BUILT

BUILT Editors

Editorial Message

With great enthusiasm that we present the latest issue of the International Journal of Building, Urban, Interior, and Landscape Technology (BUILT), Vol. 21(2), 2023. Our mission remains steadfast to provide a platform for original research in technological applications and to showcase the advancements in the fields of built environment.

BUILT has always been committed to fostering innovation and knowledge exchange among professionals and academics alike. In this issue, we continue to uphold this tradition by featuring a diverse range of articles. Our goal is to provide a comprehensive understanding of the multifaceted nature of technological research and its impact on our built environment. The featured articles include:

- " Between User's Practice and Infrastructure Condition: Safety Challenges of E-scooters Utilization in Bangkok, Thailand": This research reveals that both user practices and infrastructure conditions contribute to the safety of e-scooters utilization in Bangkok. To improve safety, Bangkok needs more bike lanes and parking spaces, standardized e-scooters use, and e-scooters education platforms. Policymakers must consider regulating and standardizing the use of e-scooters in Bangkok for its safety.

- "Defining Townscape Characteristic of Chiang Mai Old City of Thailand through Townscape Character Assessment": Historic Townscape represents tangible and intangible scenes related to historical artifacts and the historical value of the places. Townscape Character Assessment (TCA) can apply to evaluate the quality of urban elements that represent the significance of social, cultural, and human perception of urban heritage. This study has considered the ongoing new world heritage site as Chiang Mai is a "living heritage" that has faced the loss of greenery, cleanliness, and identity in its inner city.

- " Agricultural land use changes and the remaining/ emerging peri-urban farmers in Kathmandu Valley of Nepal": This paper investigated the Kathmandu Valley's case in Nepal using peri-urban farmers as the key informants growing perishable vegetables in the three adjoining districts and the key reasons behind the permanence of Peri-urban agriculture and the strategic approaches peri-urban farmers have adopted in the changing urban context of the Kathmandu Valley.

- " The Effect of Light Shelf and Translucent Ceiling on Daylighting in Office Building in Thailand": This study investigates the performance of daylight control strategies in office rooms using a light shelf with translucent ceiling. The results showed that the external light shelf with a translucent ceiling and static louver was the best solution for office rooms, providing illuminance level above the standard.

These articles exemplify the diverse research showcased in BUILT, demonstrating the wide-ranging applications of technology. By disseminating this knowledge, we aim to inspire and empower researchers to challenge traditional boundaries and embrace the possibilities offered by emerging technologies.

I extend my heartfelt appreciation to the contributors, reviewers, and the dedicated editorial team whose unwavering commitment has made this volume possible. Their collective efforts have ensured the quality and rigor of the articles presented here.

Professor Pusit Lertwattanaruk, Ph.D.
Editor-in-chief
International Journal of Building, Urban,
Interior, and Landscape Technology (BUILT)

CONTENTS

Between User's Practice and Infrastructure Condition: Safety Challenges of E-scooters Utilization in Bangkok, Thailand

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Abstract

In Bangkok, e-scooters have become one of the transportation options for many users. Despite the growing number of users, e-scooters remain illegal to operate on public roads. The absence of regulations raises concerns about the safety of utilizing e-scooters in Bangkok. This paper aims to explore the safety challenges associated with the use of e-scoters in Bangkok, based on the practice of users and the infrastructure condition. Semi-structured interview with purposive sampling is conducted for Group A (n=6) and Group B (n=2) to discover the situation from the perspective of users, supplier, and service provider. Additionally, a combination of user interviews and field observations was conducted to assess the infrastructure. Thematic analysis was applied to analyze the interview data, leading to the identification of four themes: infrastructure condition, users practice, accident experience, and maintaining safety. The findings reveal that both user practices and infrastructure conditions contribute to the safety of e-scooters utilization in Bangkok. These include dispersed speed usage, unsafe space choice, and the lack of bike lane availability. To improve safety, Bangkok needs more bike lanes and parking spaces, standardized e-scooters use, and e-scooters education platforms. Policymakers must consider regulating and standardizing the use of e-scooters in Bangkok for its safety.

Keywords: Bangkok, e-scooters, micromobility, safety, urban mobility

1. Introduction

The idea of sustainable mobility emphasizes the interconnection among urban infrastructure. As development is indivisible by its mobility system, that idea ascents the challenges of providing sustainable urban transportation. By definition, cities are challenged to deliver a transportation mode that: allows for its inhabitant's basic needs in terms of access and development; is affordable and operated efficiently; and produces low emissions (Goldman & Gorham, 2006). Municipalities in many countries have attempted to elevate the modal share of public transportation to address congestion and environmental issues due to the externalities of private cars. Public transportation was designed to meet the sustainable principle. However, the deficiency of delivering door-to-door service with public transportation makes it inconvenient for some groups.

With millions of people commuting on a daily basis, the capital city of Thailand needs more options for its transportation system. Micromobility offers the option to serve door-to-door transportation needs. The usage of micromobility during the COVID-19 pandemic has grown in popularity because of the lower chance of contracting the virus (ITDP, 2021). In addition, powered micromobility provides benefits for short-distance trips (Cao et al., 2021) to travel in a small vehicle without being affected by traffic and possibly to be integrated with public transportation. The integration potentially upsurges the accessibility and, in the longer run, shifts the car travel behavior to a more sustainable transportation mode (Oeschger et al., 2020).

E-scooters are not fully perceived positively because of some issues of parking and safety (Gössling, 2020). Nevertheless, e-scooters remains a good option for urban mobility as long as having clear regulation and are implemented cautiously (de Bortoli & Christoforou, 2020). In Thailand, e-scooters have become one of the options for many users, in particular in its capital city. In 2020, Thailand's micromobility market earned more than 430 million THB, and it is expected to continue to expand (PS Intelligence, 2021). E-scooter users could be found on the roads and even on Bangkok's public transportation.

While the number of users grows, e-scooters remain illegal to operate on Bangkok's public roads. Apparently, the absence of regulation also questions the safety of utilizing e-scooters in Bangkok. This paper explores about safety challenges of using e-scoters in Bangkok based on the user's experience and the infrastructure condition.

This paper is expected to stimulate the urban mobility strategy to involve e-scooters as a transportation option as well as to stimulate the future regulation design of e-scooters utilization in Bangkok.

2. Literature review

The concept of micromobility emerged from the new mobilities paradigm introduced by Sheller (2011). Small-sized, short distances, light vehicles, and two-wheelers are all critical components of micromobility (Eccarius & Lu, 2020). According to the International Travel Forum, micromobility refers to the use of micro-vehicles. The proposed definition specifies that micro-vehicles have a mass of less than 350 kg and a speed of less than 45 km/h (ITF, 2020). Micromobility is further subdivided into kinds based on mass and speed. Micromobility, according to this definition, comprises both driven and unpowered vehicles such as bicycles, electric bicycles, kick scooters, electric scooters, skates, and one-wheeled balance boards.

Electric scooters, also known as e-scooters, fall under the category of powered micromobility. E-scooters are considered personal electric vehicles that can transport a single passenger for distances of up to 10 km, utilizing electricity as their energy source for the motor (Ulrich, 2005). However, some literature defines e-scooters as powered two-wheelers, similar to mopeds, with a maximum speed of 30 mph or 45 km/h (Hardt & Bogenberger, 2019). In this research, e-scooters are defined as vehicles designed for short-distance transportation, equipped with a small electric motor and a deck where a single rider stands (Hollingsworth et al., 2019).

In cities all across the world, e-scooters were a relatively new form of mobility. E-scooters have recently appeared in various nations, surprising the local government. For instance, the rise in e-scooter sharing in Brisbane was recognized as a crisis of regulation brought on by an over-the-night arrival (Field & Jon, 2021). One of the first issues for the local authorities is the examination of several factors in deciding whether to permit or reject the operation of e-scooters (Anderson-Hall et al., 2019). Cities must investigate and assess the effects on other road users before approving the usage of e-scooters (Zagorskas & Burinskiene, 2020). Meaning that safety rules are important for the adoption of e-scooters. An accident risk associated with motorized micromobility is believed to be three times higher than that associated with non-powered micromobility, mostly due to the higher speed (King et al., 2020).

Due to the safety concern, municipalities face a dilemma when deciding where e-scooters should be used. E-scooters frequently have an influence on other road or sidewalk users, such as riding accidents and inappropriate parking (Zagorskas & Burinskiene, 2020). The issue compelled the major players to design and construct a safer road system in addition to a sensible regulatory framework (Cao et al., 2021). Due to safety concerns and the fact that there are fewer big vehicles, e-scooter riders actually prefer to ride in a bike lane that is separated from the traffic (Pazzini et al., 2022). Safety issues are significant to be addressed for their benefit to help municipalities to define the ideal space usage and the standard requirements (O'hern & Estgfaeller, 2020).

To address concerns about e-scooter use in their urban environments, many municipalities have established regulations that specifically refer to e-scooters as powered micromobility. It is because, safety issues (eg. crashes) on e-scooters do not completely intersect with bicycle crashes (Shah et al., 2021). Several nations in Europe have adopted rules and legislation that particularly address the problem of e-scooters (Zagorskas & Burinskiene, 2020). Most nations in Europe adopt speed limitations of no more than 25 km/h in order to standardize the use of e-scooters. Speed limitation is extremely important because it is found that e-scooters speed usage is dispersed and it should be incorporated into the policymaking scheme (Almannaa et al., 2021). Additionally, users must be at least 14 years old. Children and the elderly are more vulnerable to getting injured while using e-scooters (Yang et al., 2020). In addition to guiding users, the legislation concentrated on overseeing e-scooter firms as well. The law could be employed as a tool to control the number of service providers in the city.

In the Asian cities context, Singapore is recognized as one of the major players in the e-scooter sector in Asia since several e-scooters startup companies have emerged and established a presence in there (Cao et al., 2021). According to Singapore's Land Transport Authority, up to 1.300 km of bike lanes would be provided across the country by 2030 in order to promote more e-scooters and other micromobilities. Although regulation has been established in Singapore, however, executing the regulations would be another challenge (Field & Jon, 2021). Improper parking is one of the biggest obstacles to service-provider-based deployment. In Singapore, the service provider was mandated to penalize customers who failed to park their vehicles in an allocated space. However, inappropriate parking is still a widespread issue (Zhu et al., 2020).

In Thailand, according to the Motor Vehicle Act B.E. 1979, e-scooters fall under the category of motorbike which definition is "a vehicle operated by a motor or electric power with not more than two wheels". However, it is important to note that currently, e-scooters are not able to be registered in Thailand, which means their operation on public roads remains illegal. Indeed, as stipulated in Section 6 and Section 59 of the Motor Vehicle Act B.E. 2522, operating an unregistered vehicle is considered a violation and can result in a fine of up to 10,000 THB. This legal situation poses a challenge for both e-scooter service providers and personal users who wish to operate e-scooters on Bangkok's roads. The current state of regulation creates an absence in ensuring the safety of using e-scooters in Bangkok.

This research explores the safety challenges of e-scooters utilization through the lens of both users' practice and infrastructure. The users' practice refers to the activity of users during the utilization of e-scooters as a transportation mode which includes speed usage, helmet usage, and space usage. These three elements are most important based on the e-scooters regulation across the world. On the infrastructure side, to achieve the objective of sustainable mobility, there is the need to provide streets, public spaces, and parking spaces (Meyer & Shaheen, 2017) . In the context of e-scooters, the infrastructure refers to parking stations and lanes with signs and marks.

3. Methodology and data

The paper is qualitative research that assesses the safety of e-scooters utilization in Bangkok, Thailand. There are several data collection methods for the data: such as interviews with the purposive sampling method; research for the primary data; and internet source for the secondary data. For the sampling method to conduct the interview, this paper adapts the "Criterion-i" strategies among many types of purposive sampling explained by Palinkas et al. (2015). Purposeful sampling is a procedure to identify the "information-rich cases" and select individuals that are knowledgeable or experienced with the issues so that the sampling would be effective (Cresswell & Plano Clark, 2011; Patton, 2002). Criterion-i could be used to select cases that meet some predetermined criteria (Palinkas et al., 2015).

The semi-structured interview would be practiced by collecting data from Group A (users) and Group B (service provider and supplier). The criteria for Group A include the following: individuals should be a minimum of 14 years old, students or workers who own and have been using e-scooters for more than two months, and have resided in Bangkok for at least 90 days. On the other hand, the criteria for Group B are actors working in the e-scooter sector in Bangkok, such as service providers and suppliers.
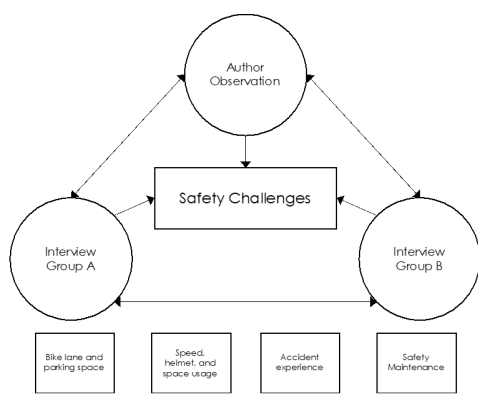
Figure 1. The research conceptual framework

Table 1. Information of participants (Group A)

No	Information	Participants					
		User 1	User 2	User 3	User 4	User 5	User 6
1	Age (years old)	16	24	38	19	37	28
2	Time period of using e-scooters	6 months	9 months	3 years	3 years	3 years	3 months
3	Speed usage	30 km/hr	20 km/hr	50 km/hr	25 km/hr	25-35 km/hr	30 km/hr
4	Helmet usage	Full face helmet	No	Bicycle helmet	Not anymore	No	Bicycle helmet
5	Accident experience	More than three times	Never	Two times	Two times	One time	Two times
6	Space usage	Road side	Road side	Road	Bike lane	Road	Road side
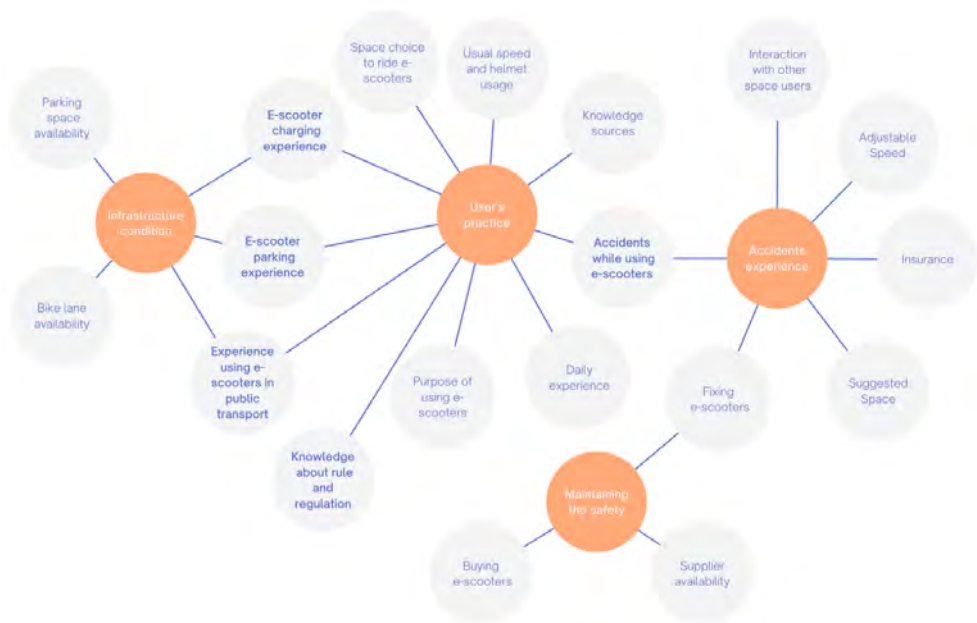
Figure 2. The thematic analysis map

This research would like to understand detailed information about the e-scooters phenomenon in Bangkok. Instead of using surveys that would come up with quantitative analysis, in-depth interviews with a small number of respondents would be more suitable for this research topic. The author would like to understand the real situation of e-scooters utilization and safety in Bangkok from the participants' stories. In this case, it should be noted that the sample size is small and become the delimitation for this research.

