Measuring Streetscape Qualities in a Car-dependent City: The Case of Three Historical Streets in Bangkok

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ABSTRACT

This study aims to apply the five urban design qualities identified by Reid Ewing and Otto Clemente in a different context. To conduct this empirical study, Bangkok was selected to exemplify a car-dependent city, and three Bangkok streets were chosen for study. The measurement of streetscape qualities was carried out using two approaches, objective and subjective, which were then compared in order to gain insight. The study employed convergent parallel mixed methods, in which both the quantitative and qualitative data were taken into account. Objective measurement of streetscape qualities was done based on qualitative data using fieldwork studies, while subjective evaluation of users' perceptions was done based on a quantitative questionnaire. Analysis was based on a set of physical features that affect people's perceptions of the street environment and the measurement protocol. Its application in this study revealed how the features and protocol can be further developed by considering the background and context of the studied area in order to more effectively capture the streetscape qualities of the city. The results revealed that the streetscape elements that are less perceived by car drivers and passengers in the city are the ones located on sidewalks and that building details are hardly noticed by these motorists. Apparently, spatial perception and streetscape qualities are likely to be overlooked or less perceived in a car-dependent city. In hindsight, this study tends to support the study of users' perceptions and satisfaction as part of the data collection and analysis process in the study of urban design.

Keywords: streetscape, urban design quality, spatial perception

INTRODUCTION

One of the critical domains in urban design is understanding the human experience of public spaces (Ho & Au, 2020). Urban streets are the public spaces that are the most commonly used and are closely related to urban residents as the streets are perceived in everyday living. Good street environments can provide a positive experience and increase the frequency of users' outdoor activities (Tang & Long, 2019). The contextual environment of urban streets that are perceived and communicated to users can be called "streetscape", which conveys not only symbolic meanings that help with navigation but also creates emotional experiences that are associated with aesthetic attributes that tinge representations of space (Galvez-Pol et al., 2021; Salhi & Dönmez, 2021). Good quality streetscape can provide a good impression, create a vital image for the city that attracts visitors and generates liveliness and enhanced quality of living for local users, which is one of the key objectives of urban design (Qiu et al., 2021). However, research into streetscape qualities is usually undertaken as a field survey by technicians or specialists in the urban design field, without explicitly taking users' perceptions into account.

Designing a human-oriented streetscape is interrelated with users' perceptions and has become one of the crucial environmental improvement strategies to enhance users' satisfaction with urban streets (Tang & Long, 2019). The study of streetscape quality cannot be dictated merely by the objective condition, but should also include subjective perceptions and provide insight into people's satisfaction and preferences (Ho & Au, 2020; Pacione, 2003). It is necessary to apply both objective and subjective evaluations to obtain a proper understanding of urban environmental quality (Ho & Au, 2020; Qiu et al., 2021). As Pacione explained, objective measurements capture "the city on the ground", whereas subjective perception captures "the city in the mind" (Pacione, 2003, pp. 20–21). In consequence, the primary research activity of this study is to explore and measure the quality of streetscapes using both approaches, and then to ask whether the perceptions of general users conform to the objective measurement outcomes.

Among the tools and methods typically used to quantitatively evaluate the street environment, few cover micro-scale pedestrian infrastructure like sidewalks, building frontage, kiosks, and street lighting (Ewing et al., 2016; Zhu et al., 2019). One study has successfully created a method used in the measurement of urban design qualities (Ewing & Clemente, 2013). However, the study of Ewing and Clemente was based on the context of New York City. Although urban streets are commonly seen as public spaces worldwide, the functions and perceptions of streets and sidewalks are different and context-dependent. Streets and sidewalks have different characteristics in Western and Southeast Asian cities and are used and appropriated differently Rawiwan Oranratmanee & Veera Sachakul, 2014). Furthermore, cities in Southeast Asia are mostly car-dependent, which means that traveling by car is favored over alternate forms of transportation such as bicycles, public transit, and walking. Consequently, the second purpose of this study is to determine whether the measurement protocol is applicable, and in which aspects the features could be adjusted to capture the streetscape qualities in a car-dependent city in Southeast Asia.

In this study, Bangkok, the capital of Thailand, is chosen for investigation since it can represent a typical car-dependent city in Southeast Asia (Newman & Kenworthy, 1999). The majority of the population of the city commutes by car, motorcycle, or bus (Varameth Vichiensan et al., 2022). Studying the perceptions of the city's residents with respect to the streetscape in Bangkok can exemplify how streetscape is perceived in a city where the majority of street users either drive or sit in vehicles. Finally, this study proposes two research questions:

1) According to the results gained from the two approaches to measuring streetscape qualities, to what extent the results are related to each other?

2) What factors are of greatest significance when measuring streetscape qualities in a car-dependent city?

LITERATURE REVIEW

Spatial Perception and Interpretation

Perception is a mental process of giving meaning to sense experience and trying to understand the relationships between ongoing affairs and the meaning of objects (Mohammad Hossein Imani Khoshkhoo & Mahdieh Shahrabi Farahani, 2019). Spatial Perception of the streetscape, likewise, is the perception of a physical environment when users experience spaces or travel alongside the streets. It is how physical features on the streets are encountered and visually communicated to users (Ewing & Handy, 2009). The process of perception is, in fact, a two-way communication process in which space and users have a significant influence on each other.

The communication between users and streetscapes occurs during the process of perception (see Figure 1). When users experience spaces (A) or travel alongside the streets, the physical environment is caught through sensory receptors. The users will attempt to interpret (B) or recreate their understanding and give meaning (C) to the environment (Piga & Morello, 2015). The perception (D) of streetscapes is how users define and memorize space, which can be explained as the correlation between users and physical features along the streets. In other words, the streetscape qualities are received and processed by users, and within this process, users define and memorize the streets as an evaluative response. The process of spatial perception reveals how users perceive and interpret streetscape and how streetscape qualities can influence user satisfaction.

Streetscape Qualities

The word 'streetscapes' means physical features along the streets. 'Streetscapes' also refers to the design and conditions of the streets as they impact users and nearby residents (Harvey, 2014). The design of urban streets is shaped by a combination of horizontal and vertical elements. Horizontal elements define space on the ground; e.g. lanes, curbs, sidewalks, crosswalks, medians, and green strips, while vertical elements are buildings that define the proportions of a street and influence vertical delineators (Harvey et al., 2017). While streets are in use, the design elements of the streets are visually perceived and communicated to users. As an example, closely connected buildings on a street can increase the feeling of an outdoor room, while a street with widely spaced or few buildings, on the other hand, can give a feeling of vast and ill-defined space. As Lynch (1960)

Figure 1

Spatial Perception of the Streetscape
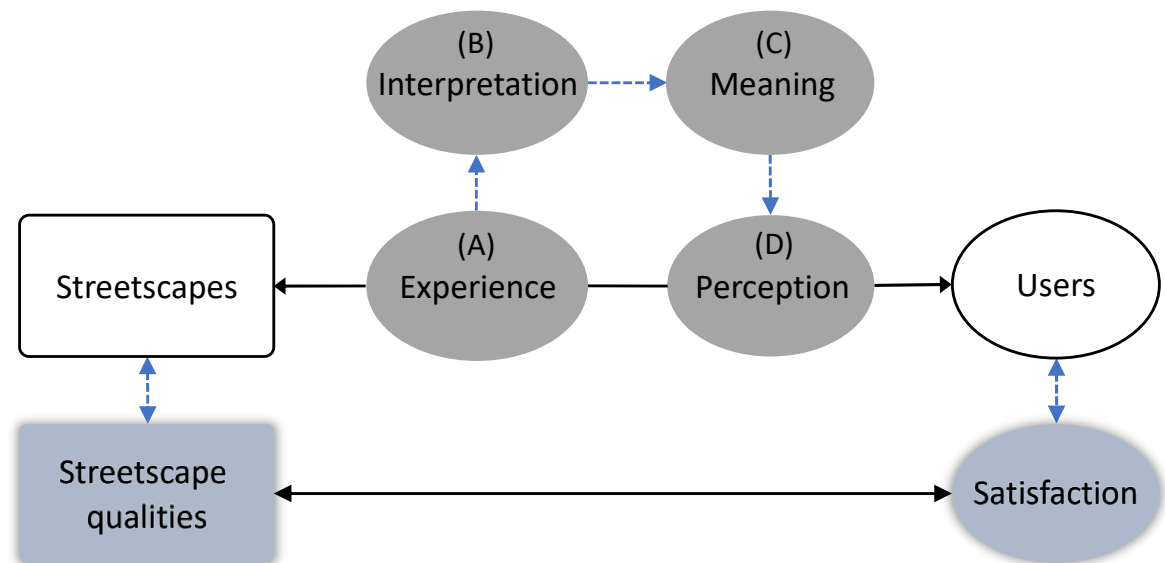
explained, physical features along the streets can promote a vivid and memorable sense of place and help people orient themselves within the built environment (Neckerman et al., 2013). The design elements on the streets are being perceived and recognized by users and, thus, are the main influential factors in the quality of streetscapes (Gehl, 2010; Qiu et al., 2021; Werner et al., 2018). In this paper, the quality of the streetscape refers to the physical conditions and functional ability of the streets (Tang & Long, 2019), which enhance users' perceptions and satisfaction, and contribute to urban design qualities.

