part, the shophouses are divided into buildings based on styles and structures, which are 4 buildings in A01, 15 buildings in A02, 23 buildings in A03, 25 buildings in A04, 16 buildings in A05, and 12 buildings in A06, a total of 113 buildings.

Fig. 5: Map of selected study sites on Ratchadamneon Road
Source: Google Earth, Edited by Author, 2023
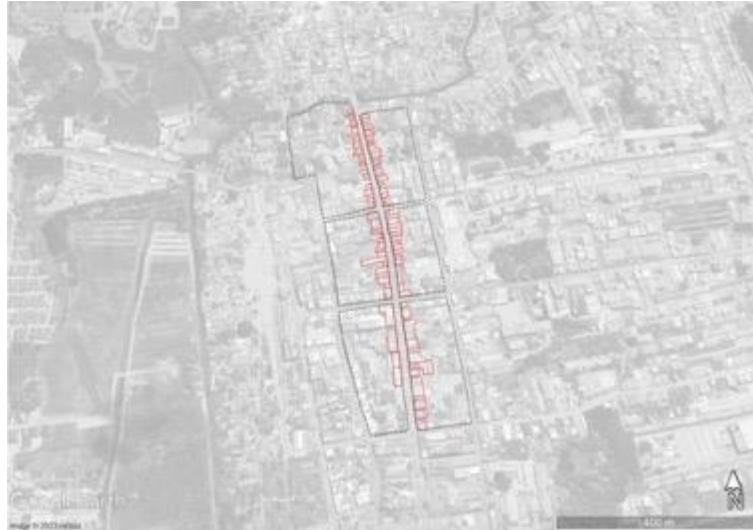
Fig. 6: Map of selected buildings on Ratchadamneon Road
Source: Google Earth, Edited by Author, 2023

Fig. 7: Map of selected buildings in the A01 study site
Source: Google Earth, Edited by Author, 2023

Fig. 8: Map of selected buildings in the A02 study site
Source: Google Earth, Edited by Author, 2023
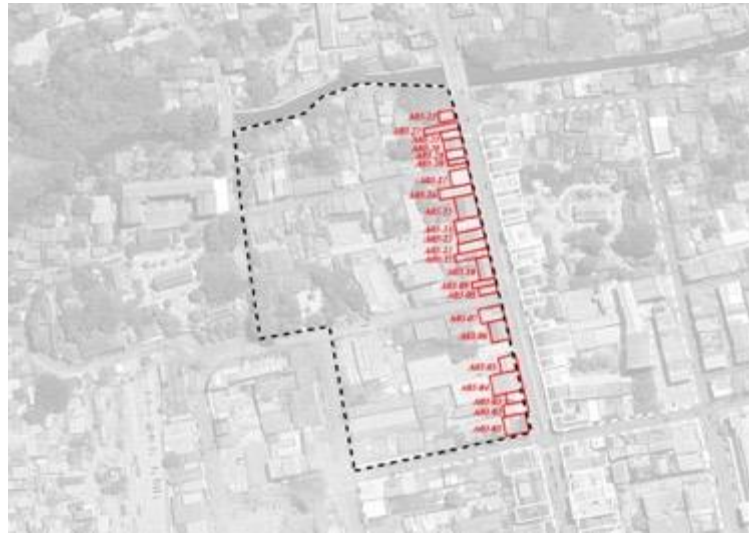
Fig. 9: Map of selected buildings in the A03 study site
Source: Google Earth, Edited by Author, 2023