The participants from the users' side being selected for the interview should satisfy the requirements. Six participants from the users' side have successfully interviewed using semi-structured interview which takes around 20 minutes each to understand the safety phenomena of e-scooters. For Group B, we interview Provider 1 and Supplier 1 using semi-structured interviews which take around 30 minutes each. This paper is qualitative research that involves an in-depth interview as a data collection method. With a relatively small sample size (n Group A=6; n Group B=2), therefore, it is not designed for statistical analysis. Subsequently, the thematic analysis would be used to qualitatively analyze the interview data. By definition, thematic analysis is a method for defining, examining, and summarizing certain themes in data. Thematic analysis is adaptable and flexible, it may be compatible with several theories (Braun & Clarke, 2006).

The thematic analysis involves six phases comprised of familiarizing with the data, generating initial codes, searching for themes, reviewing themes, naming the themes, and producing reports (Braun & Clarke, 2006). To begin, the author transcribes the interview results and translates relevant data into English to familiarize themselves with the material. Next, nineteen initial codes are generated to identify key concepts and ideas. The author then identifies and develops four distinct themes: e-scooter utilization infrastructure, user practices including speed, helmet usage, and space utilization, experiences with accidents, and strategies for maintaining safety. The results of the thematic analysis are visually represented in a thematic analysis map, shown in Figure 2.

4. Results and discussions

In this section, the phenomena of e-scooters safety in Bangkok would be discussed through four themes that were identified at the end of the thematic analysis: bike lane and parking space; user's practice (speed, helmet, and space usage); accidents experience; and maintaining the safety.

4.1 Theme 1: Infrastructure condition

Municipalities around the world have made built environment infrastructure adjustments – such as building shared paths, bike lanes, and sidewalks – to encourage active transportation (Lanza et al., 2022). In contrast to other vehicles which normally operate in defined lanes, e-scooters lack specialized facilities for travel, which makes e-scooters often interact with their surroundings due to the use of shared infrastructure (e.g., sidewalks and roads) with other users (Ma et al., 2021). In Virginia, it is discovered that most e-scooters users prefer to ride on bike lanes rather than other spaces, for example, sidewalks and roadsides (Lanza et al., 2022). Riding on bike lanes is more comfortable because users do not need to adjust to pedestrians' speed and do not require to put extra awareness of big vehicles on the road. It is found that e-scooters users tend to ride subtly faster on bike lanes rather than on roadways and sidewalks (Zuniga-Garcia et al., 2021). Scholars also discover that riding on bike lanes could result in less injury due to accidents compared to other spaces, especially on roads (Lanza et al., 2022). However, if bike lane availability is poor, users would have no choice but to ride on the roads. E-scooter users are more prone to engage in risky activities compared to bicycle users, such as being more likely to ride on roads (Bai et al., 2015).

The situation that occurred in Bangkok is nothing much different from the finding from Lanza et al. (2022), wherein users prefer to ride on bike lanes to avoid conflicts with cars if using the roads and conflicts with pedestrians if using sidewalks. However, according to data from Bangkok GIS, the bike lanes in Bangkok are only around 128 km in total (bike lanes on private property are not included). With this length, people question the bike lane availability in the city (Quote 1). The situation forces e-scooters users in Bangkok to ride on the road, even though their preference is bike lanes themselves (Quote 2).
> (1) "I want to ask a question that, the Bangkok have the bike lane? I didn't see that before."
> (2) "Well, if there is a bike lane, I would prefer ride on bike lane, but in Thailand bike lane is not often see as the road and sidewalk…."

Nevertheless, in universities area (Chulalongkorn University, Kasetsart University, Mahidol University, and Thammasat University), the bike lane availability is considerably good (see Figure 3). Thus, students who use e-scooters inside the university choose to ride on a bicycle way (Quote 3). Not only the users, but Provider 1 also believe that the presence of bike lanes in most of Bangkok's leading institutions is adequate

(a)   (b)   (c)   (d)
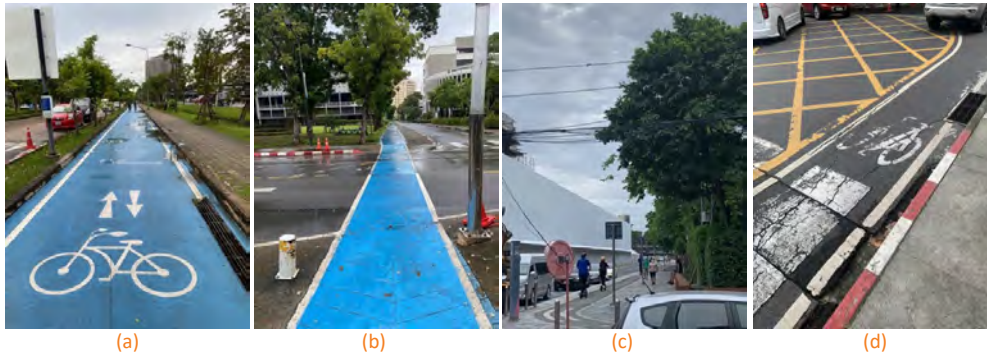
Figure 3. Bike lane availability in (a, b) Mahidol University and (c, d) Chulalongkorn University

(Quote 4). Indeed, the availability of bike lanes is one of the reasons that e-scooter service providers chose colleges as their deployment strategy for the e-scooter sharing business. Logically, if bike lanes are plentiful, service providers would not be concerned about the safety of their consumers riding e-scooters. However, the bike lane needs some adjustment as it is viewed that the route is less effective for e-scooters users.

(3) *"….so I think the bike lane in Chula is good, but it has weakness, so for example if I want to go straight from Hor Nai, to go to the U-center, I want to go straight right? But the lane is forced me to go around this, this section, and go over there."*

(4) *"For Chula, here in campus of course most of the area they have bike lanes. So this is our first choice. So if you see bike lanes. Please go to the bike lane. Most of the top university in Bangkok. We believe that they have bike lanes inside campus."*

Parking spaces are another significant infrastructure for e-scooters utilization in the city. If e-scooters are parked improperly, this will increase the risk of making other people uncomfortable with taking the space (Zagorskas & Burinskiene, 2020). The lack of parking provisions could escalate the risk of vehicle stealing (Chen et al.,

(a)   (b)

Figure 4. The situation of e-scooters (a) in bicycle parking and (b) being brought inside shopping malls.

2018), meaning that it is not safe to park e-scooters without locking the vehicle in the bicycle parking. In Bangkok, most users would park their scooters in the bicycle parking and lock the scooters to the structure (see Figure 4a). Users found that e-scooters are prone to get stolen if they do not lock them. (Quote 5 and 6)

(5) *"I will park it in front of my office, but they don't have, like, a lock to anything. Just lock my wheels to the body of the scooter. So, they can't turn the wheels."*

(6) *"Yeah, I just lock it at.. I already lock it as… Ahh, more than that, it's just a bicycle station, I don't know how to call it, the bicycle parking and the motorcycle parking."*

The availability of parking space for either e-scooters or bicycles in Bangkok depends on the user's perspective on how they would perceive the space to park their e-scooters. Some users believe that, as long as there is motorcycle parking, they can park their scooters alongside and lock them. But other users might argue that it is hard to find a specific parking space for their scooters, which forces them to bring the scooters with them (see Figure 4b). Though, it is found that many buildings in Bangkok provide free parking spaces for bicycles to be parked in motorcycle parking. E-scooters are counted as bicycles by the parking management; so, they exempt them from the fees. (Quote 7 and 8)

> (7) "It is hard (to find parking spaces) haha. Yeah, but sometimes you aaa it is normal that you take carry on with e-scooters to the space."
> (8) "But here, you can park at the motorcycle parking lot at the Camchuri Square, for free (laugh). They look, ahhh, they see e-scooters like a bicycle. Many, many buildings like that."

Parking areas are thought to be easily defined in e-scooters sharing services. E-scooters parking does not require any structure for safety reasons because the scooters have their own technology to secure the vehicle. The dockless e-scooter sharing concept eliminates the requirement for a "bicycle parking" infrastructure provided by either the service provider or the landowner. In the instance of Provider 1, numerous factors are used to define parking locations, including the origin and destination of the trips, the location of the public transportation station, and so on. (Quote 9)

> (9) "First thing is that our parking spot we require no attachment at all. No rack, no bicycle rack. Scooters, it can lock itself. Uh, when it's not in use, right? So, to determine the parking spot there quite many factors."

4.2 Theme 2: User's practice (speed, helmet, and space usage)

Having no rules and regulations could be interpreted that users having more flexibility on how they operate the e-scooters. Meaning that users in Bangkok are vulnerable to unsafe riding that potentially induces accidents. While e-scooters users in some countries are fenced not to overuse certain speed limits, users in Bangkok use their scooters' maximum speed as their limitation. There is barely a chance for users to use an average speed less than its maximum speed unless they are interacting with pedestrians either on sidewalks or on the side of the road. Users feel that their scooter's maximum speed is not so fast and is considered safe. (Quote 10 and 11)

> (10) "Ahhh, normally, I use as 25 km/hour and it's the maximum limit that my scooter can ride."
> (11) Well, for riding, this kind e-scooter is about 30 km max so I ride at about 30 km max because, well, 30 km is too slow but I'm good at it."

However, it has also often been found on the road, there is some standing e-scooters model which able to run very fast just like a motorcycle. These types of e-scooters are sold through both online and on-site stores. The size is usually much bigger and heavier than the normal e-scooters. When riders stand up, they can see the traffic above cars in the front. Referring to micromobility and e-scooters definition (Hardt & Bogenberger, 2019; ITF, 2020), these types of vehicles are excluded from either e-scooters or micromobility for their maximum speed exceeding 45 km/hour. In Thailand, since there is no clear regulation of what e-scooters are, this type of e-scooters is placed on the same illegality status level as regular e-scooters. Subsequently, users of fast e-scooters rely on their own judgment to ride at a certain speed for their own safety. (Quote 12 and 13)

> (12) "And the speed, I usually use around 50 kilometers. Maximum for the scooter is about 80."
> (13) "I have one that it goes about 55 kilometres very fast. Uh, that one if I use, I go roughly 35 kilometres. The one I have now that I use most is the Xiaomi. And it goes 25 kilometres per hour."

According to Supplier 1, the speed limit of fast e-scooters can actually be adjusted depending on the purpose and requirements of usage (Quote 14). Users can use the scooters as a regular e-scooter which speed is around 20-30km/hour. However, if the users want to go further to use the e-scooters for leisure activity in other provinces (e.g., tracking), users can utilize the scooter's powerful speed.

> (14) "When it has high speed limit, customer can choose the speed limit within its range. They can use it as a regular e-scooter of 25 km/hour."

For the operation of e-scooter sharing, Provider 1 uses a speed limit of 25 km/h. The model of e-scooters they utilize is capable of exceeding that speed. Because there is no speed limit in Bangkok, Provider 1 restricts speed usage by using the maximum speed limit from their headquarters nation, Australia (Quote 15). Provider 1 considers that the ideal speed for the current implementation is 25 km/h. If the pace is set too slowly, crossing the street between two sides of campus becomes unsafe, and users may fail to keep up with vehicles.

(15) "We got it from our, uh, another market which is Australia. They had the regulation about the speed limit, the safety measure and everything."

The use of helmets among scooter users varies based on e-scooters users' judgment and awareness. It differs from other countries that have clear rules and regulations to mandate helmet usage for e-scooters users. In Bangkok, at some point, helmet usage might be associated with the maximum speed of their e-scooters. If the scooter's speed is slower, users are unlikely to wear helmets because they think it is safe already (Quote 16). However, users with higher speeds and more intense riding in traffic would likely wear helmets as protective tools (Quote 17).

(16) "So, I didn't wear like anything to protect myself, but actually my scooter max speed is only twenty kilometer, so it's a bit slow."

(17) "I usually use around 50 kilometers.... Yes, I'm wearing the helmet, but it's a bicycle helmet."

Currently, the safety equipment provision does not become a priority for Provider 1 since there is no regulation for e-scooters usage in Bangkok. They provide safety equipment in another country to comply with the regulation. However, Provider 1 would like to try out the deployment without providing a helmet first in Bangkok. In spite of that, they are willing to provide safety helmets if required by the regulation. (Quote 18)

(18) "So, uhm, we have helmets in Australia and New Zealand. But here in Thailand we have no rules. If there's a regulation specific regulation, and they say, you have to wear your helmet. Our company is more than happy to do that."

Space usage is a fascinating topic to be discussed since it is linked to interaction with other space users. In some countries (e.g., French and Germany), e-scooters are banned to be operated on sidewalks (Zagorskas & Burinskiene, 2020). Some municipalities (e.g., Singapore and Victoria) allow e-scooters to be operated on the sidewalk with speed limitations (Haworth et al., 2021). While other countries try to limit or ban e-scooters to run on pedestrian ways, space choice to ride e-scooters in Bangkok is situated by the infrastructure condition. Most users prefer to ride on the road because that space could provide more comfort than riding on sidewalks (Quote 19). It is because of the sidewalk's quality that makes e-scooters hard to be ridden there (Quote 20). Moreover, they prefer to interact with cars and motorcycles rather than pedestrians, since they have to reduce their speed if they pass by on the sidewalk.

(19) "I prefer to ride on the aaa on the road because the sidewalk is not good as a road, also there is the people on the sidewalk, not as the road there is a car."

(20) "Yes. Mostly on the road. Because my scooter, when you're using the powerful scooters, like you use a motorcycle. Yeahh, because it's too fast. Maybe some of the sidewalk, like a, have a, what's it called, not, not like a straight. You cannot control your scooter"

However, riding on the road is considered dangerous to some users (Quote 21). There are big vehicles (e.g., buses and trucks) that could trigger adrenaline while riding on the road. Users need to be aware of using protection gears because, in some areas, the roads have certain dynamics. The lack of bike lanes makes roads in Bangkok unsafe for riding not only e-scooters but also bicycles as well. The same goes with crossing the wide road (Quote 22), for example, in some areas, users have to choose either to cross in traffic or use pedestrian crossing (on different elevations). If the pedestrian crossing is bicycle friendly, that would not be tricky, otherwise, the users need to lift their scooters or cross in dangerous traffic.