Although the correlation between human perception and the built environment has been studied for over four decades (e.g., Alexander et al., 1977; Appleyard, 1969; Arnold, 1993; Cullen, 1961; Gehl,2011; Jacobs, 1993), the attempt to measure the perceptual qualities has not

previously been explicitly seen in urban design literature (Nia & Atun, 2016). The operational definitions and measurement protocols of urban design qualities were not adopted until the study of Ewing, Handy, Brownson, Clemente, and Winston in 2006. The study of Ewing et al. developed the operationalized "urban design qualities" that are related to the walkability of the streets in New York City. The "visual assessment survey" process of the study identifies physical features associated with urban design qualities. Five qualities were chosen by a panel of experts as being of the most significance: imageability, enclosure, human scale, transparency, and complexity. In this study, the five qualities and their features are used to examine streetscapes. The definitions of all five qualities are presented in Table 1, and keywords have been selected to summarize the issues of each quality. Clear definitions and keywords are meant to help with effective implementation of this research.

Table 1

The Definitions and Keywords of Streetscape Qualities

Streetscape Qualities	Definitions	Keywords
Imageability	Imageability is the quality of a place that makes it distinct, recognizable, and memorable. A place has high imageability when specific physical elements and their arrangement capture attention, evoke feelings, and create a lasting impression.	Distinct Recognizable Memorable Emotion Impression
Enclosure	Enclosure refers to the degree to which streets are visually defined by buildings, walls, trees, and other vertical elements. Spaces where the height of vertical elements is proportionally related to the width of the space between them have a room-like quality.	Visually defined Height of vertical elements Width of the space Room-like quality
Human Scale	Human scale refers to the size, texture, and articulation of physical elements that match the size and proportions of humans.	Size and proportions of humans
Transparency	Transparency refers to the degree to which people can see or perceive what lies beyond the edge of a street and, more specifically, the degree to which people can see or perceive human activity beyond the edge of a street.	Able to see or perceive human activity beyond the edge of a street

Table 1 (Continued)

Streetscape Qualities	Definitions	Keywords
Complexity	Complexity refers to the visual richness of a place, which depends on variety in the physical environment, i.e. buildings, ornamentation, landscape elements, street furniture, signage, and human activity.	The richness of a place

Note. Adapted from (1)"Identifying and Measuring Urban Design Qualities Related to Walkability," by R. Edwing, S. Handy, R.C. Brownson, O. Clemente, & E. Winston, 2006, *Journal of Physical Activity and Health*, 3(1), p. S223–S240 (https://doi.org/10.1123/jpah.3.s1.s223). Copyright 2006 by Human Kinetics, Inc.; (2)"Measuring the Unmeasurable: Urban Design Qualities Related to Walkability," by R. Ewing, and S. Handy, 2009, *Journal of Urban Design, 14*(1), pp. 65–84 (https://doi.org/10.1080/13574800802451155). Copyright 2009 by Taylor & Francis; and (3)"The Influence of Low- and Mid-Level Visual Features on the Perception of Streetscape Qualities, by G.N. Akcelik, K.E. Schertz, and M.G. Berman, in B. Lonescu, W.A. Bainbridge, and N. Murray (Eds.), *Human Perception of Visual Information* (pp. 241–262), 2022, Springer Nature Switzerland. Copyright 2022 by Springer Nature Switzerland.

The Measurement of Streetscape Qualities

Measuring streetscape qualities refers to the process of quantifying the design and conditions of the streets as they are perceived by users. The five qualities of streetscape can be quantified by the amount and proportion of correlated features and the criteria for consideration are as follows.

The first key quality of streetscape is *imageability*. A street with strong imageability is distinct, recognizable, and memorable. A place has high imageability when physical elements and their arrangement capture attention, evoke feelings, and create a lasting impression on the users (Lynch, 1960). Imageability is a quality that makes an area unique and gives users a sense of place (Gehl, 1996), which refers to the emotive bonds and attachments people develop or experience in particular locations and environments. The elements that enhance the imageability of a street are mainly physical things that can represent the distinct character of the area such as historic buildings, buildings with identifiers, courtyards, plazas or parks, landscape features, or plants (Ewing & Handy, 2009). The word 'identifier' refers to clear signs or universal symbols that reveal a building's street-level use (Ewing & Clemente, 2013). Imageability can be clearly perceived when there are an ample number of characteristic elements on the street. This means that the more characteristic elements there are, the more likely it is that imageability impacts user perception.

Enclosure is the second quality of streetscape, which refers to the user's perception of the territory. The feeling of enclosure on a street can be created by seeing physical elements that obstruct a sightline. Cullen (1961) explained enclosure as a room outside a building that can be perceived and generates a sense of place. Alexander et al. (1977) described enclosure as an outside functional room that is defined by surrounding buildings. Accordingly, the key element of enclosure in the streetscape is an existing territory line of walls or buildings. There are three issues to be considered with respect to the degree of enclosure. Firstly, a cross-sectional proportion is a ratio between street width and building height. The appropriate ratio is 1:1. While a lower ratio can give users a narrow feeling, a ratio above 1:1 will reduce users' perception of enclosure (see Figure 2).

The proportion of visible sky ahead is the third issue; this refers to the percentage of sky within users' eye frames. In summary, the proportion of the street wall and the proportion of the sky ahead are two key issues to be considered with regard to the degree of enclosure.
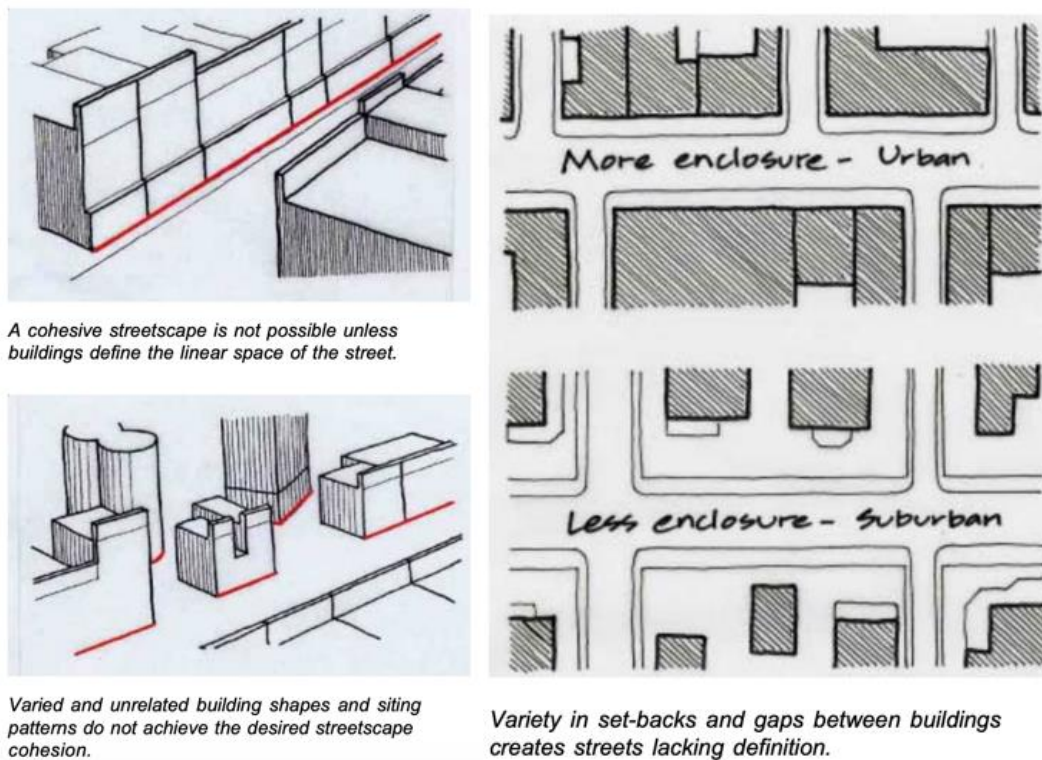
Figure 2