Fig. 10: Map of selected buildings in the A04 study site
Source: Google Earth, Edited by Author, 2023
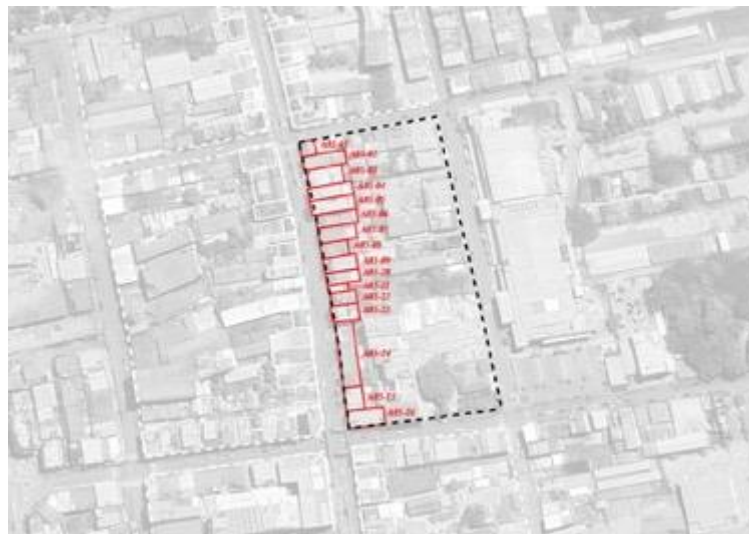
Fig. 11: Map of selected buildings in the A05 study site
Source: Google Earth, Edited by Author, 2023

Fig. 12: Map of selected buildings in the A06 study site
Source: Google Earth, Edited by Author, 2023

This research will use 5 characteristics of shophouses, pre-colonial, post-colonial, eclectic, early modern, and modern, to classify the façade of shophouses and use these typologies and their characteristics as the input for the image segmentation method. Generative Adversarial Network (GAN) was used in machine learning as pix2pix to identify and generate building façade with the Chinese-façade dataset (Yu, Malaeb, and Ma, 2020) Therefore, this research will use the pix2pix method combine with the input dataset of the building façade on Ratchadumneon Road, Tha Wang neighborhood, Thailand, to generate the predicted façade based on the location and settlement pattern.

As in this research, the first style of the shophouse characteristic is the pre-colonization style which is the traditional style before the year of colonization. Even if Thailand, Siam at the time, was the only state left independent, the influence of the Western colonizers still spread through the areas, especially the areas of southern Thailand which was affected by the British colonization in British Malaya: the present part of Malaysia and Singapore. This style is mostly made from wood or half-wood half-concrete with simple wood doors and windows. The air ventilations were built to ventilate air between the inside and outside of the shophouses. This type of air ventilation was separated from the windows, usually on the top of the second-floor wall, and created only for functional purposes. The gable roof was used because of the monsoon area in Southern Thailand.
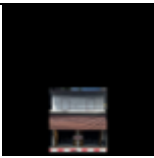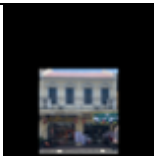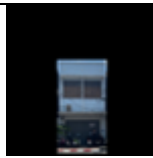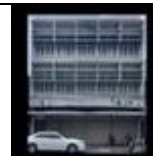
The second style is post-colonization which is a style that has British influence by the time of colonization. This architectural style was referred to as the neo-classical style. Decorated columns were used to separate each unit. Decorative ornaments were seen mostly in this style. It is believed that they represented the status of the shophouse owners. Gable roofs from the Malay peninsula are still usable in this area, because of the same climate. The windows and air ventilations were attached to each other and were decorated.

After the expansion of the urban area, the popularity of art deco architecture spread to Thailand. This style has simple vertical and horizontal fins, for both functional and non-functional purposes. The specialty of this characteristic was materials. There was a huge shift in architectural material from wood to concrete and glass. Then this characteristic was transferred into the modern style in later years. However, there is also the eclectic style which is the combination of different styles. As there are people with many cultures and beliefs living together in the Tha Wang neighborhood, this character can be the mix of curves and lines from each style. In conclusion, each characteristic, of the ornaments on the shophouse façade has different styles and relationships which can be defined by materials, windows, air ventilation, roofs and decorations.