(21) "So, I'm cautious of the other vehicles 'cause I know the accident rate here is very high and road safety is not a big thing. Like it's very dangerous on the roads."

(22) "Yes, I follow with the green lights. Just go cross when the green light is already on. So, I just cross. But, sometimes, I think it's very dangerous, because I think, I think it's three lanes road, so if you just have an accident (laugh), it's just very dangerous. I don't like to go cross with that. Normally, I just go with the tunnel, yeah. But sometimes, if I need to go quickly, I use the road."

4.3 Theme 3: Accident experience

E-scooters accident becomes a significant issue for the user's vulnerability to getting injured. E-scooters have a faster speed than unpowered micromobility, which triggers accidents (e.g., falling and crashing). Faster e-scooters could result in riders experiencing injuries, which fosters the recommendation to mandate using protective helmets (Nikolaj et al., 2019). The case of accidents among e-scooters users in Bangkok is related to the fleet's maximum speed. One of the users has never faced accidents while riding the scooter. It is claimed that their speed maximum is 20 km/hour, similar to the speed

of a regular bicycle when the riders are in a hurry (Jensen et al., 2010; Thornley et al., 2008). Never experiencing accidents could also mean the user is not triggered to wear a safety helmet as in the case of User 2 (Quote23).

> (23) "Not yet (laugh) I think not yet. Because like, I'll be aware for like during driving on the road, and I'm being aware a lot. Yes, the speed is too slow, only twenty kilometer per hour, so, not yet hahaha."

However, other participants have experienced accidents more than once. In cases from other countries, many major injuries are brought about by incidents involving e-scooters, which involve surgical intervention frequently to treat the wounds (Störmann et al., 2020). According to Störmann et al. (2020), accidents are also caused by the low usage of safety equipment, such as helmets, in addition to the fast speed and quick reaction time associated with using an e-scooter. In the case of Bangkok, some accidents are related to the quick reaction time of users seeing obstacles on the road as well, such as asphalt holes. The accidents do not require surgical suture but are hurtful enough that sometimes involves bleeding. Despite the quick reaction time to obstacles, the case portrays that the condition of infrastructures (e.g., roads and sidewalks) are another factor that roots accidents of e-scooters. (Quote 24 and 25)

> (24) "I never get bleeding something like that, but ohhh, there is one time that I go to the stadium, the Chula stadium. So, there is a hole, a deep hole on the floor, today they already fix it. But, that day, I just go and I didn't see the hole, and I just "buzz", and I fell out from the scooter and yeah, you know "buzz" on the floor. So, sometimes, I got some blood, but not that much. It's just some bleeding, just yeah yeah, just there is nothing."
> (25) "Yes, some. Some of the some motorcycle is stop and they don't notice I'm behind, yeah, so I think scooter is, scooter brake is very umm well it is really short to brake, yeah. So yeah, they have an accident."

Another cause of e-scooters accidents, which is still related to a quick reaction, is not getting familiarized to utilize the scooters. For example, some e-scooters brand has a sensitive braking system. When the user faces a sudden situation (e.g., asphalt hole or vehicle crash), the user falls into the road after over-pushing the powerful brake. Even though it does not involve bleeding, however, the accident makes the user's head very hurtful. (Quote 26)

> (26) "Yes, yes. Only two times, and yeah really hurt. But, but, any other one not hurt, only me (laugh). Because, first time, I just, not usually using this brake, so it's very powerful brake when you press it really hard so you hit the floor, hit the road, yeah."

Interestingly, a case shows that users still rely on e-scooters even though have experienced accidents frequently. User 1 uses regular e-scooters with a speed of 30 km/hour which is relatively higher than other models. Compared to User 2, who never experienced accidents with their 20 km/hour e-scooters, it depicts that faster speed induces the risk of facing accidents. Even though does not require the user to get medical help, the accidents give injury to the user and was considered bad accidents. This might be the help of helmet usage as well because the user wears a full-face motorcycle helmet to protect the head. In fact, User 1 uses more safety protection than other participants which is probably associated with the accident experiences that trigger User 1 to protect themselves if the same accidents happen. (Quote 27)

> (27) "Oooohh (excited) a lot of times. The last time I had is when because I try to signal the car to turn left but (ahh) I can't balance so I crashed it at about 20 km, I don't get hurt but the scooter hand just punches me at the my aaa at my bottom. But it's not really bad accident. The last bad accident was about one month ago, when I fall into sewer pipe."

On the e-scooters sharing side, if the users experience an accident while using the e-scooter sharing service, users can claim the medical expenses using sharp insurance provided by Provider 1. Users are eligible to claim the insurance if they follow the right safety measures, such as not riding under alcohol influence (sober) and not taking passengers while riding e-scooters. The scheme would make users stay in a safe riding so that they could claim the insurance if accidents happen. (Quote 28)

> (28) "For for riders, we have riders insurance. You can claim if you got into accident."

4.4 Theme 4: Maintaining the safety

Transport operations are connected to the production structures where those services are provided, and it is dependable on vehicle maintenance (Hedvall et al., 2016). Vehicle maintenance has frequently been perceived as an unavoidable cost for transportation

(Murthy et al., 2002). Nevertheless, vehicle maintenance is an essential activity to enhance the safety and reliability of transportation operations (Dobromirov et al., 2018; Shafi et al., 2018). It is also significant to increase the lifetime of a vehicle (Shafi et al., 2018). E-scooters themselves are not different from other vehicles in terms of maintenance needs. E-scooters need at least replacements in braking pads and tires regularly, but not often. Moreover, if users have just experienced accidents, it will break some parts of the scooters, hence, the need for a service center is necessary (Quote 29 and 30.

(29) *"It's not uhh, in a month, no, no need to repair anything in a month, but uhh, it's around six months. I have to change, uhh, the brake pads, yeah."*

(30) *"Yes, last week I have changed my break. Yeah, and some accessories. A break is 190 baht yeah."*

Interestingly, the service center availability in Bangkok is decent for some brands. Service centers are accessible to customers in that particular brand (Quote 31). In some cases, the maintenance service is included in the warranty given to the customers for a specific timeframe. However, for users of some brands that do not have service center networks in the city, it is quite tricky to repair the scooters if problems occurred. Users have to give extra care to maintain the vehicle's health. Alternatively, users have to fix the scooters by themselves. For some brands, spare parts are widely available in the online market either locally or overseas (Quote 32).

(31) *"Yes, there is a service center at aa, near the Chula at the 100year park. It is only limited to that brand."*

(32) *"…maybe if it's not require so, like a, like a, manpower, like a stronger than me, I can fix it myself. Because it has, uhh, many parts online, I can buy."*

To prevent accidents from the manufacturing side, Supplier 1 claims that they have add-ons for the e-scooters to improve the safety of riding it, such as changing the damping system and tires to a better quality. Supplier 1 believes that those spare parts are significant to increase the safety of riders while using e-scooters. However, Supplier 1 is unable to install the add-ons to any scooters except what they sell because Supplier 1 needs to make sure of the availability of the spare parts. (Quote 33)

(33) *"There is other safety equipment that we can instal it in the e-scooter, for example: damping system that can reduce the shake of the tire. Or the high quality tire in which we can install into the scooter."*

5. Conclusions and recommendations

With millions of people commuting on a daily basis, Bangkok needs more options for its transportation system. E-scooters provide benefits for short-distance trips to travel without being affected by traffic and possibly to be integrated with public transportation. However, the safety of using e-scooters in Bangkok is called into doubt because e-scooters have not been specifically addressed in the regulation. That phenomenon is being researched by exploring the user's practice and the infrastructure condition to understand the safety challenges of implementing e-scooters utilization in Bangkok.

Even though riding e-scooters in a mixed-traffic is less safe than either on sidewalks or bike lanes, e-scooters users in the area of observation choose to ride on the side of the roads because bike lanes are not widely available. Indeed, due to infrastructure conditions, riding on sidewalks is considerably not comfortable. To park the e-scooters, users commonly utilize a lock system to keep the vehicle safe from stealing. The parking space availability itself is perceived in two views. First, defining e-scooters parking spaces as bicycle parking, in this case, not all buildings would have safe parking spaces for e-scooters. Second, if motorcycle parking is defined as a space for e-scooters to be parked, thus the parking spaces are easy to be found. Other infrastructures which also significant to maintain safety are service centers. Surprisingly, service centers for e-scooters in Bangkok are accessible to e-scooters users of certain brands.

The use of e-scooters in the area of observation is not standardized, resulting in dispersed speed usage. One of the factors that influence speed usage is the vehicle's maximum speed. Users believe that the top speed of their scooter is safe and not too high. However, users whose scooter's maximum speed is very high (more than 60 km/hour) would likely use personal judgment on which speed level is safe. In terms of safety equipment, some e-scooters users in the area of observation wear a safety helmet, while others do not. The helmet usage really depends on each user's awareness as well as their accident experience. Users who experienced more accidents would likely wear safety helmets, while users

who have never gotten injured are not wearing a safety helmet. In spite of that, the accidents that e-scooter riders in the area of observation have faced are associated with speed usage. Generally, while the accidents may not necessitate surgical sutures, they are nonetheless painful enough to occasionally result in bleeding.

This research might well represent the area of observation rather than Bangkok. Therefore, the findings are limited to depicting the situation of e-scooters utilization in Bangkok, also due to the small number of samples. However, the findings are beneficial to stimulate the future regulation design for policymakers if Bangkok will involve e-scooters as a transportation option. From the analysis, there are several aspects that should be considered to enhance the safety issues in Bangkok. First, bike lanes and parking space availability must be extended to accommodate the rising trend of e-scooters and other micromobilities utilization in the city, not only beneficial for e-scooters users but also for bicycles as well. Second, the use of e-scooters should be standardized to uniform its speed usage as well as to mandate the use of safety equipment. Third, providing a platform to educate about e-scooters' ideal utilization is important to increase the awareness of maintaining safety. Ultimately, e-scooters could be a good option for transportation mode if implemented carefully and supported by regulations. It is recommended for future research to consider different kinds of methodology that involve a significant number of samples.

Acknowledgement

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Defining Townscape Characteristic of Chiang Mai Old City of Thailand through Townscape Character Assessment

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Abstract

Townscape in urban heritage sites contributes a vital visual perception of the public realm. It consists of the streetscape, buildings, natural features, and human perception, which include the social, cultural, and way of life on the scenes. Historic Townscape represents tangible and intangible scenes related to historical artifacts and the historical value of the places. Townscape Character Assessment (TCA) can apply to evaluate the quality of urban elements which represent the significance of social, cultural, and human perception of urban heritage. However, Chiang Mai City Council should have paid more attention to the valued process of establishing a townscape character assessment policy and has not been part of the ongoing heritage preservation process. In the critical urban heritage environment of Chiang Mai Old City, the aim is to define the townscape characteristics of the city and to be used as fundamental knowledge to establish the suitable Townscape Character Assessment (TCA) for Chiang Mai Old City.

This research study has considered four aspects in terms of townscape Character Assessment Policy study that could establish the Townscape Characteristics of Chiang Mai Old City. These are the quality of the streetscape; cultural expression; perceptual factors; and socio-cultural values. Generally, Townscape Character Assessment employs the four significant factors to value townscape characteristics. This study has considered the ongoing new world heritage site as Chiang Mai is a "living heritage" which has faced the loss of greenery, cleanliness, and identity in its inner city and is likely to have issues when the city becomes a heritage tourism destination. The study involved twenty-five local participants and used a mixed methodology consisting of questionnaires, photo-elicitation interviews (PEI), needle method, and in-depth interviews. The results found that the connection of religious places, urban heritage artifacts, cultural activities, and the natural colors of local flowers in the city represented its characteristics. The study revealed possible factors to evaluate a townscape character assessment policy for CMOC, including the physical need for

Agricultural land use changes and the remaining/ emerging peri-urban farmers in Kathmandu Valley of Nepal

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Abstract

Peri-urban agriculture (PUA) is the agriculture practices in urban/ peri-urban areas, working dynamically to provide food at short supply chain, empowering farmers, ensuring a reliable vegetable supply, and creating job opportunities. This paper identified the key reasons behind the permanence of PUA in Kathmandu Valley. The paper looks into the peri-urban farmers in the Kathmandu Valley; using different strategies to cope with the changing urban context. This case study investigated the transitions of the peri-urban farmers of the Kathmandu Valley in contemporary bounded scenarios. One hundred twenty-six peri-urban farmers of the Kathmandu Valley were interviewed with open-ended questionnaires and categorized into groups based on their agricultural practices and the subsistence level or surplus they achieved. It is found that preserving PUA practices and fostering resilience in the Kathmandu Valley amid increasing imports requires synchronized studying of the both, changing land use patterns and emerging peri-urban farmers to know the actual status of farmers in the Kathmandu Valley. This study identified an interesting transition of PUA practices from traditional to business farmers and increased interest in urban household leisure agriculture.

1. Introduction

The problems related to achieving food security especially in the developing and underdeveloped countries without much dependency on the imports remain a significant concern with the growing population, changing climate, and depleting resources (Hazell & Wood, 2008; Orsini et al., 2013; Vermeulen et al., 2012). Unorganized and strategy-less transformation is observed in the peri-urban agricultural land near the cities (Duzi et al., 2017; Turner et al., 2017), which causes problems in food accessibility. The multifunctional benefits of peri-urban agriculture (PUA) are less recognized (Cocklin et al., 2006; Dahal et al., 2020; Rana et al., 2017; Specht et al., 2013). The spatial changes are guided by people's instant needs where environmental priorities are barely considered (Blay-Palmer et al., 2018; Sullivan, 1994). The agricultural plots of the peri-urban areas of the Kathmandu Valley are transforming in an unorganized manner inconsiderate of the growing food-related issues (Karki, 2004; Rana et al., 2017; Thapa & Murayama, 2012). Agricultural lands are converted to residences, industries, brick factories, and spaces for the storage of construction materials. Such transitions offer a high return rate in a short time but losing fertility and agricultural yield (DeFries et al., 2004). The consequences of reckless urbanization are not only the fragmentation of agricultural land into smaller plots but also in the changing crop varieties and harvest where the traditional low-value crops are replaced by high-value cash crops[1] such as perishable vegetables[2] (Shrestha, 2007; Turner et al., 2017). The agricultural land potential near cities is never accounted for its diversity, fertility, and easy accessibility by the land use plan and policy and this holds in the case of the peri-urban areas of the Kathmandu Valley (Allen, 2003; Rana & Marwasta, 2015).