Distance Between Buildings (D) and Height of Buildings (H)
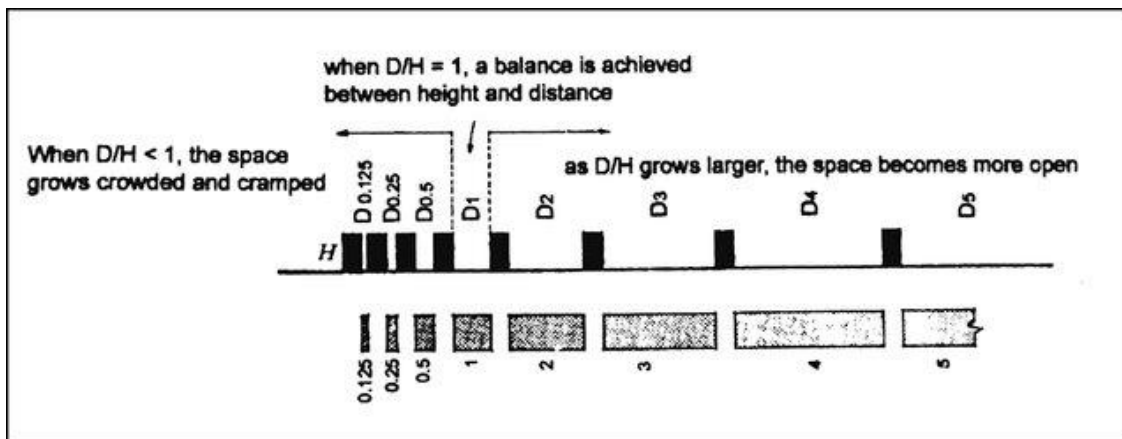
Note. From "Identifying Characters of Good Street for Greater Urban Quality of Life," by Z. Ab Rahman, S.K. Syed Othman Thani, & R. Roslan, 2017, *Asian Journal of Quality of Life, 4*(15), pp.19–31 (DOI:https://doi.org/10.21834/ajqol.v4i15.184). Copyright 2019 by Zainuddin Ab Rahman, Sharifah Khalizas Syed Othman Thani, and Rafiuddin Roslan .

Figure 3

A Continuity of Street Wall

A cohesive streetscape is not possible unless buildings define the linear space of the street.

Varied and unrelated building shapes and siting patterns do not achieve the desired streetscape cohesion.

More enclosure – Urban

Less enclosure – Suburban

Variety in set-backs and gaps between buildings creates streets lacking definition.

Note. From *Supplementary Planning Guidance (SPG)* (p. 37, p. 44), by Southampton City Council, 2004, (https://www.southampton.gov.uk/planning/planning-policy/supplementary-planning/development-design-guide-spg/). Copyright 2004 by Southampton City Council.

Human scale is the third quality of streetscape to be considered. It refers to the proportion, materials and measurement of the streetscape suitable for users' perception and satisfaction while walking or traveling along the street (Harvey et al., 2017). The perception of human scale can be indicated by 3 variables (Ewing & Clemente, 2013). The first is the building height, which has the greatest impact on the perception of the human scale. Although a higher building decreases the perception of human scale, the width of a street can help restore the perception. Secondly, being able to see activities inside buildings or being visible on the street can help create human-friendliness; therefore, the presence of first-floor windows increases the perception of human scale. Lastly, the number of street items that are provided on a sidewalk, i.e., street trees, small planters, benches, stalls, garbage bins, bicycle racks, signage, and bus stops, can make users feel comfortable on the street and increase the perception of human scale.

The fourth quality of streetscape is **transparency,** which refers to the visibility of space and buildings along streets. Creating transparency in streetscape requires transparent building frontage or walls that allow the inside of the building or area to be seen from the outside. Transparency can also be increased by being accessible from a street, which creates the perception of movement and activities inside the building or on the other side of the wall. Accordingly, three variables of streetscape can increase transparency. Actively used buildings comprise the first variable that increases activity, and thus transparency, on the street. The second variable is the proportion of the street wall, which indicates the level of transparency. A continuous building wall on each side of the street will decrease the quality of transparency (Ewing & Clemente, 2013). The proportion of the first floor with windows is the third variable to be considered to increase transparency.

Complexity is the fifth quality of streetscape to be considered. Complexity results from perceiving a variety of physical environments on both sides of a street, i.e., buildings, different styles of architecture, landscape features, street furniture, signage, or activities. According to Rapoport (1990), complexity is related to the number of perceptible differences that a viewer

perceives per unit of time. Human beings are most comfortable with a suitable number of changes. Therefore, the proper amount of complexity creates attractions to the streetscape, while too few changes produce a dull sameness. Meanwhile, too many changes or surprises can create the feeling of being unordered or chaotic. Several variables can greatly enhance the complexity of streetscape, i.e., buildings in different shapes, sizes, materials, colors, architecture and ornamentation, trees, street furniture, signage, and the presence and activity of people. While all these variables can, to a greater or lesser extent, affect complexity, the two variables that do so most strongly are the colors of the structures and the activity of people, both inside and in front of buildings.

Streetscape Qualities of a Car-dependent City

The affect measurement of streetscape qualities has been verified to be correlated to the physical environments that are visually perceived by users on the streets. Some past research in the urban design field has developed protocols for measuring and quantifying the qualities of urban streets (e.g., Ewing & Handy, 2009; Harvey, 2014). The majority of past studies focused primarily on the experience of pedestrians, and the results were related to walkability (e.g., Adkins et al., 2012; D'Acci, 2019; Ewing et al., 2016; Qiu et al., 2021). The fact that walking speed allows people to perceive and process data about the street environment provides a good reason for taking an approach based on perceptual characteristics. However, the perception of the streetscape in real life is not confined to walking or moving at a low speed. Several car-dependent cities are overly-reliant on passenger cars due to a lack of infrastructure to support other modes of transport such as rail, cycling, or walking. Streetscape qualities in a car-dependent city could be differently perceived, and may require different considerations. According to Rapoport (1990), simplicity and relatively distant views are appropriate at high speed, whereas enclosure and complexity are preferable at slow speed. As he mentioned, "An

environment [that is] comfortably stimulating from a car becomes monotonously boring on foot, whereas what is interesting on foot becomes chaotic in a car" (Rapoport, 1990, p. 280).

This research aims to adapt and apply the protocol for measuring the perception of streetscape qualities by pedestrians in the context of a car-dependent city. The intention is to develop a measurement process by collecting objective measurements by doing a site survey, and also the subjective perceptions of street users in order to reveal how streetscape is perceived in the context of a car-dependent city. The results from the two approaches of measurement will be compared, and the premises can be deduced.

STUDY AREA AND RESEARCH METHODOLOGY

Study Area: Three Historic Streets

In this research, an empirical study was conducted on three streets in the inner area of Bangkok, i.e., Ratchadamnoen Klang, Yaowarat, and Charoen Krung Streets (see Figure 4). The selection is based on three criteria. Firstly, the selected streets should symbolize the typical character of Southeast Asian streets and be related to Bangkok as a car-dependent city. Secondly, the streets serve the general function of Bangkok's streets. Thirdly, the streets represent the identity of Bangkok and are part of Bangkok's history, including traditional styles of architecture.

Ratchadamnoen Klang Street (see Figure 5) was commissioned by King Chulalongkorn the Great (King Rama V) in 1909. The initial intention was to connect the two royal palace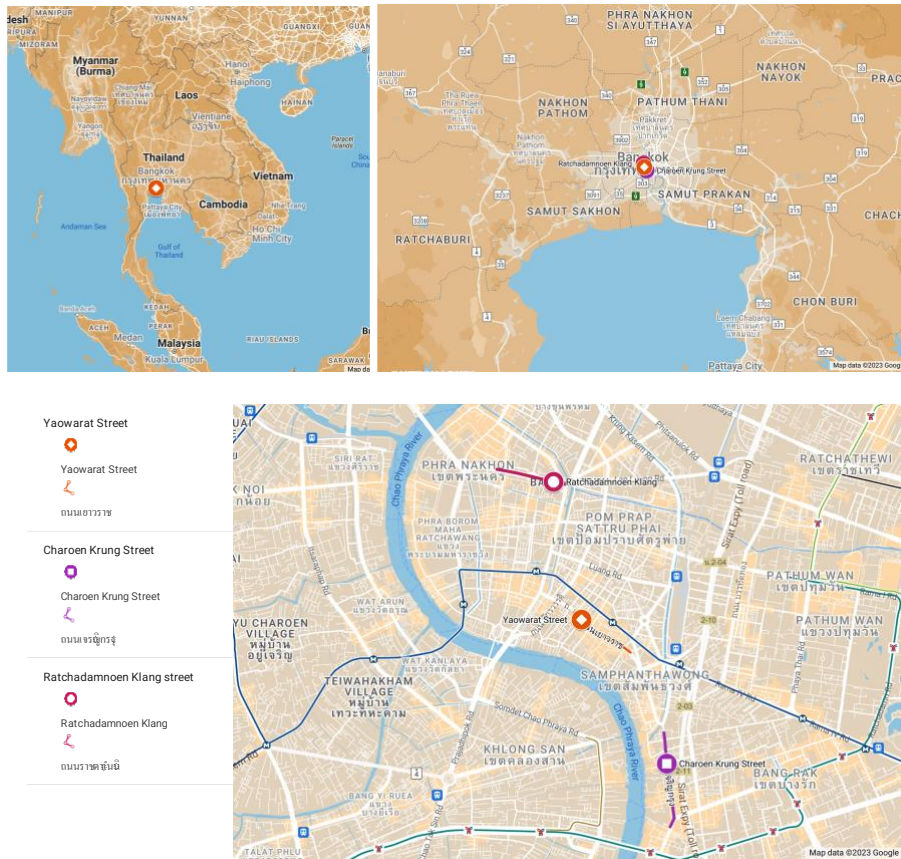s -- the Dusit Palace (currently known as Ananta Samakhom Throne Hall) and the Grand Palace (currently known as the Temple of the Emerald Buddha). In constructing Ratchadamnoen Klang Street, the intention was to locate public government buildings there, and to provide urban public space. As a consequence, the street was designed to have a broad sidewalk, and shophouses were not allowed to be built, in order to avoid commercial activity. Today, most of the traditional buildings have been preserved and renovated, and some are used as museums or offices of public and private companies.