Table 1: Shophouse façade characteristic and definition
Source: Author

Characteristic	Pre-Colonial (Traditional)	Post-colonial (Britain Influence)	Eclectic (Combination)	Early Modern (Art Deco)	Modern
Example Image					
Definition	**Material:** Wood **Window:** Simple Wood **Air Ventilation:** Simple wood and separated from window **Roof:** Gable **Decoration:** None	**Material:** Concrete **Window:** Decorated Wood **Air Ventilation:** Decorated Wood attached to window **Roof:** Gable **Decoration:** Neo-classical style ornaments and decorated column separate each unit	**Material:** Concrete **Window:** Simple wood or glass **Air Ventilation:** Simple attached to window (usually close) **Roof:** Gable with decorated elements at the front **Decoration:** The mix of curves and lines of different styles (usually has balcony)	**Material:** Concrete **Window:** Simple glass **Air Ventilation:** Simple attached to window (usually close) **Roof:** Flat **Decoration:** Simple horizontal lines and vertical fin separated each unit (usually has curve and the corner of the building)	**Material:** Concrete **Window:** Simple glass **Air Ventilation:** None **Roof:** Flat **Decoration:** None

Findings and Discussion

The findings show the characteristics of the shophouse façades along Ratchadamneon Road. There are 5 styles of shophouse façades: pre-colonial, post-colonial, eclectic, early modern and modern. These styles of buildings were identified by the definition of shophouse façade characteristic above. However, there are also buildings that cannot be identified because of the façade are ruined, or are covered by façade renovations. Therefore, these buildings will be identified as having not identifiable characteristics.

Table 4: Selected façades, analyzed by characteristic
Source: Author

Name	Characteristic	Picture
A01-01	Early Modern	
A01-02	Early Modern	

Name	Characteristic	Picture
A01-03	Early Modern	
A01-04	Early Modern	
A02-01	Early Modern	

A02-02	Early Modern		A03-06	Post-colonial	
A02-03	Early Modern		A03-07	Post-colonial	
A02-04	Early Modern		A03-08	Pre-colonial	
A02-05	Modern		A03-09	Eclectic	
A02-06	Pre-colonial		A03-10	Pre-colonial	
A02-07	Modern		A03-11	Eclectic	
A02-08	Pre-colonial		A03-12	Not identified	
A02-09	Early Modern		A03-13	Eclectic	
A02-10	Post-colonial		A03-14	Eclectic	
A02-11	Not identified		A03-15	Post-colonial	
A02-12	Pre-colonial		A03-16	Post-colonial	
A02-13	Early Modern		A03-17	Post-colonial	
A02-14	Post-colonial		A03-18	Early Modern	
A02-15	Early Modern		A03-19	Eclectic	
A03-01	Eclectic		A03-20	Pre-colonial	
A03-02	Eclectic		A03-21	Early Modern	
A03-03	Eclectic		A03-22	Not identified	
A03-04	Not identified		A03-23	Eclectic	
A03-05	Post-colonial		A04-01	Pre-colonial	

A04-02	Post-colonial		A04-21	Post-colonial	
A04-03	Post-colonial		A04-22	Post-colonial	
A04-04	Not identified		A04-23	Not identified	
A04-05	Pre-colonial		A04-24	Pre-colonial	
A04-06	Eclectic		A04-25	Early Modern	
A04-07	Not identified		A05-01	Post-colonial	
A04-08	Early Modern		A05-02	Early Modern	
A04-09	Pre-colonial		A05-03	Early Modern	
A04-10	Eclectic		A05-04	Early Modern	
A04-11	Eclectic		A05-05	Early Modern	
A04-12	Not identified		A05-06	Post-colonial	
A04-13	Eclectic		A05-07	Early Modern	
A04-14	Post-colonial		A05-08	Pre-colonial	
A04-15	Post-colonial		A05-09	Early Modern	
A04-16	Pre-colonial		A05-10	Eclectic	
A04-17	Post-colonial		A05-11	Eclectic	
A04-18	Post-colonial		A05-12	Early Modern	
A04-19	Post-colonial		A05-13	Early Modern	
A04-20	Post-colonial		A05-14	Early Modern	
			A05-15	Early Modern	