Peri-urban areas are the transitional zone between urban and rural areas, mainly pictured as the areas with sprouting-built environments amidst agricultural land or forest (Duzi et al., 2017). The peri-urban characteristics are similar to the case of Kathmandu Valley in Nepal as shown in figure 1. The habitat of a diverse group of people, heterogeneous land use, morphological conditions and densities of the built-up areas, the complex functional relations, and the changing social structure are some of the characteristics of the peri-urban area (Adell, 1999; Allen, 2003; Nadal et al., 2018; Tacoli, 2001; Thapa & Murayama, 2008). The land-use changes in many cases of transformation have improved the livelihood and living standards of the farmers (Östberg et al., 2018; Turner et al., 2017) amid the increasing population, their demand,

and diversity in the agricultural produced (Artmann & Sartisonn, 2018; Nadal et al., 2018). This research paper examined how the practices of peri-urban farmers in the Kathmandu Valley have changed in response to shifts in land use. The study is significant because it fills a gap in existing research on peri-urban farmers and their evolving composition and interests. It aims to provide insights into the unique dynamics of agriculture in the Kathmandu Valley.

2. PUA in Nepal

Peri-urban agriculture in the Kathmandu Valley of Nepal hasn't received much attention from researchers in the past. But considering the pressing food security challenges, it's incredibly important to delve into the study of both the farmers and PUA in that specific context. In the course of the field observation in the Kathmandu Valley, the evidence of the PUA practices found the adaptive characteristics of the existing peri-urban farmers, which are different from the native traditional farmers. Simultaneously, the changing political structure, unstable relationship with the immediate neighbors (India and China), increasing demand for the perishable vegetable goods, and fondness for the locally produced are riveting parts of the paper. Studies showed the agriculture investment in Nepal is less compared to other SAARC and ASEAN regions with the least assertion in the urban development agendas (Dahal et al., 2020; Paudel, 2016). Rapid urbanization either replaces the agricultural land or changes the cropping system from low-value crops to high-value crops (Shrestha, 2007).

In Kathmandu Valley of Nepal, there is no any concrete evidence that directly connects the changing situations of farmers with the potential of peri-urban agriculture land and its existing diversity (Dahal et al., 2020). Urbanization and development not prioritizing agriculture (Ives & Kendal, 2013) approach have resulted decreasing fertile agricultural land around the valley as well (Dahal et al., 2020). Furthermore, the multifunctionality of PUA still lacks recognition in the urban planning approaches and development strategies (Cocklin et al., 2006; Phuong & Nguyen, 2018; Rana & Marwasta, 2015; Rana et al., 2017). The role of PUA and its farmers in sustainable urban development (Artmann & Sartison, 2018; Blay-Palmer et al., 2018; Duzi et al., 2017; Specht et al., 2013) is still a big dilemma when trying to compete with other non-agricultural activities and similar in Kathmandu Valley (Thapa & Murayama, 2012). The peri-urban farmers in the valley include both the native and the innovative ones. However their preferences and values (Ives &

Kendal, 2013) to choose PUA are never reckoned. In the Kathmandu Valley and its three districts, farmers can be categorized into two groups. The first group consists of those who cultivate traditional low-value crops. The second are those growing perishable high-value cash crops, such as perishable vegetables that are an essential part of the Nepalese diet. The literature available here primarily focuses on the latter group of farmers.

Based on the existing research, it is crucial to implement smart development and management approaches that go beyond just exploiting the remaining resources. By taking into account the various aspects of peri-urban agriculture (PUA) and learning from others experiences, transcending the urban food challanges (Duzi et al., 2017).

3. Objectives and Case Study Research Method

The study investigated the PUA practices of the Kathmandu Valley based on the transitioning peri-urban farmers. Through Key Informant Interview KII, it explored the transitioning peri-urban farmers amid the changing land use, political structure, urbanization and market inflation.

The case-study research method (Yin, 2009) had been adopted to investigate the scenario and find solution for the contemporary problem of unaccounted PUA practices in Kathmandu Valley. The case-study research method (Yin, 2009; Ridder, 2017) as the methodological tool investigated the transitions of the peri-urban farmers of the Kathmandu Valley within the current limited context. The research adopts the bottom-up evaluation approach (Greenawalt, 2016), using established and commercial peri-urban farmers as the KII from the three districts. Then, farmers engaged in both surplus production and subsistence were considered as the main sources of information.

Peri-urban farmers of the Kathmandu Valley were interviewed with open-ended questionnaires based on the sustainable livelihood framework designed by Scoones (2009). Each interview with peri-urban farmers as the KII of the study had been further classified. Like Kaplan (1984), the qualitative analysis focused on examining the responses and expressions of peri-urban farmers of the study areas. This approach allowed to capture their perspectives (Sullivan, 1994), highlighting both the similarities and differences among them. To maintain the precision of the informants' responses, only PUA practitioners for the perishable vegetable production were taken of different scales, districts, socio-economic background (Ridder, 2017). Consequently, the findings had been further organized creating multiple peri-urban farmers groups' cases and later compared with the peri-urban farmers practicing conventional methods of agriculture and only growing low-value crops such as rice, wheat, maize, etc. to distinguish the livelihood and land occupancy patterns along with their sustaibability. This paper has incorporated various qualitative steps in translating and analyzing the data of peri- urban farmers of the three districts if the valley. These steps encompass transcribing interviews or recordings, organizing the data into meaningful units of analysis (Yin, 2009).

These analyses conducted help gain a comprehensive understanding of the PUA. Analyzing within-case analyses of different groups of peri-urban farmers allowed to explore the unique characteristics and practices. Between case analyses, such as examining business farmers of different scales and market reach, helped to identify variations and similarities across different types of peri-urban farmers.

4. Study Area: Kathmandu Valley

Kathmandu Valley lies in Bagmati Province of the newly restructured the Federal Democratic Republic of Nepal, composed of seven federal provinces established by the current constitution of Nepal. This province houses all the three districts selected i.e., 1) Kathmandu; 2) Lalitpur; 3) Bhaktapur as shown in Figure 1. The selected peri-urban agricultural land is almost a flat floor of the valley along the mid-hills is at an average elevation of 1,300 m and the sides of the valley at an elevation of 2,000 m (International Centre for Integrated Mountain Development [ICIMOD], 2016). It includes all the three landscapes of urban, peri-urban, and rural as mentioned in Table 1. The selection of these three districts provides interesting cross-case analysis with the case study research method where the Kathmandu Valley incorporates 81% of the Kathmandu district; 32% of Lalitpur and whole of the Bhaktapur district (ibid).

The annual population growth in the municipalities of the peri-urban areas is significantly higher resulting in the land-use change (Allen, 2003; Central Bureau of Statistics [CBS], 2011; Ishtiaque et al., 2017; Karki, 2004) as shown in Figure 2. The PUA practices are performed mostly on the leased land and very few buy the land. The transition process has brought positive impacts to the livelihoods of the emerging peri-urban farmers compared to the native farmers following traditional farming approaches. These farmers are oriented to grow surplus focusing market's perishable vegetable demand and terms the urban growth with major roads in a concentric pattern as the advantage.
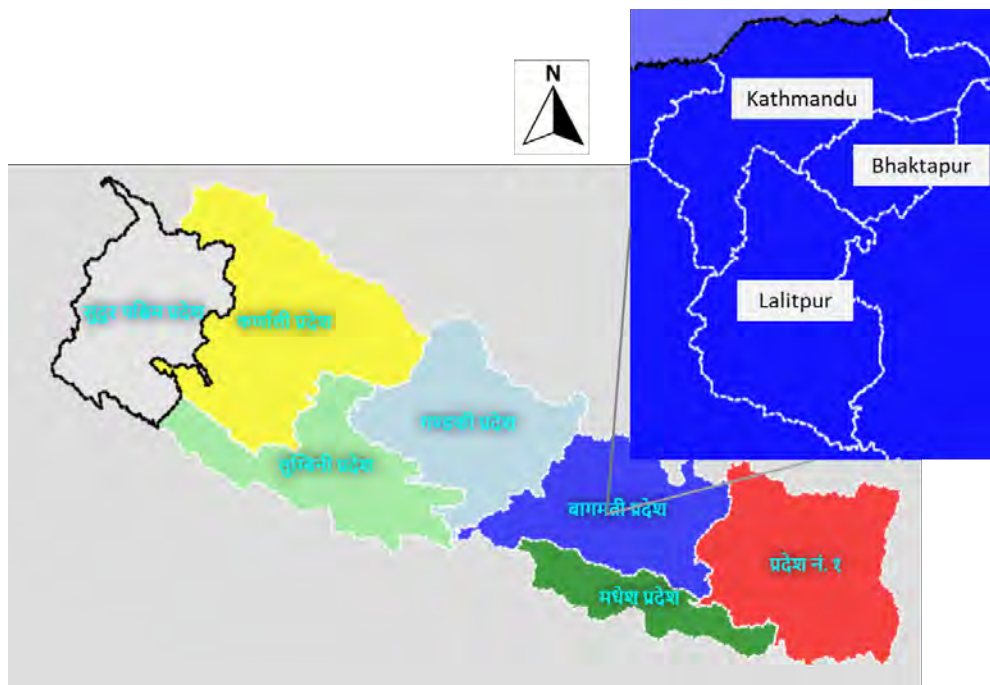
Figure 1. Location of the study area 'Kathmandu Valley' in the map of Nepal (Source: MoFAGA, 2020) AUTHOR MODIFIED
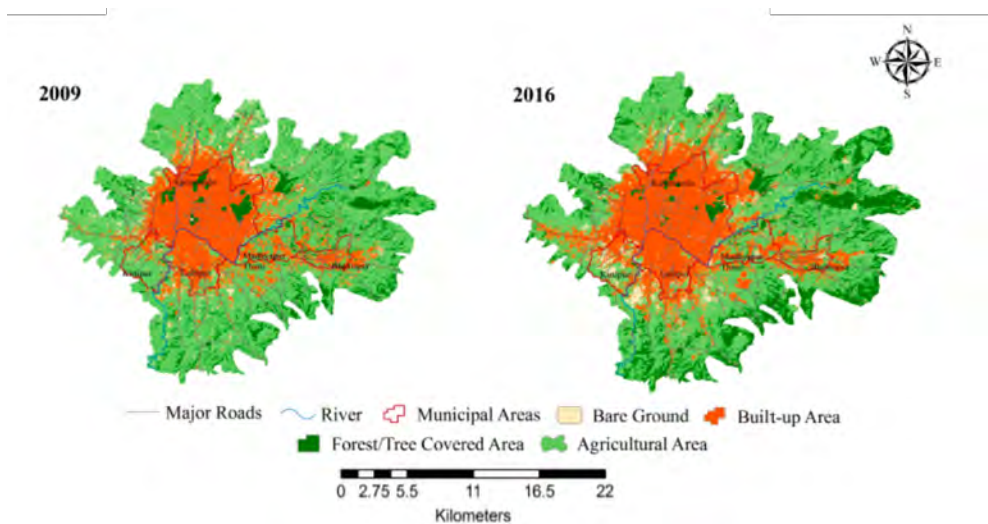

Figure 2. Land-use change in the Kathmandu Valley (Source: Ishtiaque et al., 2017)

District	Urban Area	Peri-urban area
Kathmandu	Gongabu Nayabazar Shova Bhagwati Kalimati Syambu Teku Tahachak Kalanki	Sankhu Baneshwor Dhapasi Sundarujal Pharping Balambu Sitapaila
Lalitpur	Sanepa Balkumari Sankhamul	Lele Sisneri Imadole Bungamati Godavari Thacho Chapagaun Thaiba Champi
Bhaktapur	Thimi Sano Thimi Kamal Binayak Bode Kasaultar Jagati Nagadesh Byasi Lokanthali	Bageshwori Balkot Sipadole Gamacha Chunadevi Balkot Sipadole Gamacha Chunadevi

Table 1 shows the area of study where the peri-urban farmers were interviewed. The individuals interviewed included traditional local farmers, farmers who migrated to the area, farmers who cultivated crops on their own land, and larger agricultural cooperatives.

The informants in Bhaktapur district were mostly the native farmers producing perishable vegetables on the large scale compared to the other two districts. Lalitpur district had the highest number of agricultural cooperatives operating and creating job opportunities for the locals while Kathmandu District mostly had migrant farmers doing agribusiness.

The land use of the valley shows (refer to Figure 2) the PUA practices are moving farther from the city center in the case of Kathmandu district bringing peripheral land of the district in agriculture use. The perishable vegetable supply of the capital in the valley depends dominantly on these three districts; followed by the neighboring districts i.e., Kavre, Sindhupalchok, Nuwakot, etc.; Terai regions, and the neighboring countries i.e., India and China. There is a need to improve the awareness among the local government, peri-urban landowners including farmers to improve the existing PUA practices and retain the peri-urban farmers to meet the perishable vegetable demands.

5. Basis of Peri-uban Farmer's Grouping

The KII had been done with the peri-urban farmers producing perishable vegetables in the three districts of the valley. The purpose of the KII was to accumulate evidences of the PUA practice from a wide range of peri-urban farmers i.e. native farmers; business farmers; migrant farmers and household farmers as named based on the specific practicies and roles they perform. Most of the informants were native farmers, witnessing the advancing demand for the valley's land. The years-long practiced earned experiences, helped to gather evidence offering intuition on the agriculture-related problems with recommendations. Also, grouping the diverse farmers ensured to gather unbiased evidence for the research based on their specific practices and roles they perform. The peri-urban farmers' interview had a varied range of social and economic backgrounds offering different thoughts and strategies for the underlying issues in the transitioning. The transitioning is found to cope with; food prices, fertilizer-induced food, food growing open spaces, food near the living, daily exercises to grow own, etc., and many more (Blay-Palmer et al., 2018).

As explained above in the study area and excerpt of Table 2, the findings from the in-depth interviews have been segregated into the different units of peri-urban farmers. Table 2 has also enhanced the level of heterogeneity which is one of the advantages of using the case study research method. Multiple units of analysis of the case study research method designed by Yin (2009) have been used to classify, interpret, validate, and triangulate the information from the heterogeneous units of peri-urban farmers.