Yaowarat Street (See Figure 6) is the main artery of Bangkok's Chinatown. The construction of the street was ordered by King Rama V, and it took 8 years, from 1892 to 1900, to build. The path of the street is curvy since, in line with the king's policy, it was laid out to avoid existing clusters of houses. The curvy path is said to resemble a dragon's body, which some believe makes it an auspicious location for business. Yaowarat Street is well known for its variety of foods that draw tourists and locals. Also, a variety of shops are located along the street, most of them selling gold. As a consequence, Yaowarat Street has been labeled the "Golden Road" or "Dragon Road".

Charoen Krung Street (see Figure 7) was built between 1862 and 1864, during the reign of King Mongkut (Rama IV). The street runs from the old city center in Rattanakosin Island, passing through Bangkok's Chinatown, and continuing into the Bang Rak district, a community of European expatriates. It is the first street in Thailand that was built using modern construction methods, and it marked a major change in Bangkok's urban development, with the major mode of transport shifting from water to land. Charoen Krung was Bangkok's main street up until the early 20th century. Historic buildings can be seen on the street, but this is at risk of changing as a possible extension of the underground MRT subway system would drive new development if it were to eventuate.

Figure 4

Locations of Ratchadamnoen Klang, Yaowarat and Charoen Krung Streets
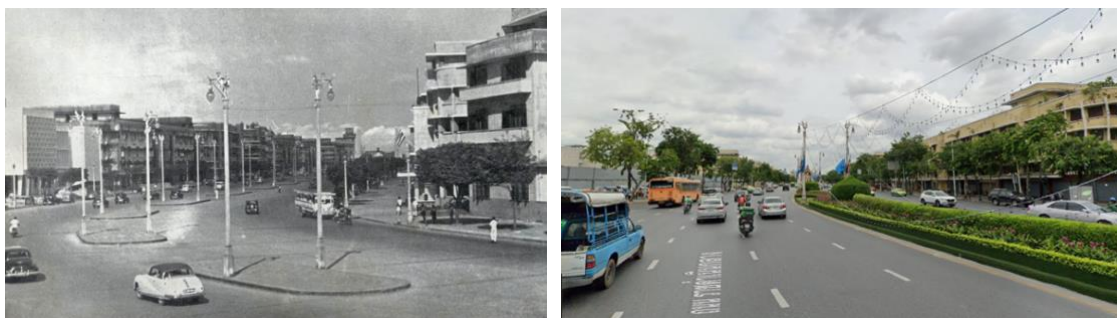

Note. From *Map of Ratchadamnoen Klang, Yaowarat and Charoen Krung Streets*, by Google Map, 2023
(https://www.google.com/maps/d/edit?hl=en&mid=1iIhkx9QSRsOu6jdHsp1LoTAZ7HOduYA&ll=13.747
130621199496%2C100.49953885925596&z=13). Copyright 2023 by Google LLC.

Figure 5

Ratchadamnoen Klang Street in 1954 and 2022

Note. From *Ratchadamnoen Avenue http://mobile.nlt.go.th/readall/371351*, by Thailand Illustrated, 1954, National Library of Thailand (http://mobile.nlt.go.th/bmo/NLT61060752.bmk/.0020_B.jpg). Copyright 2022 by National Library of Thailand.; and *Ratchadamnoen Klang Street in 2022*, by Google Earth, 2023
(https://earth.google.com/web/@13.75591499,100.5048486,9.49947358a,0d,59.99999999y,284.26831
514h,105.18651906t,0r/data=IhoKFl9sMkZzYXFBMkVoNVhPNW84OUVPancQAg). Copyright 2023 by Google LLC.

Figure 6

Yaowarat Street in 1958 and 2022

Note. From *Siam, Thailand & Bangkok Old Photo Thread*, by TeakDoor, 2021 (https://teakdoor.com/famous-threads/39970-siam-thailand-bangkok-old-photo-thread-150.html). Copyright 2021 by TeakDoor.; and *Yaowarat Street in 2022*, by Google Earth, 2023 (https://earth.google.com/web/@13.73974157,100.51097047,13.76042271a,0d,60y,305.61692242h,94.72649004t,0r/data=IhoKFjFOdHI4T0R5YWpxdFVqbUpneFV4MXcQAjIpCicKJQohMUZiYS1xVlBLSHA4WHozbTBIT24xSWlYSlFhMmR6eThSIAE). Copyright 2023 by Google LLC.

Figure 7

Charoen Krung Street in 1951 and 2022

Note. From *Bangkok traffic 1951 Old Pics of Bangkok 1950s,* by Entertainment *B*log *P*ictures*, 2014,* Entertainmentblogpictures, blogspot (https://2.bp.blogspot.com/-76WO8p1BR5s/TxU4rm4dzXI/AAAAAAAAq4U/ALyN42nay7w/s1600/Bangkok+1950+-+160112+-+004.jpg). Copyright 2023 by Entertainment Blog Pictures.; and *Charoen Krung Street in 2022*, by Google Earth, 2023 (https://earth.google.com/web/@13.72582148,100.51621534,13.58810806a,0d,60y,346.17332436h,89.25770521t,0r/data=IhoKFlFJNWF4bXEyTS1Wa0VGelNxaDlEbGcQAjIpCicKJQohMUZiYS1xVlBLSHA4WHozbTBIT24xSWlYSlFhMmR6eThSIAE). Copyright 2023 by Google LLC.

Research Methodology

This research adopted the variables and urban design qualities developed by Ewing et al. and applied them to the three selected streets in Bangkok's old town. The aim was not only to measure streetscape qualities, but also to understand the subjective perceptions of general users. The study will be done using two different approaches. The first is to objectively measure the streetscape qualities, while the second is to study users' perception of streetscape qualities. However, individuals' perceptions of a streetscape in a car-dependent city like Bangkok, where the majority of users perceive streetscape while driving or sitting in a car, can be different from those of pedestrians on a sidewalk in other contexts. This issue has been taken into account as it could significantly affect the perception of small-scale features.

The study employed convergent parallel mixed methods in which both the quantitative and qualitative data were taken into account to provide a comprehensive analysis. The diagram in Figure 8 illustrates the procedure of building up a theoretical framework, collecting and analyzing the empirical data, and drawing conclusions. In the theoretical part of this study, a set of variables and a measuring scale were developed for the measurement of streetscape qualities. Data on streetscape qualities of the three selected historical streets were collected, with data for objective evaluation derived from field survey techniques and Google Earth Street View. The derived data were qualitatively reviewed and rated according to the measuring scale of streetscape qualities (see Table 3). The results reveal details of the relevant streetscape qualities.

In addition, an online survey was utilized to collect subjective data aimed at exploring streetscape qualities, as perceived by general users, and to identify the degree to which each variable is perceived and linked to these streetscape qualities. However, the words commonly used by researchers and academics for describing visual perceptions and streetscape qualities are not familiar to the average person. To make the survey more understandable and feasible for use as an online questionnaire, the words were adapted, employing simple and familiar keywords with pictures and explanations.

The questionnaire is divided into two parts. The first part is the demographic data of each sample. The second part asks about the perception of streetscape qualities, aiming to measure the degree to which each variable contributes to the urban design qualities of the streetscape. A semantic differential scale is applied to make subjective data measurable, and the data are quantitatively analyzed and rated.