A05-16	Early Modern	
A06-01	Modern	
A06-02	Early Modern	
A06-03	Early Modern	
A06-04	Post-colonial	
A06-05	Post-colonial	
A06-06	Early Modern	
A06-07	Early Modern	
A06-08	Early Modern	
A06-09	Modern	
A06-10	Early Modern	
A06-11	Eclectic	
A06-12	Early Modern	
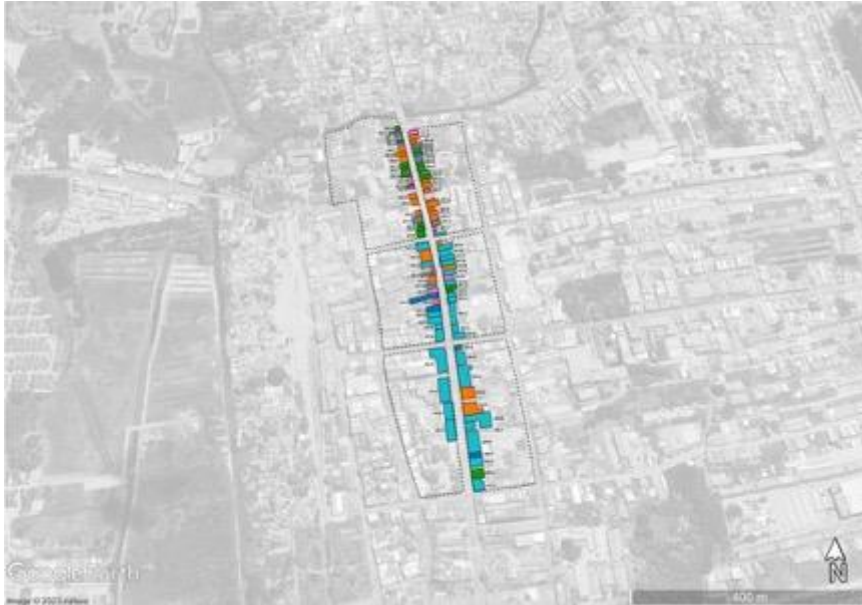
Fig. 13: Map of selected buildings classified by characteristics
Source: Google Earth, Edited by Author, 2023

From the data of the selected shophouse façade, the 5 characteristics appeared along the street. There are 12 buildings in pre-colonial style, 22 buildings in post-colonial style, 16 buildings in eclectic style, 33 buildings in early modern style, 4 buildings in modern style, and 8 buildings that are not able to be identified. In the area next to Tha Sak Canal, post-colonial-style shophouses have been built. It is believed that this style of building was built during the period of the peak of the trade between Thailand and other countries through the Gulf of Thailand. Because Tha Wang was the main port of Southern Thailand, many traders, especially Chinese were more likely to build their houses near the port area. Their settlement was bringing the culture from Malaya, Penang, which is also the center of trading, especially the area of architecture. The architectural style that has effects on this type of shophouse was the Western influenced architecture, Britain in this case, which came to this part of the world from colonization.

However, further away from the canal, the more early modern, art deco and modern architecture are seen. They are evidence that the urban settlement in Tha Wang is expanding from the canal, the old way of transportation, to the road. The style of architecture is more likely to be the later style. There are also pre-colonial style architecture in between the other buildings. It is believed that there are old residential buildings without renovation that changed their characteristic among newer shophouses that already changed.

Although Tha Wang is a diverse area, the eclectic style shophouses have been seen in every part of the road. It can be assumed that these buildings were built later with the influence of the existing buildings around them or the intention of the owners. In terms of the size of the shophouses, because of the change in building use, the shophouses in early modern style trend are bigger than the pre-colonial and post-colonial ones. In the past, shophouse buildings have been built for residential and small or family businesses only. Therefore, the buildings are smaller than the buildings in the early modern section that have been built later for residential renting purposes.