S.NO.	HETEROGENEOUS UNITS (NOS.)	CHARACTERISTICS
1.	Native peri-urban farmers (36)	• Prior existences with a long history; • Mostly from the newars[3] community; • Transitioned in the agricultural tool and technology; • Old market linkage; • Landowner; • Helped slow the agricultural land use changes mostly in the Bhaktapur district; and • Landholdings more than a *ropani*[4]
2.	Emerging business peri-urban farmers (30)	• Includes both individual and cooperative group of farmers; • Modern agriculture approaches and practices; • Good market linkage; • Land on the lease; • Found only in Kathmandu and Lalitpur districts; • Very few PUA practices along with the urban centers; • Mostly emerging in the new areas with the road infrastructures; and • Landholdings more than a ropani
3.	Migrant peri-urban farmers (15)	• Migrants from the periphery districts of the valley; • Mostly individual and those returned from foreign labor; • Good market linkage; • Land on the lease; • Found only in Kathmandu and Lalitpur districts; and • All the cases in the new areas with the road infrastructures; and • Landholdings more than a ropani
4.	Household peri-urban farmers (45)	• All individuals; • No business motive; • Practiced both on land and roof; • Guided by the daily benefits in the health and dealing with the market uncertainty (both price and availability) • Landowners; • Found only in Kathmandu and Lalitpur districts; • Existing both in the urban centers and the newly emerging areas; • Not mapped in the land use; and • Mixed land holdings (Mostly above 4 aana)

The characteristics of the multiple units of peri-urban farmers (Table 2) clearly state the diverse composition of the peri-urban farmers. It had been classified as: i) Native peri-urban farmers (36), ii) Emerging business peri-urban farmers (30), iii) Migrant peri-urban farmers (15), and iv) Household peri-urban farmers (45) making a total of 126 KII under different units of analysis. The practice as guided by Yin (2009) is very accurate in terms of effectiveness in getting the unique individual unit case and amalgamated under the criteria (Rachmawati et al., 2015). The pattern matching and variability among the interviewed peri-urban farmers presented data validity among themselves. Pattern matching from the case study research method (Almutairi et al., 2013;

Yin, 2009) is used to categorize the sequential triangulation of the interviewed peri-urban farmers in the three districts of the valley. The validity had been an eminent part of the data qualitative data analysis using semi-structured questionnaires for all three districts. The studied diverse group of farmers were evaluated based on their satisfaction regarding land availability, irrigation water, market access, and policy support. These factors are important because they directly impact the farmers' ability to cultivate their land, access necessary resources like water for irrigation, find markets for their produce, and receive support from policies that can help enhance their agricultural activities (Kassem et al., 2021).

Table 3. Factors influencing peri-urban farmers' decisions.

Important parameters	HETEROGENEOUS UNITS (NOS.)			
	Native peri-urban farmers	Emerging business peri-urban farmers	Migrant peri-urban farmers	Household peri-urban farmers
	(36)	(30)	(15)	(45)
Market reach	G	G	C	NA
Land availability	G	C	C	G
Supporting policies	S	S	S	S

** Good (G); Competent (C); Struggling (S); and not applicable (NA)

The table summarizes the important factors for peri-urban farmers, including market reach, land availability, and supporting policies. Native peri-urban farmers have a strong market reach and ample land for farming, but they face challenges with supporting policies. Business peri-urban farmers also have a good market reach and access to suitable land, but they encounter difficulties with policies as well. Migrant peri-urban farmers have a competent market reach and sufficient land through leasing, but they also face obstacles due to unsupportive policies. Lastly, household peri-urban farmers engage in leisure farming using small spaces like terraces and yards. Despite the lack of supportive policies, they're not concerned as their focus is on leisure farming.

6. Results and Discussion

The key discoveries from the various groups of peri-urban farmers clearly indicated a significant shift that is unnoticed in both urban studies and the changing land use patterns in the Kathmandu Valley. The known aspect of this transition is the reduction of agricultural land, as farming becomes less of a primary income source. However, it's important to acknowledge that there's also a new perspective emerging. i.e. migrants are leasing large agricultural lands and engaging in agriculture as a business. It's an exciting and dynamic shift that showcases the changing landscape of agriculture in the region. Again, enhancing these positive transitions with multiple benefits to the local food security (Cocklin et al., 2006)

needs recognition from the government agenda at different levels by recognizing these different groups of PUA practitioners.

The comparison of the evidence from different groups of peri-urban farmers showed Bhaktapur district is occupied only with the native groups of peri-urban farmers. These groups of farmers used to be the sole vegetable suppliers about 25 years back when the valley had less population (CBS, 2011; Shrestha, 2007). In Bhaktapur district, the farmers were growing both grains and vegetables. The interviews showed how the division of agricultural land affected grain growers, leading them to transition into vegetable production. Despite the land fragmentation, the overall use of agricultural land remains largely unchanged, except for shifts in crop patterns. The interviews with peri-urban farmers in Bhaktapur highlighted the significant influence of community knowledge, preferences, and values in sustaining peri-urban agriculture practices. The strategies implemented by peri-urban farmers have greatly established Bhaktapur district as a major source of vegetables in the valley. However, it is important to strengthen the farmers' market connections without relying heavily on intermediaries or commission agents. In the case of peri-urban farmers in Kathmandu and Lalitpur districts, they were either the traders or the wholesalers themselves, directly involved in the market. On the other hand, despite the agricultural land fragmentation in Bhaktapur district, the peri-urban farmers there did not experience the same direct benefits as those in the other two districts.

Likewise, in the case of the Kathmandu and Lalitpur districts, most farmers were migrants taking agricultural land on lease. From the KII, the peri-urban farmers found PUA as a prospective opportunity for business with profit. Some of the interviewed peri-urban farmers had even extended their agriculture plots beyond the Kathmandu district's boundary due to the increased vegetable demand. Such an extension was possible due to the low land price and well-connected road infrastructure because of which they can reach the market. In the Kathmandu district, there are a growing number of peri-urban farmers that returned from working abroad as laborers. These rural immigrants utilized their acquired skills, newfound creativity, and proximity to markets as opportunities to practice peri-urban agriculture in the Kathmandu and Lalitpur districts. The business-oriented groups of peri-urban farmers saw urbanization and their presence in peri-urban areas as incentives. However, they remained concerned about the availability of land for an extended period, unless the government intervened. The highest number of migrant peri-urban farmers was in the Kathmandu district, followed by Lalitpur district, with none in the Bhaktapur district. This absence indicates that migration and commercialization had minimal effects in the Bhaktapur district compared to the other two districts. However, in all the units of analysis the number of interviewed peri-urban farmers does not quantify the actual number of farmers ("how much"); but represents the participation and interest as qualities ("where, who, and why"). The household-level peri-urban farmers comprise farmers growing perishable vegetables for self-consumption. The spaces for PUA practices by the household peri-urban farmers used terraces and utilized non-biodegradable household waste such as plastic sacks, thermo bins, plastic cans, etc. showcasing the multifunctionality of PUA.

The evidence shows the subsistence agriculture practices in the valley are transitioning (Blay-Palmer et al., 2018; Dahal et al., 2020) to business agriculture due to the increasing market demand of the reliable perishable vegetable produced like the case of Southern Bolivia (Turner et al., 2017). Likewise, according to Kaplan (1984), spatial and natural settings tend to be highly favored for decision making by urban farmers, also in the case of the Kathmandu Valley the natural settings with the vegetable market demand play a vital role in the transitioning of the peri-urban farmers. The business-oriented group of peri-urban farmers were more satisfied compared to the native farmers in the evidence gathered for the transition. However, sustaining the peri-urban farmers in the valley first needs preserving fertile agricultural land which is

diminishing haphazardly. The control of the haphazard conversion can be done if the local government could intervene by identifying the potential agricultural land using land inventories like that in Portland and Vancouver (Mendes et al., 2008). The foreign labor returnee as peri-urban farmers and investors in PUA practices in the Lalitpur district said the availability of potential land for PUA practices, market and incentives, and support from the government could help escalate job opportunities not only in the valley but the surrounding districts as well.

A survey was conducted at the Kalimati Fruits and Vegetables Market Development Board (KFVMDB), in addition to data triangulation within multiple units of farmers from three districts. The board approved the transition that is taking place in the Valley's vegetable supply which is unnoticed by the government. Also, added the existing urban development plan policy encourages the agricultural land conversion and more dependency on the import which might be very harmful for a nation with an unstable government and its structuring. One of which was already experienced during the Indian border blockade after the 2015 earthquake in Nepal. The KFVMDB report (2014), showed Kathmandu, Lalitpur, and Bhaktapur districts provide about 70% of the total vegetables consumed depending on the favorable season, 15% by Terai region of Nepal, and 15% through import from the neighboring country India. The peri-urban farmers irrespective of the district said- PUA could be made capable to compete with other urban jobs if practiced commercially and receive support from all the tiers of government as mentioned by the cases of Lancelotti et al. (2016). When examining the 'farmers' satisfaction and awareness' findings in a descriptive way, it became evident that Native peri-urban farmers (36) and Emerging business peri-urban farmers (30) were familiar with the supportive policies. However, the transition to federalism and the new constitution 2072 has created a dilemma for the Native farmers than the business group. Among the four farmer groups, it appears that Migrant peri-urban farmers (15) faced the most challenges. The agricultural policies in urban areas differ from those in rural areas, causing difficulties for these farmers. On the other hand, in Nepal there have been challenges with the effectiveness of agricultural policies, there are agricultural policies in place, but their implementation and impact can vary. Factors such as limited resources, inadequate infrastructure, and bureaucratic hurdles can hinder the effectiveness of these policies. The agricultural policies in Nepal mainly focus on supporting farmers in rural areas. Their main goals are to increase productivity, ensure food security, and promote sustainable farming practices.

The government provides subsidies, incentives, and extension services to help farmers adopt modern techniques and adapt to climate change. They are also working on improving market access and infrastructure. However, it's important to give equal attention and support to farmers in urban and peri-urban areas too. The existence of different groups of peri-urban farmers shows that there are diverse challenges and opportunities to address.

Despite their expertise in agricultural tools and techniques, including fertilizer usage, they are struggling in the urban and peri-urban areas of the valley. However, their produce is competing with that of business-oriented groups, where livelihood is not the primary objective but rather profit-driven. Household peri-urban farmers (45) didn't prioritize land use changes, resource access, market availability, or policy support as they focused on leisure agriculture without surplus production goals. Based on the study's analysis of farmers in the valley, it is expected that as agricultural land use decreases (Ishtiaque et al., 2017; Sarif et al., 2020; Thapa & Murayama, 2012), urban leisure agriculture will be significant (Gulyas & Edmondson 2021; Nie et al., 2021) in the case of Kathmandu Valley. It's worth noting that this trend is not limited to new peri-urban areas but is also becoming more common in the core of urban environments and addresses the decreasing availability of agriculture land sizes. The findings from all three districts suggest the benefits people derive from the PUA practices producing perishable vegetables could help maintain both the cultural and aesthetical values. PUA practices have values closer to people's health and the environment (Blay-Palmer et al., 2018). The government interventions in PUA practices in the valley can compete with the urban jobs providing ample benefits as mentioned. The changing landscape of agricultural land in the peri-urban areas from the low-value crops to all-year-round perishable vegetable produced shows a prospective future for Nepal which had been an agricultural nation. Apart from the farmers' preferences (Ives & Kendal, 2013) increasing food fuel price and health awareness and nutrition are value-adding to the steady transition.

7. Conclusion

In this paper, the evidence of transitioning PUA practices in Kathmandu Valley is descriptively discussed. Farmers' satisfaction and prosperity are closely tied to factors like the market, land availability, and supporting policies. However, upon closer examination within the diverse group of farmers, it becomes evident that farmers' satisfaction is closely linked to their awareness and accessibility. In the case of household peri-urban farmers, the market, land availability, and policies have little impact. As a result, the paper predicts that with changes in agricultural land use of Kathmandu Valley, there will be an increase in the number of urban leisure farmers that fulfill their daily vegetable needs in terms of preferences. The growing demand for urban and peri-urban agriculture is now acknowledged for ensuring food security, creating employment and income opportunities, and effectively utilizing unused resources (Nyapendi et al.,2010). According to the United Nations Development Program (UNDP), around 800 million people are involved in urban agriculture globally, with a significant concentration in Asian cities and approximately 200 million classified as market-oriented producers (ibid). The study here in the valley also supports the need to support the emerging farmer groups, it is crucial to raise local awareness and promote the use of locally grown vegetables. This will help replace the import of high-priced and chemically adulterated vegetables. the government of Nepal to prioritize policies that promote local farming and make agricultural resources easily accessible. Instead of relying on imported chemically treated vegetables from neighboring countries, the focus should be on enhancing the quality and quantity of locally produced vegetables. This positive transition can be achieved by taking inspiration from countries like Indonesia, which effectively promotes their coffee through advertisements to capture a larger market share and encourage the peri-urban coffee farmers (Djamaludin & Silmie, 2021). The effective promotion of PUA of KV with changing agriculture land use requires synchronized and coordinated attention for the peri-urban farmer's values and preferences, locals, urban land use developers, and policymakers. Further research is necessary on the market and consumption of perishable vegetables in the Kathmandu Valley to better understand the dynamics and provide valuable insights for policy recommendations promoting local production, agriculture infrastructure and storage facilities, and enhancing market linkages for farmers.

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streetscape improvement, cultural expression along the streetscapes, perception of the quality of the streetscapes, and representation of socio-cultural values of the streetscapes. These results can be implemented in developing assessment guidelines for any heritage sites undergoing heritage nomination or any historical cities concerned with townscape character.

1. Introduction

The identity of Chiang Mai old city can be found in its unique places which are informed by the perception of local people, Phetsuriya and Heath (2021) mentioned five such distinctive places in the city that represent the urban heritage identity. These consist of two significant temples in the city, two urban spaces, and the Chiang Mai City Moat which reflect the cultural heritage values and the city's outstanding universal value. The place has provided an extraordinary aspect for the nomination process to the UNESCO World Heritage Site Committee. Unfortunately, in its application, the Chiang Mai Heritage Committee (CMHC) has neglected to focus upon the built environment, despite this being crucial in maintaining and improving the city's unique townscape scenes and developing a townscape character assessment plan. Townscape character assessment policies are standard worldwide in cities with important urban heritage assets; however, they have been traditionally underused in Thailand. The city has been losing its quality of urban life and townscape character due to rapid urbanization (Moe ,2001; UNESCO,2020). Furthermore, the local council continues to introduce conservation areas according to the history of the areas with no attention to townscape assessment. This is likely to lead to further issues when the city becomes a world heritage site with the associated impact of an expanded tourist industry.

Chiang Mai Old City has been announced as the 'tentative list' of World Heritage Sites. Currently, the Chiang Mai Heritage Committee (CMHC) is proposing its dossier to the advisory bodies of UNESCO. Although the nominated places are the majority of the nomination process, thus the built environment is also linked to the distinctive places that affect the heritage city's environment. In addition, the built environment plays a key role in affirming the cultural, economic, and social (Watson & Bentley,2007). The main advantage of townscape characterization is that it encourages developers and stakeholders to follow the policies and guidelines of the planning system. Townscape character assessment policies provide a beneficial description of the townscape character and, therefore, assist in negotiations

for modifying the planning system. A townscape's visual aesthetic perception contributes to a positive experience for the city and its communities. The defining process of the townscape character assessment policy is based on the understanding and response from the Chiang Mai community, which encourages communities to increase their sense of local identity. A description of townscape character provides valuable information for the tourism industry and can support preventing inappropriate development from devaluing a city's identity (Walsh, 2012).