Figure 8

The Research Framework
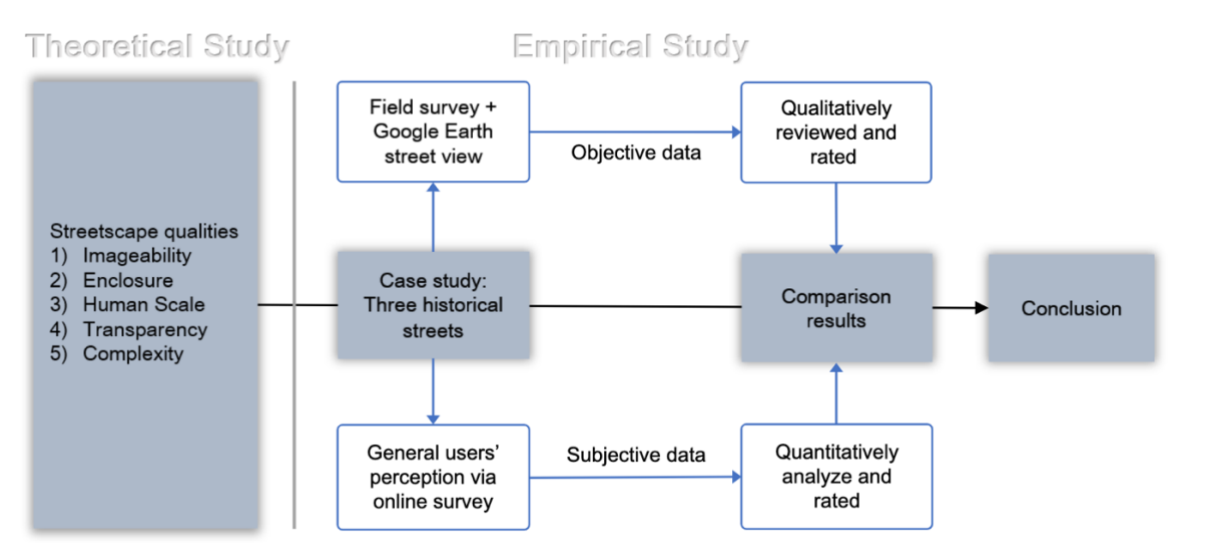
The sample population of this study consisted of 103 participants who lived in the area, or people who used one or more of the three streets. The demographic data of the sample population is presented in Table 2. The scale has five components -- imageability, visual enclosure, human scale, transparency, and complexity -- measured using 18 items, each measured on a 5-point Likert scale ranging from 1 "disagree" to 5 "totally agree". Descriptive statistics were used to analyze the survey data collected from 103 respondents.

ANALYSIS AND FINDINGS

To operationalize the evaluation of streetscape qualities, each variable has been given 3 measurement ranges; high, moderate, and low (see Table 3). Each is meant to indicate the level of intensity and generalize the degree of streetscape qualities. 'Low' means a low possibility to generate impacts on streetscape qualities due to a small number of variables. Likewise, 'Moderate' refers to moderate possibility, and 'High' refers to the high possibility to generate such impacts.

Table 2

Demographic Data of the Sample

Age		Education	
<25	13.6%	Secondary school	1%
25-41	62.1%	High school	6.8%
42-57	18.4%	Bachelor degree	46.6%
57-67	4.9%	Master degree	34%
>67	1%	Doctorate	11.7%
Total	100	Total	100
Occupation		**Income**	
No permanent job	9.7%	<15,000	17.5%
Retired	2.9%	15,001-20,000	12.6%
Business owner/ Entrepreneur	9.7%	20,001-25,000	10.7%
Employee	28.2%	25,001-30,000	16.5%
Government officer	25.2%	>30,000	42.7%
Freelancer	11.7%	Total	100
Others	12.6%	**Career field**	
Total	100	Architecture or related field	50.5%
		Others	49.5%
		Total	100

Table 3

Streetscape Qualities, Variables, and Measurement Ranges

Qualities	Variables	Measurement range		
		Low	**Moderate**	**High**
1)Imageability	1.1) Percentage of historic buildings	0-35%	35-70%	>70%
	1.2) Percentage of buildings with an identifier	0-35%	35-70%	>70%
	1.3) Number of courtyards, plazas, parks	0-1	2	>3
	1.4) Planters on private and public property	<300m^2	301-1,000m^2	>1,000m^2
2)Enclosure	2.1) Cross-sectional proportion (Average height of building facade: Average width of the street)	<1:1	1:1	>1:1
	2.2) Percentage of a street wall or continuity of building's frontage	0-35%	35-70%	>70%
	2.3) Percentage of the sky in a frame of vision	>70%	35-70%	0-35%
3)Human Scale	3.1) Street furniture	<50	50-100	>100
	3.2) Percentage of street-level façade on your side that is covered by windows	0-35%	35-70%	>70%
	3.3) Number of trees on the sidewalk	<50	50-100	>100
	3.4) Percentage of a street wall or continuity of building's frontage	0-35%	35-70%	>70%
4)Transparency	4.1) Percentage of active-use buildings	0-35%	35-70%	>70%
	4.2) A façade or wall greater than five feet providing a defined street edge	70%	35-70%	>0-35%
	4.3) Percentage of street-level façade that is covered by windows	0-35%	35-70%	>70%
5)Complexity	5.1) Number of dominant colors used for buildings and street objects	0-2	3-5	>5
	5.2) Percentage of active-use buildings	0-35%	35-70%	>70%
	5.3) Number of sidewalk café; Street Vendors; Kiosks	<10	10-20	>20
	5.4) Number of public arts	0-1	2	>3

Note. The number and proportion are calculated for ~600 m. street length.

The measurement of streetscape qualities

The results of the objective evaluation were described and scored (see Table 4). In terms of imageability, Ratchadamnoen Klang Street shows the highest score in all variables. High scores were given for having lots of planters on private and public property, while other variables were rated moderate. The percentage of historic buildings is moderate on Ratchadamnoen Klang street, while the levels are low on the other two streets (see Figure 9). In all three streets, over 68% of existing buildings were found to have identifiers, which, on Yaowarat Street, are mainly shop signs and jewelry displays (see Figure 10) as along with names of stores on Charoen Krung Street (see Figure 11).
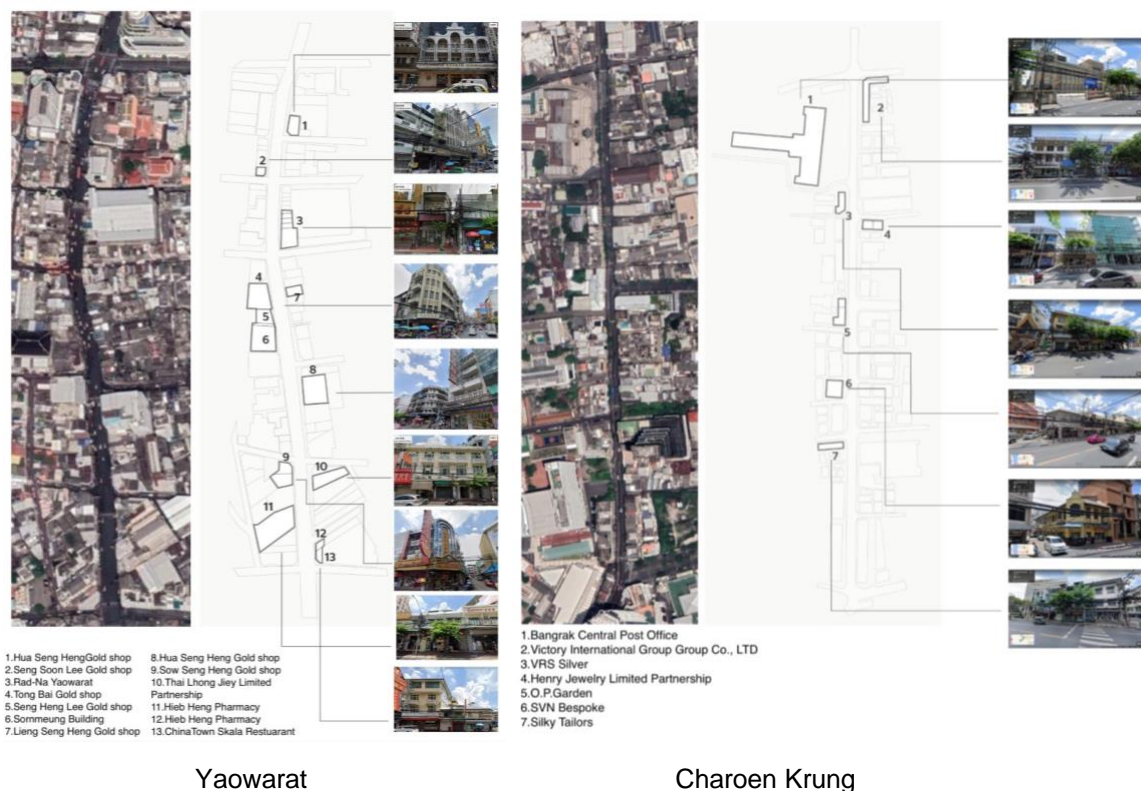
The quality of enclosure scored well on Yaowarat and Charoen Krung Streets. The proportions of the cross-sectional areas of Yaowarat and Charoen Krung were found to comprise the appropriate ratio of 1:1, while Ratchadamnoen Klang is a wider street with a ratio of 1:3. All three streets scored high on the continuity of building façades and sidewalks. Evaluation of the visibility of the sky in a frame of vision revealed small percentages on Yaowarat and Charoen Krung Streets and a moderate percentage on Ratchadamnoen Klang Street (see Figure 12).

The quality of human scale was rated high on Ratchadamnoen Klang Street based on the amount of street furniture and the number of trees in the sidewalk areas (see Figure 13). Yaowarat and Charoen Krung Streets, on the other hand, were rated low to moderate on these two variables. Meanwhile, a high score was given to the quality of human scale perception of the three streets based on the continuity of building façades on those streets.