In the first part, A01, early modern-style shophouses have been found. There are 4 shophouse buildings in this section, all of them were built in the same style, early modern. The repetition of the ornament, vertical decorations, and windows make the unity out of the buildings. They have a 3-floor height, but the building at the corner, A01-04, is significantly taller with a 7-floor height. It is believed that it was built later for the full rental residential purpose on the second to the seventh floor and for commercial purposes on the first floor.
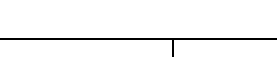
The second section is A02, the mix of buildings in different styles. Because this section appears in the middle of the study site, it acts like a transition sector. The small shophouses with a 2-floor height in the pre-colonial and post-colonial styles have been built among the taller buildings: 3 – 4-floor height in both early modern and modern styles. The nearest section to the Tha Sak canal is the A03 part. In this section, there is more likely to be a post-colonial style, as from the urban settlement in the past of this neighborhood, the waterway was the main way of transportation. Therefore, the older buildings have been built close to the canal. However, the eclectic style shophouses are still seen because of the renovation and rebuilding.

Across the road from the A03 sector, is the A04. This section has almost the same style as the A03 but has more post-colonial buildings with public utility and commercial purposes. The A05 sector still keeps the same atmosphere as the buildings on the opposite. The change in architectural styles can clearly be seen in both A02 and A05 parts. Lastly, in the A06 section, the early modern style still is the main style. However, there are a few buildings in the post-colonial style, A06-04, and A06-05, because of the architectural conservation.

To be more specific in each building and to prepare the dataset for machine learning, the ornaments on the shophouse façades are identified into 9 ornaments with the specific CSS color number for each description, air ventilation, window, door, vertical decoration, horizontal decoration, diagonal decoration, roof, enclosure, and balcony and classified into 5 characteristics based on the relationship of them. In the pre-colonial style, the buildings are more likely to have separate windows and air ventilation. However, the rest of the building's façades were not decorated. In the post-colonial style, a dramatic change in the decorations occurred in both window and air ventilation into the neo-classical influenced style and most importantly the diagonal decoration. The early modern style, the most common style on Ratchadamneon Road, also has decoration but vertical and horizontal elements instead. Contrary to the modern style façade, this characteristic has no air ventilation and no decoration. Finally, there is the eclectic style, which is the combination of the styles above.

Table 2: Color scheme for input images
Source: Author
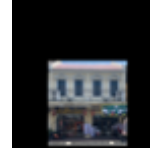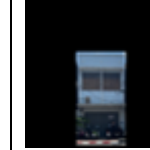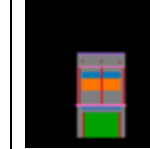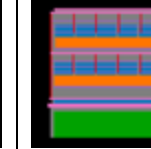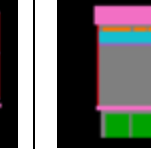
Color	Description	Hex Color Code	CSS Color
	Air Ventilation	#1F77B4	rgb(31, 119, 180)
	Window	#FF7F0F	rgb(255, 127, 15)
	Door	#2BA02B	rgb(43, 160, 43)
	Vertical Decoration	#D62727	rgb(214, 39, 39)
	Horizontal Decoration	#9467BD	rgb(148, 103, 189)
	Diagonal Decoration	#8C564C	rgb(140, 86, 76)
	Roof	#E377C1	rgb(227, 119, 193)
	Enclosure	#7F7F7F	rgb(127, 127, 127)
	Balcony	#16BECF	rgb(22, 190, 207)

Table 3: Ornament relationship for façade characteristic analysis
Source: Author

Characteristic	Pre-Colonial (Traditional)	Post-colonial (Britain Influence)	Eclectic (Combination)	Early Modern (Art Deco)	Modern
Relationship between ornaments	Separated window and simple air ventilation Non-Decoration	Window with decorated air ventilation Decorated with Neo-classical style columns and elements	Window with simple air ventilation Combination of different styles decoration	Window with simple air ventilation Plain vertical and horizontal decoration	Window without air ventilation Less or non-decoration

Ground Truth					
Input for ML					

. The dataset will be created from the photographic images of the shophouse's façades, converting 1200 x 1200 pixels on a black background with the same scale of building in each image. Based on the 95 buildings, the pictures of shophouses are used as the ground truth images in the same size and scale of buildings. Therefore, the buildings are separated into 2 – 4 columns per image, depending on the size or height. The 113 ground truth images are identified by the color of their ornaments on the façade, resulting in the input images for machine learning at the same size as the square.