In Chiang Mai, the valued process of establishing a townscape character assessment policy needs to be addressed and be part of the ongoing heritage preservation process. In a critical urban heritage environment such as Chiang Mai, the city's approach must embrace the community and the local council. The positive perception of urban space requires local communities to participate in the conservation process as part of increased engagement between the authorities and the community. As such, this study focuses on the early stage of policy development for a townscape character assessment of Chiang Mai Old City. The research aims to examine a community's perception in terms of the socio-cultural value and the streetscape qualities that represent the heritage value of the city. This study employed mixed methods, and the result define the townscape characteristics and informs the city's initial townscape character assessment policy and suggests that the city should take a step backward and consider developing the policy parallel with the nomination process.

2. Theory

2.1 Townscape Character Assessment (TCA)
'Townscape' as an approach to understanding one aspect of quality in the built environment and it has had mixed fortunes over the last few decades. Nonetheless, it remains a useful category within which the question of how places work at an aesthetic level can be considered (Reeve et al., 2007, p.25).

Guidelines for Landscape and Visual Impact Assessment mentioned townscape as "Townscape is the landscape within the built-up area, including the buildings, the relationship between them, the different types of urban open spaces, including green spaces and the relationship between buildings and open spaces." (Landscape Institute, 2020, paragraph 2.7)

Townscape characters involve the interaction of the physical, social, and cultural elements of cities, which consider the historical development associated with an urban environment, cultural and heritage qualities, the mass and scale of the existing built form and existing urban structure (Jeffery, 2020; Rooney & Houlston, 2017; Colchester Borough Council, 2006). It also includes green infrastructure, streetscapes, vistas, skylines, public realm, legibility, landmarks, connectivity, utilities, and perceptual qualities (Jeffery, 2020). The significance of townscape character assessment is to present distinctiveness supported by maps, illustrations, and photographs of places. This evidence leads to understanding the evolution of places and development over time in response to nature, social life, and economic aspects (Rooney & Houlston, 2017). Assessment can form the fundamental for evaluation related to the effects of change in multiple ways. The information from the assessment can also guide the developers in positive decision-making to promote and maintain the distinctive townscape characteristics and the sense of place (Rooney & Houlston, 2017; Colchester Borough Council, 2006).

Interestingly, it can assist stakeholders and developers with an evidence-based approach to their objectives. The assessment allows for more robust evidence linked to specific sites and neighborhoods. To inform development policies is to ensure that new development contributes positively to townscape distinctiveness and contributes to the pride of the place feeling and ownership of the cities, which in turn contributes to environmental, social, and economic vitality (Rooney & Houlston, 2017; Colchester Borough Council, 2006).

2.2 Value in the view

The relationship between urban space and architecture on streetscapes can reveal the distinctiveness and sense of place, which is evaluated through the quality of urban attributes and natural features (Phetsuriya, 2023). Moreover, describing streetscape characters contributes significant data influencing city identity development (Walsh, 2012). The positive visual image of cities represents the value of sociocultural places and urban spaces (Gibson, 2009). A city's views are promoted as 'brandscape' or place-branding, and tourism reveals underlying tensions between the demands of cities to develop and grow while at the same time retaining their historical form and relationship to nature. Indeed, city views are promoted as historical or natural 'assets' for the consumption of a growing number of
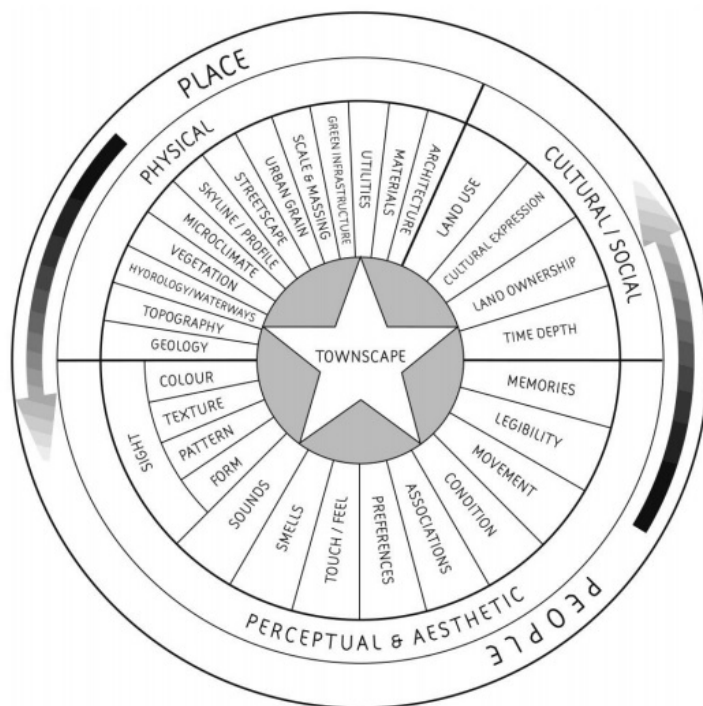

Figure 1. 'An Approach to Landscape Character Assessment' (Rooney & Houlston, 2017, p3)

tourists (Brigden, 2018, p.122). Significantly, scenic beauty also contributes to residents' quality of life and attracts visitors. Due to the dynamic relationship between people, land, and rural development, there is an increasing interest in estimating the value of scenic quality using non-market valuation techniques (Mathews et al., 2004). To look at the scene of a city economically, 'brandscape' would be a persuasive
lifestyle and powerful identity. The identification and value of significant views should be informed by consultation with local communities (Brigden, 2018). Visual perception is one of the translation tools from visual information to the brain. It can be divided into three parts: perceptual organization, depth perception, and size constancy (Romcai, 2007).

Visual perception relates to the process of user experience of a place, which focuses on the stimulation of physical elements of public spaces such as commercial signs, shapes, colors of buildings, street furniture, and so on. It also involves symbolic meaning associated with places and can be influenced by the user's urban context, values, culture, and individual experiences (Portella, 2014). To value the visual resource is focused on the visual impact in the city is the method to identify problems of visual culture, such as the diversity of signs in the city or the signs that disturb the visual culture of the community. This method can be used to preserve the visual resource by studying the visual impact on the city and the visual corridor to specify the vital views of the city (Sourachai, 2006).

2.3 Sociocultural Values is Heritage Values

'Social value' relates to the value of objects and places within communities and people rather professionals identification of meaning. Gibson (2009, p.73) notes that a report on social value commissioned by the Australian Heritage Commission, defines places with social value as those which firstly, can provide a spiritual connection or traditional connection between past and present and tie both periods together. Moreover, in terms of community relations, the social value can connect people back to their history, provide an essential reference point in a community's identity, loom large in the daily comings and goings of life, provide an essential community function that develops into an attachment, and shape some aspects of community behavior or attitudes.

This value consists of historical values, social values, aesthetic values, and spiritual values (Lipe, 1984; Mason, 2002; Doğan, 2020). Historical values are the core of the heritage concept and the capability to react to the

past of heritage objects is significant in explaining their meaning. There are several ways to accrue the value, such as the age, people's association, events, uniqueness, and documentary potential (Lipe, 1984; Mason, 2002). The two sub-types of historical value consist of the education values and the artistic values. Education values relate to the potential of heritage knowledge gains and looking forward from the past to further knowledge combined with another knowledge field. The expression of uniqueness or being good or best in any aspect is included as the artistic value in historical value (Gibson, 2009; Mason, 2002). Cultural values are similar to historical values, heritage always relates to cultural values, and the advantage is to build cultural values in the present to continue the historical meaning.

Social values are essential in the field of social science, the social values of heritage sites include the assembly of people in social space for purposes such as celebrations, markets, picnics, or other activities (Gibson, 2009; Mason, 2002). All activities do not necessarily need to relate to the historical value or the cultural purpose but can share the space qualities within neighborhood or groups with the same interest. Social values can also contribute to the "place attachment" aspects of heritage value. These include aspects such as social cohesion and community identity, which are derived from specific characteristics of the heritage and environment (Gibson, 2009). Aesthetic values refer to the qualities of the visualization of heritage. The sense of aesthetic is widely interpreted to beauty, the ruins and the fundamental senses of humans such as smell, sound, touch, and sight. These contribute a strong sense of well-being of place through human perception. Spiritual values relate to the religious or sacred meanings that evolve from beliefs or religions (Lipe, 1984; Mason, 2002).

Finally, spiritual values are mainly related to the evolution from belief and religion to sacred meanings (Lipe, 1984; Mason, 2002). Otherwise, the rootedness of non-religion in human experience also contributes to spiritual value, such as the experience with loved ones in the city or the priceless memory of loved ones (Willson, 2016). The bonding of spiritual value is combined with emotional, intangible, or tangible (Cross, 2001).

2.4 Quality of Streetscape

In this study, the quality of streetscape has been concerned into a part of the townscape character assessment which consists of walkability, accessibility connectivity, transparency, safety, livability, vitality, diversity, adaptivity, social value, form and visual quality (see table 1). Rehan (2013:p.174) articulates that:

Indicators for streetscape quality	Definition	Question design in this study
Walkability	Walkability as '...the extent to which the built environment supports and encourages walking by providing for pedestrian comfort and safety, connecting people with varied destinations within a reasonable amount of time and effort, and offering visual interest in journeys throughout the network' Southworth (2005, p.248).	(Q1) The street is clean and well organized. (Q2) I feel satisfied walking on this street.
Accessibility	'Access' as a key component of ideal urban form consists of multipurpose, firstly, access to other people and certain activities: it is the fact that human beings are social animals. Moreover, the resource accessibility to various other goods and basic supportive energy and environment sources. The natural environment on urban space such as open space, landscapes, wasteland, or places with recreational activities. Lynch (1981, pp.188-190)	(Q5) I can easily access the pavement.
Connectivity	Street connectivity and walking is partly mediated through other environmental attributes, particularly utilitarian destinations (such as local shops and services) that are found well-connected areas (Koohsari et al.,2014, p.119).	(Q4) The street is perfectly connected between each of the pavements.
Connectivity	Tucker et al. (2005) Connectivity is well connected to urban space to improve quality and concerns to the connection of urban transport, such as public transport, bicycle lane, continuous and accessible pavement.	(Q6) The pavement/space on the street has been designed for universal users.
Transparency	'...ability to see beyond whatever it is that defines a street' (Jacobs, 2010, p.165). Transparency of street is mainly related to an 'active frontage' which involves an interaction between indoor and outer space; and presents the inner life to citizens to let them in, it is a component of urban life and space in the meaning of access to buildings and continuity of urban space (Erkartal & Uzunkaya, 2018).	(Q9) I can easily access the shops along the street.
Safety	A great street is physically comfortable and safe (Jacobs, 1993).	(Q3) I feel safe walking on this street.
Livability	Urban livability refers to places where people can live in relative comfort. This starts with the availability of most basic things such as places with clean air, clean water, a well-managed environment relatively devoid of dirt, trash, noise, danger, overcrowding; a physically healthy living environment (Jacobs, 2011,p.177).	(Q13) I have a social life integrated with this street.
Vitality	Lynch (1981) mentioned vitality of place is supposed to encourage the health and survival of species. The vitality of a street is defined as the presence of people engaged with activities. (Mehta, 2011). Accordingly, vitality reflects activity, alongside a diversity of transactions (not necessarily economic) between people (Montgomery, 1995, p.106).	(Q15) I feel engaged with the streetscape.
Adaptivity	'This may be achieved by adaptation of the place to the activity, or vice versa, and also by mutual adaptation . . . adaptability in the more general sense is also achieved by the presence of adaptable persons . . . .' (Lynch, 1981, p.167)	(Q7) I think everyone can use the street for commercial purposes.
Adaptivity	The concept of adaptability is an adaptable urban settings, therefore, have '...a greater chance of taking the impact of a stressor, addressing its impact, and then quickly reconfiguring itself to continue its operation and generate value' (Desouza & Flanery, 2013, p.96)	(Q8) I think everyone can use the pavement for commercial purposes.
Form Visual Quality	The aesthetic of visual character of urban places included colour, texture and surfaces can defined urban space character (Carmona et al., 2010).	(Q10) It has an attractive landscape.
Form Visual Quality	An excellent visual quality of city streetscape will give a good visual aesthetic experience for the community and Psychologically create a positive thought and action. Moreover, forms of urban environment both physical and non-physical form an interwoven perception and appreciation closely with humans (Santosa et al., 2018, p.2).	(Q16) The façade design represents the historical value. (Q12) The streetscape/space is green and shady to the streetscape.
Social Value	The social value of public space is wide ranging and lies in the contribution it makes to 'people's attachment to their locality and opportunities for mixing with others, and in people's memory of places. Places can provide opportunities for social interaction, social mixing and social inclusion, and can facilitate the development of community ties (Worpole, 2007, p.5).	(Q11) The streetscape brings the value of history of CMOC. (Q14) I consider the socio-culture value of this street reflects the value of CMOC.

"Streetscape is a term used to describe the natural and built fabric of the street, and defined as the design quality of the street and its visual effect, particularly how the paved area is laid out and treated. It includes buildings, the street surface, and also the fixtures and fittings that facilitate its use – from bus shelters and signage to planting schemes."

The inter-relationship of defining townscape characteristics primarily concerns place and people; these two factors can be explained more through the physical, cultural/societal, and perceptual/aesthetic. However, the study applies the sociocultural value to explain the depth of heritage values because the case study location is located in a heritage site. Finally, the physical of its streetscape can be vital to evaluate the perception and value of townscape characteristics.

3. Chiang Mai Old City, Thailand

Chiang Mai is in the basins of the Chiang Mai-Lamphun slope and Ping River in the north of Thailand. The city itself contains unique tangible and intangible urban heritage attributes. Chiang Mai Old city was nominated on the "tentative list" of UNESCO in 2015 (UNESCO, 2020), however, it remains in the process of presenting to the nominating bodies for UNESCO. Chiang Mai was the capital city of Lanna Kingdom and embodies the initial ideology of Lanna culture and ways of life for current local people. Chiang Mai's extraordinary urban planning combines Lua belief and Chaiyaphum, and this reflects the respect of nature and belief that a city is a human body and was called *"Wananakorn"* or city of forest (Ongsakul et al., 2005) which represents the value of physical setting of the city.

Furthermore, one of the Lua beliefs is linked to the Doi Suthep (Suthep Mountain), which appears as the backdrop to the west side of the city. According to the Relic stupa of Buddha, the mountain is a location of Wat Phra Tard Doi Suthep (Doi Suthep temple), which is a sacred place for the people of Chiang Mai. Doi Suthep Mountain has therefore become part of the significant cultural landscape of the city with the study of Muangyai and Lieorungruang (2008, p.66) acknowledging Doi

Suthep's interpretative value as: "Doi Suthep Mountain can stimulate people to feel its importance as both a sacred mountain and a great influence and factor for the location of the city of Chiang Mai." Chiang Mai's old city displays considerable cultural landscape significance, which mixes both natural and cultural heritage (figure 2 (d)). Following the importance of urban planning to the sacred mountain belief, Chiang Mai life still reflects the socio-cultural value of "Lanna Wisdom" and embraces the local people with a "Spiritual Identity". However, figure 3 (a, b) illustrates the current situation of Chiang Mai Old City townscape. The visual disharmony appears in every streetscape of the city and disturbs the value of its city's identity. The city is losing its identity due to the lack of concern for townscape characteristics and visual impact assessment of the city.