Figure 9

Historic Buildings on Yaowarat and Charoen Krung Street

1.Hua Seng HengGold shop
2.Seng Soon Lee Gold shop
3.Rad-Na Yaowarat
4.Tong Bai Gold shop
5.Seng Heng Lee Gold shop
6.Sornmeung Building
7.Lieng Seng Heng Gold shop
8.Hua Seng Heng Gold shop
9.Sow Seng Heng Gold shop
10.Thai Lhong Jiey Limited Partnership
11.Hieb Heng Pharmacy
12.Hieb Heng Pharmacy
13.ChinaTown Skala Restuarant

1.Bangrak Central Post Office
2.Victory International Group Group Co., LTD
3.VRS Silver
4.Henry Jewelry Limited Partnership
5.O.P.Garden
6.SVN Bespoke
7.Silky Tailors

Yaowarat   Charoen Krung

Note. From *Locations of Ratchadamnoen Klang, Yaowarat and Charoen Krung Streets*, by Google Map, 2023 (https://www.google.com/maps/d/edit?hl=en&mid=1iIhkx9QSRsOu6jdHsp1LoTAZ7HOduYA&ll=13.731 793048121723%2C100.50791330077821&z=16). Copyright 2023 by Google LLC.

Figure 10

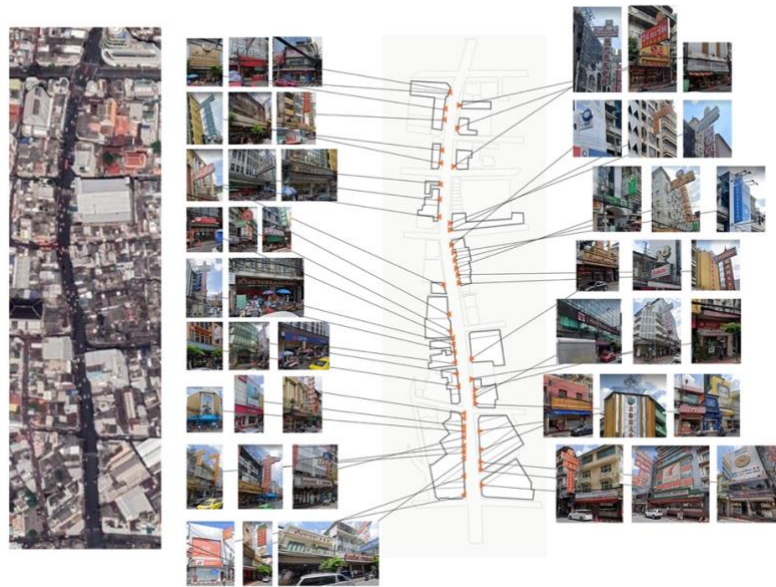*Buildings With Identifiers on Yaowarat Street*

Note. From *Locations of Ratchadamnoen Klang, Yaowarat and Charoen Krung Streets*, by Google Map, 2023 (https://www.google.com/maps/d/edit?hl=en&mid=1iIhkx9QSRsOu6jdHsp1LoTAZ7HOduYA&ll=13.744 708393795818%2C100.50791330077821&z=16). Copyright 2023 by Google LLC.

Figure 11

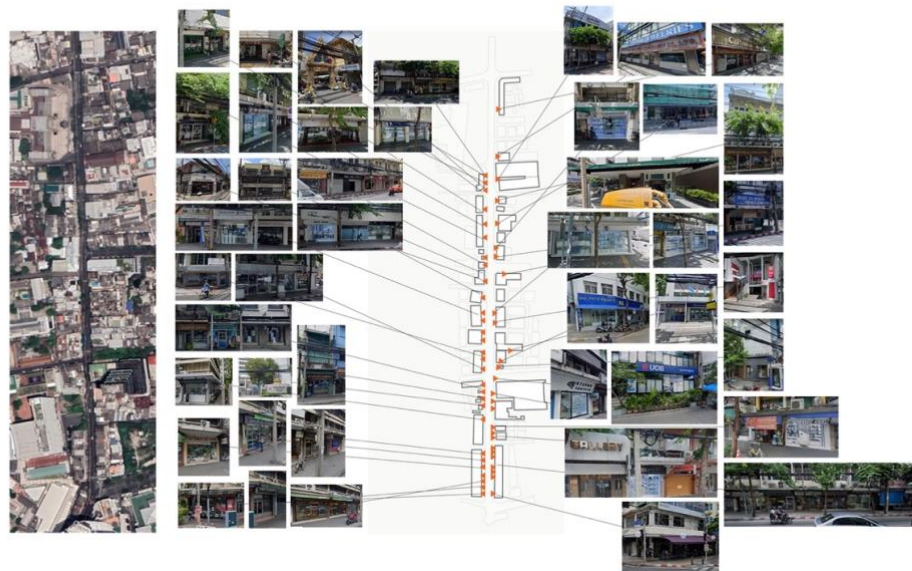*Buildings With Identifiers on Charoen Krung Street*

Note. From *Locations of Ratchadamnoen Klang, Yaowarat and Charoen Krung Streets*, by Google Map, 2023 (https://www.google.com/maps/d/edit?hl=en&mid=1iIhkx9QSRsOu6jdHsp1LoTAZ7HOduYA&ll=13.744 708393795818%2C100.50791330077821&z=16). Copyright 2023 by Google LLC.

Figure 12

Proportion of Sky in the Frame of Vision on Ratchadamnoen Klang, Yaowarat, and Charoen Krung Street

Ratchadamnoen Klang   Yaowarat   Charoen Krung

Note. Adapted from *Ratchadamnoen Klang Street in 2022*, by Google Earth, 2023 (https://earth.google.com/web/@13.75591499,100.5048486,9.49947358a,0d,59.99999999y,284.26831 514h,105.18651906t,0r/data=IhoKFl9sMkZzYXFBMkVoNVhPNW84OUVPancQAg). Copyright 2023 by Google LLC.; *Yaowarat Street in 2022*, by Google Earth, 2023 (https://earth.google.com/web/@13.73974157,100.51097047,13.76042271a,0d,60y,305.61692242h,94 .72649004t,0r/data=IhoKFjFOdHI4T0R5YWpxdFVqbUpneFV4MXcQAjIpCicKJQohMUZiYS1xVlBLSHA 4WHozbTBIT24xSWlYSlFhMmR6eThSIAE). Copyright 2023 by Google LLC.;and *Charoen Krung Street in 2022*, by Google Earth, 2023 (https://earth.google.com/web/@13.72582148,100.51621534,13.58810806a,0d,60y,346.17332436h,89 .25770521t,0r/data=IhoKFlFJNWF4bXEyTS1Wa0VGelNxaDlEbGccQAjIpCicKJQohMUZiYS1xVlBLSHA 4WHozbTBIT24xSWlYSlFhMmR6eThSIAE). Copyright 2023 by Google LLC.

Figure 13

Street Trees, Plazas, and Parks on Ratchadamnoen Klang, Yaowarat, and Charoen Krung Streets

Ratchadamnoen Klang   Yaowarat   Charoen Krung

In terms of transparency, all three streets received a high score on two variables, which are the proportion of active-use buildings and the continuity of buildings' façade and street walls. For the other variable, the proportion of street-level façade that is covered by windows, all three streets were rated moderate (see Figure 14). The level of transparency, then, is perceived to be relatively equal on Ratchadamnoen Klang, Yaowarat, and Charoen Krung Streets.

The level of complexity of Yaowarat Street resulted in a high score coming from 3 variables:

the number of colors used for buildings and street objects, the proportion of actively used buildings, and the number of sidewalk café, street vendors, and kiosks. The quality of complexity with respect to the other two streets was measured at different levels. While Ratchadamnoen Klang scored high on the proportion of active-use buildings and moderate on the number of sidewalk cafés, street vendors, kiosks, and public art, Charoen Krung scored high on building colors, but low on the number of sidewalk cafés, street vendors, kiosks, and public art.

Figure 14

Building Façades on Ratchadamnoen Klang, Yaowarat, and Charoen Krung Streets

Ratchadamnoen Klang

Yaowarat

Charoen Krung

Note. From *Locations of Ratchadamnoen Klang, Yaowarat and Charoen Krung Streets*, by Google Map, 2023 (https://www.google.com/maps/d/edit?hl=en&mid=1iIhkx9QSRsOu6jdHsp1LoTAZ7HOduYA&ll=13.749 48012050664%2C100.509398343292&z=14). Copyright 2023 by Google LLC.