Table 5: Selected façades as ground truth and input for machine learning
Source: Author

Name	Ground Truth	Input for ML
A01-01-01		
A01-01-02		
A01-01-03		
A01-02-01		
A01-02-02		
A01-02-03		
A01-03-01		
A01-03-02		
A01-03-03		
A01-04-01		
A01-04-02		
A02-01-01		
A02-02-01		
A02-03-01		
A02-04-01		
A02-05-01		
A02-06-01		
A02-07-01		
A02-08-01		

A02-09-01		
A02-10-01		
A02-11-01		
A02-12-01		
A02-13-01		
A02-14-01		
A02-15-01		
A02-15-02		
A02-16-01		
A03-01-01		
A03-02-01		
A03-03-01		
A03-04-01		
A03-05-01		
A03-06-01		
A03-07-01		
A03-08-01		
A03-09-01		
A03-10-01		

A03-10-02		
A03-11-01		
A03-12-01		
A03-13-01		
A03-14-01		
A03-15-01		
A03-15-02		
A03-16-01		
A03-17-01		
A03-18-01		
A03-19-01		
A03-20-01		
A03-21-01		
A03-22-01		
A03-23-01		
A04-01-01		
A04-02-01		
A04-03-01		
A04-04-01		

A04-05-01			A04-24-01			A05-16-01		
A04-06-01			A04-25-01			A06-01-01		
A04-07-01			A05-01-01			A06-02-01		
A04-08-01			A05-02-01			A06-02-02		
A04-09-01			A05-03-01			A06-03-01		
A04-10-01			A05-04-01			A06-03-02		
A04-11-01			A05-05-01			A06-04-01		
A04-12-01			A05-06-01			A06-05-01		
A04-13-01			A05-07-01			A06-06-01		
A04-14-01			A05-08-01			A06-07-01		
A04-15-01			A05-09-01			A06-08-01		
A04-16-01			A05-10-01			A06-08-02		
A04-17-01			A05-11-01			A06-08-03		
A04-18-01			A05-12-01			A06-09-01		
A04-19-01			A05-13-01			A06-10-01		
A04-20-01			A05-14-01			A06-11-01		
A04-21-01			A05-14-02			A06-12-01		
A04-22-01			A05-14-03			A06-12-02		
A04-23-01			A05-15-01					

The input images show the repetition and the pattern of the shophouse façades along the Ratchadamneon Road, which varies based on their architectural styles. However, the most found ornaments in most shophouse buildings, except the common ornament are boundary, window, door, and air ventilation, which is a confirmation of its importance in tropical vernacular architecture.

Conclusions

Based on the 95 buildings, the characteristics of façade are separated into 6 categories, pre-colonial, post-colonial, eclectic, early modern, modern, and not classified. The pattern of the shophouse façade is related to the urban settlement in this area. From the simple wood shophouses with wood windows and non-decorated air ventilation of traditional shophouses, they change to the fully decorated ones with curves, lines, and window frames of colonial-style shophouses. They have been influenced by the colonization of Malaya by Britain.

After the expansion of the urban settlement, the early modern, or art deco style in this case, shophouses have been built with concrete, decorated with straight lines and fins for both functional and non-functional purposes. However, because of the diversity in this neighborhood, some shophouses represent the incorporation of the styles above. To explicate the approach in the urban settlement, the characteristics of shophouse façades are slightly changed from the post-colonial style in the area close to the canal to the early modern style next to the intersection because of the expansion of settling that is changed from along the waterway to the road. Moreover, some shophouses have adopted both characteristics into the unique style of eclectic and have been built among them.

This study was limited by the changes in each building. There are some buildings that are under construction or are covered by other materials based on the use of each building during the time of data collection.

For the expansion of this research, the input images of the shophouse façade, 1200 x 1200 pixel size, will be used as the ground truth and input for machine learning and combined with the data on the location of shophouses which is related to the urban settlement of this area. Alternatively, one could use the data with more inputs from other roads where the same settlements occur to predict the building façades and use them in the conservation of buildings.

Acknowledgment

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