3.1 The selection of heritage scenes in the study: Chiang Mai Old City, Thailand

These eight key heritage scenes were selected based on their connection between distinctive places in the city following the study of Phetsuriya and Heath (2021). They consist of: the Chedi Luang temple; Pra Singha temple; Three Kings monument; Tha Pare Gate square; and Chiang Mai Old City Moat.

4. Methodology

The research study has applied four methods, which consist of questionnaire; in-depth interviews; PEI (Photo Elicitation Interviews); and the Needle method. The fundamental methods of questionnaires and in-depth interviews were implemented using the PEI and Needle methods.

4.1 Questionnaires and in-depth interviews

Questionnaires are a research instrument which was invented by Sir Francis Galton in the late 18th century, with the aim of collecting information from participants (Roopa & Rani, 2012). This study designed a mixed questionnaire with in-scaled questions (Likert scale), consisting of sixteen questions related to streetscape quality. The in-depth interview is a data collection method that engages participants individually to understand their unique perspectives. It has the advantage of being able to have follow-up questions and also to provide additional information to explain the questions if participants are confused (Brounéus, 2011).

In this study the research used face-to-face interviews with open-ended questions, which involved the PEI and Needle methods.
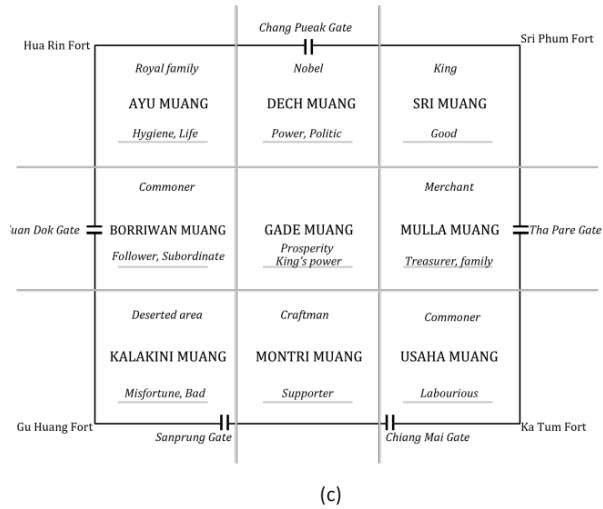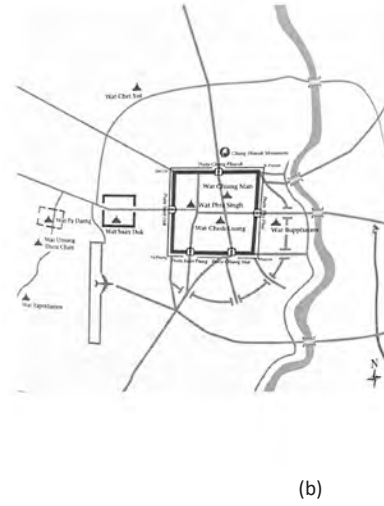
(a)

(b)

	Chang Pueak Gate	
Hua Rin Fort		Sri Phum Fort
Royal family	*Nobel*	*King*
AYU MUANG	DECH MUANG	SRI MUANG
Hygiene, Life	*Power, Politic*	*Good*
Commoner		*Merchant*
BORRIWAN MUANG	GADE MUANG	MULLA MUANG
Follower, Subordinate	*Prosperity King's power*	*Treasurer, family*
Deserted area	*Craftman*	*Commoner*
KALAKINI MUANG	MONTRI MUANG	USAHA MUANG
Misfortune, Bad	*Supporter*	*Labourious*

Suan Dok Gate / Tha Pare Gate / Gu Huang Fort / Sanprung Gate / Chiang Mai Gate / Ka Tum Fort

(c)

(d)

Figure 2 (a) Chiang Mai location on map. (Author) **(b)** Chiang Mai Old City and its relation to Vieng Suan Dok and Significant temples. (Ongsakul et al., 2005, p. 68) **(c)** "Taksa" the belief of the city as a human body which has influenced on hierarchy of space in the city (Author). **(d)** The scene of urban heritage artifact, Chiang Mai Old City moat and Suthep Mountain (Doi Suthep). (Author)

Figure 3 (a) A commercial sign on the shophouse façades at Chang Pueak gate (Phetsuriya, 2023, p.359) **(b)** A commercial sign on the shophouse façades at Tha-Pare gate square (Phetsuriya, 2023, p.359)

E001

E002

E003

E004

E005

E006

E007

E008

Figure 4 The selection of Eight scenes in the study
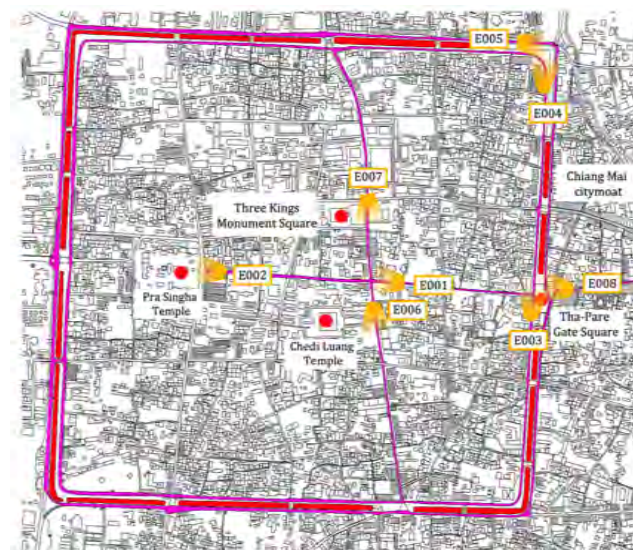
Figure 5 The key heritage scenes selected from distinctive places following the study from Phetsuriya (2023, p.288)

4.2 PEI (Photo Elicitation Interviews)

Visual tools have been used for social science research since the 1900s, to enable an understanding of multiple aspects (Heisley & Levy,1991). The use of photographs has increased in social science research applied to the investigation of social groups (Stanczak, 2004) and the use of PEI as a research tool has been significantly enhanced by two sociologists: Haper (1997) and Bank (2001). In ethnographic and social studies research, PEI has been used to invoke comments from participants, to help them express their memories, and contribute to discussions in semi-structured interviews. The structure of the PEI process in this study began with the researcher taking photographs of eight key townscape scenes which relate to distinctive places in Chiang Mai Old City following the study of Phetsuriya and Heath (2021). The pictures were modified using panoramic pictography techniques which increased the accuracy of the picture and the effective data (Shao, 2016).

4.3 Needle Method

Following the study of Shao (2016), the researchers used the needle method mixed with the PEI process to define local identity identification and assessment. Shao mentioned the original concept from Deinet (2009) to describe the identification of objects in the photograph (PEI). The method has been commonly applied in social science research. The concept of the Needle Method focuses on the relationship between participant memories

and decision-making. This involves using different coloured needles (pins) or adhesive dots on the picture to indicate places or objects which participant prefers to make significant in each case. Shao's research (2016) also mentions how this contributes to understanding the connections between social spaces from dynamic social and physical aspects in social science research. The Needle Method is suitable for evaluating the visualization of townscape by reflecting on social and cultural dynamics of a scene.

The researchers asked twenty-five respondents to mark the key elements with different colours on eight townscape scenes. These were evaluated from four aspects consisting of: the Historical Value (Yellow); the Social Activities Value (Orange); the Aesthetic value (Pink); and the Spiritual Value (Blue). An electronic device (I-Pad) was used to collect the results and this data collection method effectively enabled the visualization of the choices in the PEI and was also time efficient. However, this method has a limitation on in-depth information available for selecting the elements and it does need interviews after the labeling process to fully understand the decisions taken in making the selections.

4.4 Sample size

Sample sizes in qualitative studies are generally smaller than in quantitative research with qualitative research concentrating on the meaning and analytic process and therefore often more intensive (Mason, 2010). Bertaux (1981) suggests that the smallest number of respondents for a qualitative study is fifteen participants; however, Ritchie et al. (2003) suggested that the number for samples should "lie under fifty". Meanwhile, Morse (1994) suggests that thirty-fifty respondents are needed for interviews, however, in this study it was decided that twenty-five respondents would be recruited on site and eligible respondents who were living in Chiang Mai Old city ,were over eighteen years old

Figure 6 The example of needle method in this study (Author)

and mix of genders. The estimation of the sample size of respondents in this study was estimated to be between fifteen and fifty respondents because the respondents were recruited during the COVID-19 period, and the data collection process takes more than 40 minutes per person. The interview process asked the respondents about their perception and memory of the eight significant heritage scenes in relation to their distinctiveness and the quality of streetscapes.

This study used mixed methods corporation both quantitative and qualitative research by using questionnaires, needle method, and in-depth interviews. The questionnaire concentrated on defining the physical aspects, social aspects, and the perception aspects that contributed to the quality of the streetscape and heritage value on scenes. The Needle method mainly contributed to the participant's opinions on the socio-cultural values of these townscape scenes and the in-depth interviews focused on the expression of distinctive memories of these townscape scenes.

Figure 7 Theory and Analysis Process in this Study (Author)
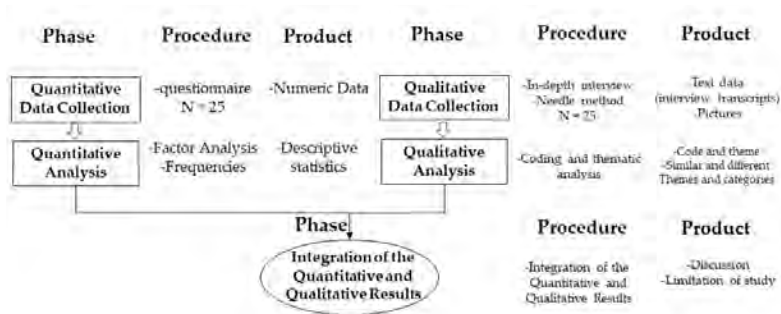
Figure 8 The diagram explains the data collection and analysis process (Author)

5. Qualitative results: *PEI, Needle Method, and in-depth interviews*

The PEI method was used to define the socio-cultural values in the significant scenes of Chiang Mai Old City' townscapes through the questions related to participant's memories of these scenes. The eight scenes were located on Radchadumnoen Road, Pra Pokklow road, Tha Pare Road, and Moon Muang Road. The PEI was used to collaborate with the Needle method to highlight the elements on the scenes.

The results revealed that the respondent's' perceptions of the socio-cultural values of the scenes from four aspects consisting of the Historical Value, Social Value, Aesthetic Value, and Spiritual Value. The respondents mostly highlighted the urban heritage artifacts on the scenes in every aspect. Secondly, the religious

	Religious Place	Urban Heritage Artifacts	General Building	Vehicle	Road	Tree
Historical Value	4	11	0	0	1	1
Social Value	2	8	2	2	4	1
Aesthetic Value	4	14	1	0	4	2
Spiritual of Place Value	4	15	0	2	2	2

Graph 1 The conclusion of socio-cultural values of the scenes (Author)

places were indicated in every scene, and even if it was obscured by the built environment the respondents could remember the temples from their memories. Roads and trees were also mentioned in all of the values whereas general buildings were only identified in the social activities value and the aesthetic value. Nevertheless, respondents highlighted the vehicles in the scenes related to the social activities value and specifically local people pointed to the "Red Truck" (unique Chiang Mai local transportation) with regards to the spiritual value of the city (Phetsuriya, 2023, p.294).

Historical Value

Twenty-five respondents drew upon their memories of the study sites from diverse perspectives. For example, respondent In-St-F-29-012 mentioned that: *"I have joined the floating lantern parade in November for the Loy-Kra-Tong festival (worship of the goddess of water in the Lunar Calendar Full Moon). It was the first time I wore authentic and priceless Lanna traditional dress and held the light lantern on the parade; such a memorable experience for me."* In-St-M-22-002 described the memory of the Songkran Festival, at Thai New Year and Lanna New Year on 13th April, saying that: *"I can remember since I was young, I spent all day around this road and walked around the Chiang Mai City Moat, enjoyed the festival with friends until now when we have any special cultural occasion. It is held at Tha-Pare Gate Square and parade goes along the road."* (Phetsuriya, 2023, p.295)

To conclude, historical value appears in urban heritage artifacts and the cultural festival events which can be described in social value as well. This defining is relevant to Landry (2002) who described that image of place can be defined from a strong culture and urban characteristics can be defined through cultural activities and 'meaning' to support the identity and value of the city (Phetsuriya & Heath 2021, p.13).

Social Value

Respondents pointed social value in urban heritage attributes and Road. The respondent In-St-F-45-015 described the community event on the road: *"I have joined in walking on the street in the old city every weekend, as it normally is held on Sundays at Radchadumnoen Road and Pra Pokklaow road. I also like to join the lantern decoration art at Three Kings Monument in November."* The participants In-St-F-31-013 and In-St-F-0-018 shared the same experience: "I used to ride a motorcycle through the narrow alleys in the old city; this made me know this place better than the main road because it had a local community hidden in those alleys and it remains their

social life if compared to the outside where all of the buildings are for tourism." Although, In-St-F-31-021 described bonding to the streets by revealing that *"I always meet friends on this street."* (Phetsuriya, 2023, p.296). Road becomes a vital element to express the social value of the streetscape. The expression of respondents can be explained to the study of Yatmo (2008) and Oranratmanee and Sachakul (2014) which mentioned streets in Southeast Asian culture create livability and encourage the growth of social and economic in a community.

Aesthetic Value

In-St-M-65-025 explained the city's cultural attractiveness: *"On the old city's streets were always assembled beautiful cultural and religious parades especially in the Songkran Festival when all of the trees on the streets were in full bloom, the magenta colour of Inthanin tree, and yellow petals in the air in the Summer of the "Lom Lang" flower or Ratchepruek (Cassia fistula)."* Meanwhile, respondent In-St-F-0-009 explained that they were *"reminded of the archaeological sites in the city, they are beautiful and perfectly blended to the city."* Also, one respondant mentioned the cultural landscape in the background of the city with In-St-M-31-014 describing how: *"I joined the walking street on Sunday at Phapokklow road around 6 pm., I could see the sun set behind the Inthakin temple with the shadow of Suthep Mountain, and the light of Suthep temple-mountain induced me to take a moment to look at it."* (Phetsuriya, 2023, p.297). Aesthetic of natural attractiveness related to Todorova et al. (2003)'s study that described the increasing of street quality can be found in the natural appreciation such as street flowers and trees that plays a vital role and influenced the preference on streetscape design and encouraging communities to keep on planting and remaining the greenery of the city.