Table 4

Measurement of Streetscape Qualities

Variables		Ratchadamnoen Klang	Yaowarat	Charoen Krung
1) Imageability				
1.1) Percentage of historic buildings		62.5	20.31	7.45
1.2) Percentage of buildings with an identifier		68.75	76.56	70.21
1.3) Number of courtyards, plazas, or parks		2	-	1
1.4) Planters on private and public property		8,060 m^2	-	-
1) Enclosure				
2.1) Cross-sectional proportion		1:3	1:1	1:1
The average height of the building facade		22m	21.5m	20.5m
The average width of the street		70m	20m	20m
2.2) Percentage of a street wall (Continuity of building's frontage)	Outbound	82.28	95.99	87.31
	Inbound	52.14	90.53	45.12
2.3) Percentage of sky ahead		67.64	12.18	14.52
2) Human Scale				
3.1) Number of street furniture		132	98	52
3.2) Percentage of the first floor with windows	Outbound	19.03	50.64	67.16
	Inbound	61.11	46.97	68.60
3.3) Number of trees on the sidewalk	Trees	235	32	75
	Shrubs	8,060 m^2	-	-
3.4) Percentage of a street wall (Continuity of building's frontage)	Outbound	82.28	95.99	87.31
	Inbound	52.14	90.53	45.12
3) Transparency				
4.1) Percentage of active uses buildings		92.86	93.75	72.73
4.2) Percentage of a street wall (Continuity of building's frontage)	Outbound	82.28	95.99	87.31
	Inbound	52.14	90.53	45.12
4.3) Percentage of the first floor with windows	Outbound	19.03	50.64	67.16
	Inbound	61.11	46.97	68.60
4) Complexity				
5.1) Number of colors used for buildings and street objects	No. of colors	2	uncountable	uncountable
	Dominant colors	1	2	2
	Accent colors	4	uncountable	uncountable
5.2) Percentage of active-use buildings		92.86	93.75	72.73
5.3) Number of sidewalk café; Street Vendors; Kiosks		10 units	31 units	4 units
5.4) Number of public arts		2	0	1

Table 4 (Continued)

Low	A small amount and a low possibility to generate impacts
Moderate	The moderate amount and possibility to generate impacts
High	The high amount and possibility to generate impacts

Users' perceptions of streetscape qualities

The results of the online survey reveal how respondents perceive the qualities of the streetscape. The survey data were analyzed, and means and standard deviations were obtained and reported (see Table 5).

The perceptions of the imageability of all three streets were rated relatively high. The variable that was strongly perceived by users is the presence of historical buildings (averages ranged between 4.03 and 4.21), particularly on Yaowarat and Ratchadamnoen Klang Streets. This is followed by the number of courtyards, plazas, or parks, with users taking note of the plazas on Ratchadamnoen Klang and Charoen Krung Streets. The perception of buildings with identifiers was relatively high (averages ranging from 2.63 to 3.95). On Charoen Krung Street, planters on private and public property showed the strongest influence.

In terms of enclosure, the average height of the building façades and the average width of the street were rated as the strongest variables affecting users' perceptions. Overall, the quality of enclosure was perceived quite well, particularly on Yaowarat and Charoen Krung Streets. All variables of enclosure were rated high, especially the building façades and the visibility of the sky in the frame of vision. Only on Charoen Krung Street was the result different; there, the two highest measured variables were the average width of the street and the continuity of the building façades and street walls.

The perceptions of the human scale were rated the lowest among the five qualities. The street with the highest rating of the human scale was Ratchadamnoen Klang. On Ratchadamnoen Klang and Charoen Krung Streets, the presence of trees on the sidewalk was the variable with a strong relationship to the human scale, while the variable that appeared to be related to the human scale on Yaowarat Street was the continuity of the building façades and street walls. The other variables—the existence of street furniture and trees on the sidewalk, a defined street edge, and the proportion of the façade covered by windows—were only slightly perceived for all three street cases.

For each of the three streets, respondents revealed a relatively high perception of transparency. The variable showing a significant link to transparency was the continuity of building façades and street walls. The average perception scores of users on the transparency of the three streets are almost identical. In descending order, the variables found to be affecting transparency were the continuity of building façades and street walls, the proportion of active-use buildings, and the proportion of façades covered by windows, respectively.

In terms of complexity, the three streets yielded fairly different results. The complexity of Yaowarat Street was strongly perceived, and the variables that influenced the perception of complexity, in descending order, were the active use of buildings, availability of sidewalk cafés, street vendors and kiosks, and the variety of colors used for buildings and street objects, respectively. On Charoen Krung and Ratchadamnoen Klang Streets, the proportion of active-use buildings on the street was the variable that most significantly influenced the perception of complexity.

Table 5

Means and Standard Deviations of Streetscape Qualities

Variables	Ratchadamnoen Klang		Yaowarat		Charoen Krung	
	Mean	S.D.	Mean	S.D.	Mean	S.D.
1) The perception of imageability	**4.00**	**1.017**	**3.98**	**0.762**	**3.93**	**0.884**
1.1) Proportion of historic buildings	4.03	1.098	4.20	0.93	4.21	0.819
1.2) Proportion of buildings with identifying features within the study area.	2.63	1.217	3.95	0.939	3.17	0.658
1.3) Number of courtyards, plazas, or parks	3.00	1.313	N/A	N/A	4.00	0.964
1.4) Planters on private and public property	2.77	1.223	N/A	N/A	2.55	1.242
2) The perception of enclosure	**2.67**	**0.994**	**4.00**	**1.034**	**3.59**	**0.983**
2.1) Average height of building facade	3.57	1.135	4.05	1.033	3.48	1.09
2.1) Average width of the street	3.50	1.358	3.59	1.148	3.52	1.184
2.2) Continuity of building's frontage	3.80	0.805	4.25	0.892	3.79	1.048
2.3) Proportion of sky ahead	3.50	1.225	3.98	0.952	3.55	1.213
3) The perception of human scale	**2.70**	**1.022**	**2.45**	**1.21**	**2.93**	**1.132**
3.1) Number of street furniture	2.97	1.217	2.11	1.125	2.41	1.296
3.2) Proportion of the first floor with windows	2.97	1.066	2.39	1.185	2.79	1.146
3.3) Number of trees on the sidewalk	3.13	1.042	1.98	1.285	2.45	1.055
3.4) Continuity of building's frontage	3.40	1.102	2.39	1.185	3.00	1.282
4) The perception of transparency	**3.57**	**0.971**	**3.41**	**1.245**	**3.45**	**1.035**
4.1) Proportion of actively used buildings	3.30	1.236	3.57	1.043	3.76	0.929
4.2) Proportion of street wall	3.83	0.699	3.55	1.088	3.62	1.000
4.3) Proportion of the first floor with windows	3.40	0.814	3.09	0.936	3.41	0.943
5) The perception of complexity	**2.70**	**1.208**	**4.52**	**0.664**	**3.86**	**0.953**
5.1) Number of colors used for buildings and street objects	2.47	1.074	4.07	0.846	3.41	1.086
5.2) Proportion of actively used buildings	3.10	1.213	4.61	0.655	4.00	1.069
5.3) Number of sidewalk café, Street Vendors, Kiosks	2.93	1.172	4.50	0.731	3.86	1.06

Table 5 (Continued)

Variables		Ratchadamnoen Klang		Yaowarat		Charoen Krung	
		Mean	S.D.	Mean	S.D.	Mean	S.D.
5.4) Number of public arts		3.07	0.944	N/A	N/A	3.24	1.123
Score 1.00-2.33	Low	Less perceived by respondents					
Score 2.34-3.66	Moderate	Moderately perceived by respondents					
Score 3.67-5.00	High	Highly perceived by respondents					

Comparison of Objective and subjective data

Comparison of the results from the two forms of measurement reveals some differences and concerns (see Figure 15). The quality of imageability revealed the most noticeable difference between survey data and users' perceptions. Interestingly, the four variables of imageability were measured at a different level. Firstly, respondents reflected a rather high perception of historical buildings in all three streets, while the survey data show only a low to moderate levels. Also, respondents reflected a rather high perception of open spaces or parks, although there is only one large plaza on Charoen Krung Street. Secondly, a large number of buildings with identifiers were found on Charoen Krung and Yaowarat Streets, but respondents indicated only a moderate level of perception. The largest gap between survey data and users' perceptions was found in the number of planters, particularly on Ratchadamnoen Klang Street; although there are lots of plants on the sidewalk, street island, and roundabout, respondents seem not to notice them.

The quality of enclosure was well observed by respondents since the perception of the three variables conformed closely to the survey data. The perception proportion of the three streets revealed almost the same result as the survey data. Also, with respect to the continuity of the building frontage, the survey data and users' perceptions were rated high for all three streets. In addition to the perception of the building frontage, the proportion of street section, and the proportion of sky ahead were well perceived by respondents for all three streets.

For the quality of human scale, the survey data and users' perceptions showed displayed noticeable differences. In all three streets, the perception was rated quite low in all variables, while the survey data were random. The highest gap was found in the continuity of the building frontage, where the three streets were highly scored on the survey, though respondents showed only low to moderate levels of perception. Similarly, the number of trees and the amount of street furniture was found to be moderate on Ratchadamnoen Klang and Charoen Krung Streets; however, the perception of respondents was rather low.

The perception of transparency largely conformed to the survey data. In fact, the survey data and users' perceptions were almost identical for one of the variables, the proportion of windows on the first floor. For all three streets, the proportion of actively used buildings and the continuity of street walls were rated high on the survey, while the perception measured by the questionnaire was moderate. The biggest gap was found for Ratchadamnoen Klang since the buildings are mostly offices, showrooms, and museums, with a 4-meter-wide sidewalk; therefore, the activities inside can hardly be noticed.

For the quality of complexity, comparison of the survey data and users' perceptions revealed some differences. The most apparent differences were found in two variables, one is the actively used buildings on Ratchadamnoen Klang, and the other is several sidewalk cafés, street vendors, and public arts on Charoen Krung Street, where most of the café and street vendors are located inside small alleys connected to the main street. Also, the colors of the buildings were less perceived at Charoen Krung Street, which may be attributable to the fact that there are many obstacles on the sidewalk.

Figure 15

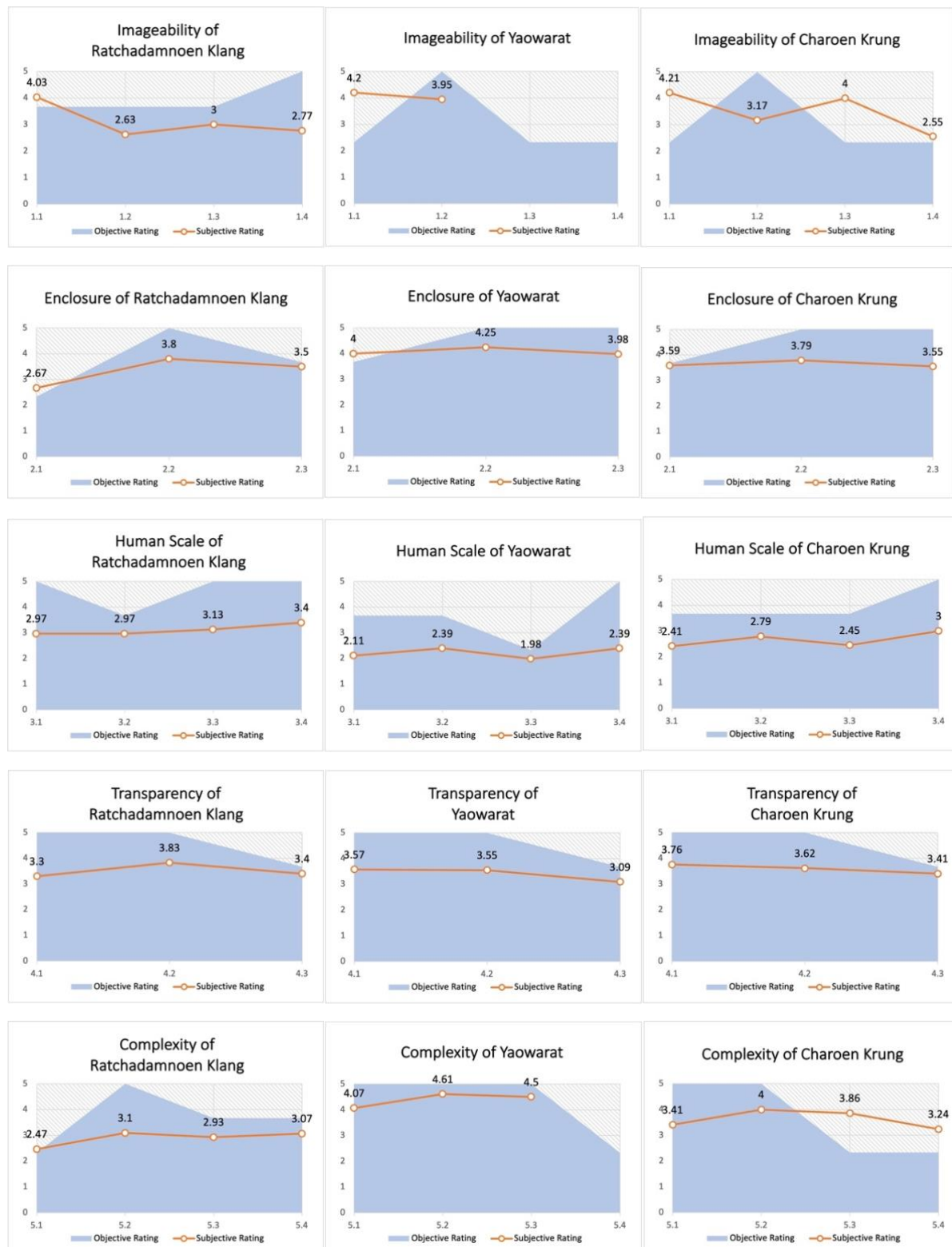*Comparison Charts of Results From the Two Forms of Measurement*

Table 16 (Continued)

Legend:							
1)	**Imageability**	**3)**	**Human scale**	**5)**	**Complexity**		
1.1	The proportion of historic buildings	3.1	Street furniture	5.1	Colors of building		
1.2	The proportion of buildings with identifiers	3.2	The proportion of the first floor with windows	5.2	The proportion of actively used buildings		
1.3	Courtyard/Plaza/Parks	3.3	Street trees	5.3	Sidewalk café / Street vendors / Kiosks		
1.4	Planters on private and public property	3.4	Continuity of building's frontage	5.4	Public arts		
2)	**Enclosure**	**4)**	**Transparency**				
2.1	Cross-sectional proportion	4.1	The proportion of actively used buildings				
2.2	Continuity of building's frontage	4.2	The proportion of street wall				
2.3	The proportion of the sky ahead	4.3	The proportion of the first floor with windows				

DISCUSSION

This study applied the five operationalized qualities of urban design from the study of Ewing et al. (2016), which developed a set of urban design qualities and variables using ratings of video clips by an expert panel based on the context of New York City. To apply the developed tool in a different context, some modifications were made. In this study, some context-specific variables were adjusted based on the context of Bangkok's old town. Firstly, the meaning of historic buildings, a significant determinant of imageability, was redefined from the history of Western architecture to the definition given for Thai architecture. Secondly, another variable was added to the quality of complexity. Since complexity is defined as the variety of physical environments and human activities, this study added sidewalk cafés, street vendors, and kiosks as part of complexity quality in an effort to capture the actual use of Bangkok's streets and sidewalks.

The study developed a rating scale to quantify the qualities of the streetscape, and the evaluations were done using two different approaches. Firstly, an objective evaluation was

carried out as a site survey in which the elements were thoroughly observed and counted. Secondly, a subjective evaluation was compiled using an online questionnaire in which the perceptions of respondents were elicited from their memories. The results from the two approaches were then compared, with attention paid to the similarities and differences in results between the two data collection methods. The most noticeable differences can be seen in the qualities of imageability and human scale. The quality of complexity revealed some differences, while the results from both sets of measured data were similar for the qualities of enclosure and transparency. The small elements of the streetscape that are located on sidewalks, i.e., planters, street furniture, and trees, showed a significantly low level of being perceived by motorists. Also, the details of building frontage, i.e. actively used buildings and buildings with identifiers, were found to be less observed.

Furthermore, the evaluation of streetscape qualities in a car-dependent city revealed some concerns In that the qualities of streetscape are context-specific, which may require adjustments to measurement tools when applied in various contexts. Firstly, the physical features and people's activities on the streets could be defined

based on the context of the study city. Examples include (1.1) the percentage of historic buildings in the area and (5.3) the presence of sidewalk cafés, street vendors, and kiosks. Secondly, the spatial perception of pedestrians and motorists is different. Bangkok is a car-dependent city; most city residents are motorists. Micro-scale features or details may not be seen by motorists. Specifically, they may not notice (1.2) the proportion of buildings with identifiers, (3.1) street furniture, or (4.1) the proportion of actively-used buildings. Also, motorists may not be aware of the temperature, which could affect the perception of (3.3) street trees. In consequence, spatial perception and streetscape qualities are likely to be overlooked or less perceived and in a car-dependent city.

CONCLUSIONS

Firstly, this attempt to complete two different approaches of evaluation has been successfully accomplished. The variables and the 5 qualities of Ewing were modified, given a rating scale, and used for both objective and subjective evaluation. The data from the two approaches were compared, and the results highlight the influences of a car-dependent city on user perceptions. The less perceived elements are those located on sidewalks as well as building details, which can hardly be noticed by motorists.

Secondly, this attempt to measure streetscape qualities in a car-dependent city like Bangkok has raised some notable issues. Firstly, it raises the question of what should be taken into consideration is the background and the character of a city. Deeper understanding of this factor could be valuable in the ongoing development of an effective tool that can capture the streetscape qualities in various contexts. Secondly, the perception of the streetscape qualities in a car-dependent city like Bangkok can be different as some details could be overlooked or less perceived. The insights gained from this study of users' perceptions have illuminated the issue more explicitly.

The study has demonstrated the process of measuring the streetscape qualities from the two approaches and revealed some concerning issues when applied in different contexts and circumstances. It is clear that surveying urban data as part of urban design study is not a straightforward task. Users' perceptions and satisfaction should be taken into account and become part of the data collection and analysis process. Consistent application of new insights in the survey, analysis and design of urban areas will ultimately lead to good quality streetscape that provides an inviting environment for outdoor activities, and a more memorable and liveable city.

DISCLOSURES AND ACKNOWLEDGMENTS

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