Spiritual Value

Most respondents revealed a perception of the urban heritage attributes as spiritual value. However, it was not related to the in-depth interview that mentioned positive feelings about places and the uniqueness of Chiang Mai people's personalities. In-St-F-0-009 said: *"The city reminded me of the past when I was joining the Songkran festival; the weather was like a flame in the air, but I had been soaked by water along the way from Tha-Pare Gate to Pra Singha temple."* The participant In-St-M-45-007 mentioned that: "People in this city have a unique personality if compared to other regions; they are always polite and courteous, and I feel comfortable, and

it is safe to walk in this city." (Phetsuriya, 2023, p.297). It can be concluded that spiritual value was involved in social value and aesthetics of places. The diverse streets ability in Chiang Mai can emerge from cultural festivals and monitor social life following the mix used and flexible and multipurpose of streets (Oranratmanee & Sachakul, 2014). Moreover, the aesthetics of the urban landscape also reveal the spiritual value of the historical urban landscape that combines humanity and nature.

6. Quantitative result: *Questionnaires*

The questionnaire asked sixteen questions which were divided into ten sections to describe the quality of the streetscape of the eight scenes. The results are illustrated in graph 2 with E007 being valued highest in every question suggesting that the local people rated this most representative of the streetscape quality of Chiang Mai Old City.

Walkability, Accessibility, Connectivity, Safety, Form and Visual Quality **Walkability** *(Q1) The street is clean and well organized. (Q2) I feel satisfied walking on this street.* **Connectivity** *(Q4) The street is perfectly connected between each pavement. (Q6) The pavement/space on the street had been designed for universal users. Accessibility (Q5) I can easily access the pavement. Safety (Q3) I feel safe walking on this street. Form and Visual Quality (Q10) It has an attractive landscape. (Q12) The streetscape is green and shady (Q16) The façade design represents the historical value related to the streetscape.*

Respondents were mostly satisfied with the walkability aspect of scene E007 (Q1= 4.52, SD= 0.58) (Q2= 4.28, SD= 1.10), which is a central urban space of the city. The Three Kings Monument Square is the most satisfying place to walk and with easy access to the pavement. However, most participants felt uncomfortable in terms of walking and access to the pavement in the E002 scene (Q1= 2.36, SD= 1.46),

Pic / Question no.	E001	E002	E003	E004	E005	E006	E007	E008
Q1	3.48	2.36	3.28	3.20	4.00	3.84	4.52	4.00
SD.	1.12	1.46	1.33	1.00	0.95	0.98	0.58	0.81
Q2	3.12	2.60	3.08	2.88	3.44	3.20	4.28	3.40
SD.	1.20	1.63	1.35	1.20	1.26	1.15	1.10	1.00
Q3	3.56	2.96	3.12	3.12	3.48	3.60	4.36	3.80
SD.	1.12	1.56	1.61	1.20	1.22	1.15	0.75	0.86
Q4	2.64	2.20	2.92	2.48	3.08	2.84	4.12	3.36
SD.	1.35	1.41	1.32	1.15	1.32	1.21	0.97	1.15
Q5	3.08	2.56	3.20	3.16	2.96	3.04	4.28	3.24
SD.	1.32	1.44	1.19	1.06	1.27	1.51	0.84	1.09
Q6	2.48	1.92	2.56	2.60	2.68	2.72	4.12	2.88
SD.	1.26	1.32	1.41	1.19	1.31	1.33	1.12	1.30
Q7	1.68	1.52	1.56	1.60	1.32	1.92	2.48	1.88
SD.	1.10	1.15	1.19	1.04	1.02	1.38	1.58	1.45
Q8	1.56	1.36	1.48	1.68	1.40	1.68	2.12	1.76
SD.	1.12	1.15	1.12	1.02	1.19	1.43	1.58	1.42
Q9	2.88	2.56	2.68	2.64	2.68	2.80	3.16	2.72
SD.	1.09	1.12	1.10	1.03	1.31	1.32	1.40	1.1
Q10	2.60	2.76	3.28	2.80	3.48	3.20	4.20	3.64
SD.	1.11	1.23	1.13	1.15	1.15	1.25	1.00	1.22
Q11	3.20	3.60	3.68	3.40	3.80	3.40	4.48	4.08
SD.	1.11	1.41	1.02	0.91	0.81	1.19	0.58	0.99
Q12	2.68	2.72	2.80	3.80	3.72	3.08	4.12	2.76
SD.	1.14	1.27	1.19	1.08	1.20	1.15	1.16	1.12
Q13	3.52	3.96	3.84	3.36	3.52	3.32	4.28	3.64
SD.	1.19	0.97	1.06	1.18	1.04	1.14	0.89	0.99
Q14	3.44	4.08	4.08	3.44	3.80	3.56	4.48	4.12
SD.	1.15	1.25	0.95	0.82	0.81	1.22	0.65	1.01
Q15	2.96	3.04	3.68	3.36	3.48	3.44	4.36	3.48
SD.	1.05	1.33	1.24	0.95	1.08	1.08	0.70	1.04
Q16	2.60	2.68	3.28	2.56	3.04	2.96	4.28	3.56
SD.	1.11	1.34	1.24	1.32	1.33	1.27	1.17	1.29

(Q2= 2.60, SD= 1.63), (Q4= 2.20, SD= 1.41), (Q5= 2.56, SD= 1.44). This is the end of the Radchadumnond Road, and it leads to the significant religious place that is a nominated site in the Chiang Mai Heritage dossier. The pavement in E002 is crowded with people and vehicles and it is a significant point for tourists and local people. Most buildings along the street have been changed from private residences

Average score

| Q1 | Q2 | Q3 | Q4 | Q5 | Q6 | Q7 | Q8 | Q9 | Q10 | Q11 | Q12 | Q13 | Q14 | Q15 | Q16 |

Walkability Safety Connectivity Accessibility Connectivity Adaptivity Transparency Form Visual Quality Social Value Form Visual Quality Livability Social Value Vitality Form Visual Quality

E001   E002   E003   E004
E005   E006   E007   E008
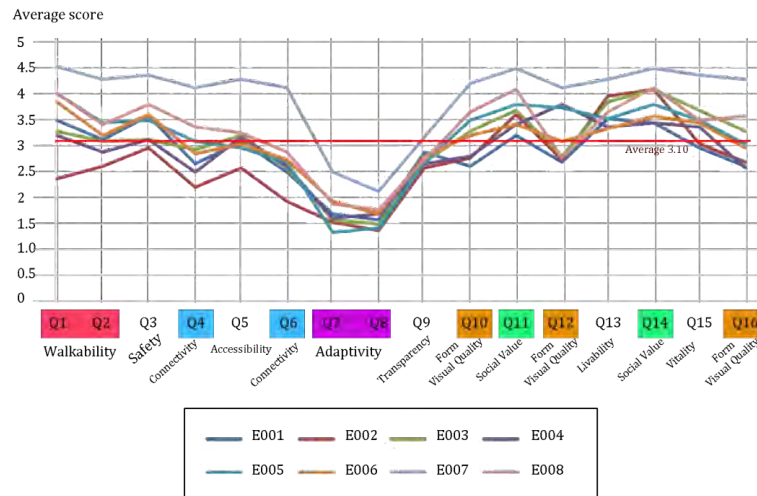
Graph 2 The conclusion of quality of streetscape (Phetsuriya, 2023, p.299)

to hotels, shops, convenience shops, spas, and education institutes. The accessibility aspect can be described following local people's perception of E007 the most, which scored (Q5 = 4.28, SD= 0.84). They identified that the pavement and public space is easier to access than E002 (Q5= 2.56, SD= 1.44). Most local people agreed that the connectivity aspect was shown in E007 (Q4 = 4.12, SD= 0.97, Q6= 4.12, SD= 1.12) and less in E002 (Q4= 2.20, SD= 1.41, Q6 = 1.92, SD= 1.32). It can be assumed that people can see the improved space and streetscape clearly in E007. People also feel safe in E007 (Q3= 4.36, SD= 0.75) and less safe in E002 (Q3 = 2.96, SD= 1.56). On the form and visual quality, respondents rated E007 with the highest score, which included the most attractive landscape (Q10 = 4.20, SD= 1), the greenest and shady streetscape (Q12= 4.12, SD= 1.16), and the façade of the scene mainly representing the historical value of the city (Q16 = 4.28, SD= 1.17). Contrastingly, E001 scored lowest in terms of the attractive landscape and green aspects (Q10= 2.60, SD= 1.11, Q12= 2.68, SD= 1.14). Moreover, E004 was rated as the lowest in terms of how the façade represented the historical value.

Transparency, Livability, Vitality and Adaptivity
Transparency *(Q9) I can easily access the shops along the street.* **Livability** *(Q13) I have a social life integrated with this street.* **Vitality** *(Q15) I feel engaged with the streetscape.* **Adaptivity** *(Q7) I think everyone can use the street for commercial purposes. (Q8) I think everyone can use the pavement for commercial purposes.*

Scene E007 again scored highest in terms of the transparency, livability, vitality, and adaptivity aspects (Q9 = 3.16, SD= 1.40, Q13= 4.28, SD= 0.89, Q15= 4.36, SD= 0.70, Q7= 2.48, SD= 1.58, Q8=2.12, SD= 1.58). However, in relation to the adaptivity aspect, respondents gave scores below the average, with respondents reacting negatively to the commercial functions and pavement in every scene. However, E002 was rated lowest (Q9= 2.56, SD= 1.12) in the transparency aspect, and E004 in terms of the lack of social life integrated to the people (Q13= 3.36, SD= 1.18). Respondents also did not feel engaged when walking in E001 (Q15= 2.96, SD= 1.05), whilst the adaptivity of the street and pavement to commercial purposes was rated the lowest for E005 (Q7= 1.32, SD= 1.02) and E002 (Q8= 1.36, SD= 1.15).

Social Value
(Q11) The streetscape reflects the value of history in Chang Mai Old City. (Q14) I consider the socio-cultural value of this street to reflect the value of Chang Mai Old City.

E007 was achieved the highest score on both questions, with the values of history (Q11= 4.48, SD= 0.58) and socio-cultural value (Q14= 4.48, SD= 0.65) both clearly demonstrated in this scene. Contrastingly, E001 recorded the lowest in terms of both the social value (Q11= 3.20, SD= 1.11) and the socio-cultural value (Q14= 3.44, SD= 1.15).

Physical	Cultural / Social		Perception / Aesthetic			Sociocultural Value			
Streetscape	Cultural Expression	Social Activities	Sight	Memories	Feeling	Historical Value	Social Value	Aesthetic Value	Spiritual Value
-Walkability Accessibility Connectivity Transparency Safety Livability Vitality Diversity Adaptivity Creativity Form and Visual quality	Religious activities and festivals	Use urban space for meeting friend and gathering for cultural activities.	- Local plant on streets Archeology sites	Positive memories to the streets and mostly related to everyday life of local people which tied with religion and cultural activities	Positive feeling on local people and the streets. Negative feeling on direction on the city.	- Urban heritage artifacts -Religion places	- Urban heritage artifacts -Religion places -Road -Vehicle -General building -Tree	- Urban heritage artifacts -Religion places -Tree	- Urban heritage artifacts -Religion places -Tree
E007	-Song Kran, -Inthakin, -Floating lantern	Community gathering for cultural activities	Inthanin flower Ratcha-pruek flower	Make merits at temples	People with a nice personality				

7. Discussion

The results revealed that most local participants agreed that scene E007 represented the archetype of Chiang Mai Old City's streetscape quality regarding the physical aspects. According to E007, streetscapes have been improved by architects who are concerned with the connection of spaces aesthetic of the place, and it is still used for cultural and religious activities of Three Kings Monument Square and the former city court, which has been changed to the local museum on the other side of the square. Furthermore, it has been improved in designing public spaces to prepare for the nomination process to UNESCO since 2015 by famous Thai architects (Prachatum, 2021). It is relevant to the study of Eliciting cultural heritage values: Landscape preferences versus representative images of the city by Ginzarly and Teller (2018), which mentioned that the most preferred urban space photo needs to be designated by a designer that represents the quality of open space. Comparatively, to the Chiang Mai locals who participated in this research, their perception indicated the strengths of scene E007 from every aspect; however, this was not stated as a nominated heritage site. It can be assumed that the participants chose the scene that mainly reflected the space's visual quality and streetscape.

Regarding the adaptivity aspect that focused on the commercial activities on streets and pavement, there was no consensus regarding the local people's opinions. Many studies have described the significance of the street as a place of commercial activity. For example, Allison et al. (2021) examined mobilizing the streets: the role of food vendors in urban life, which contrasts with the results from the adaptivity section in the research presented in this paper. Allison et al. (2021) mentioned that streets provide temporary practice toward commercial density that supports livelihood for the community. Also, Yatmo (2008) explained that in Southeast Asian culture, the street market is a regular urban phenomenon with mobility and flexibility characteristics. These outcomes contrast with the results of

this study. Even though the advantage of the commercial activities in supporting the community is a part of a livable city, the participants revealed that the commercial activities on the street disturbed the visual perception in each of the eight heritage scenes. Also, they suggested that they preferred a permanent place for commercial activity rather than temporary spaces and the inherent problems that arose. Furthermore, Oranratmanee and Sachakul (2014) study is relevant in that it mentions the significance of streets in Southeast Asia and the city's socio-economic development growth. However, the study pointed to the possible over-consumption of space and the over-proliferation of commercial activities on streets due to the higher demand, alongside a lack of awareness and control from the local authorities.

The respondents in this research can recall memories of religious festivals along the streets for each scene in the cultural expression and social activities sections. They agreed that religious festivals are a magnet for community assembly relevant to the history of Chiang Mai. They also mentioned the Three Kings Monument Square as a significant urban space for local ritual and as the gathering place for religious occasions and festivals (Ongsakul et al., 2005; Phetsuriya & Heath, 2021). Perry et al. (2020), research also highlights that festivals represent a transformative role and capability to contribute to unique cultural identities. Indeed, drawing upon the memories of local participants reveals that festivals contribute significant intangible value to the city's street scenes. The spiritual value and aesthetic values of the participants also revealed three significant elements: the flower petals, religious activities, and people's personalities.

Interestingly, Kim et al. (2021) also identify that city street trees contribute various benefits and are most accessible to citizens' perception. Significantly, trees contribute a high emotional component that stimulates positive emotions. The Inthanin flowers and Ratcha-pruek flowers (local species of trees) can positively affect people and positively represent the aesthetics of the urban visual characteristics. Regarding feelings, it is relevant to consider the Chiang Mai people's opinions on the Old City's personality. Interestingly, Kluckhohn and Mowrer (1944) study "Culture and Personality: A Conceptual Scheme" mentioned the definition of personality as an individual's "social stimulus value" based on research by May (1930). The researchers suggested that there was a difficulty with the statement and suggested that "communal personality" and "social character" described the components of personality in a biological, cultural, social, and physical environment. As such, identifying local people's personality in Chiang Mai Old City reveals the community's social character and communal personality. The most significant part of this study is the socio-cultural value, which analyses the historical, social, aesthetic, and spiritual values of the Old City. Socio-cultural value has been found chiefly in urban heritage artifacts and religious places in the city. The results related to Mason (2002, p.11) research, which explained that socio-cultural values are at the traditional core of conservation. Indeed, values are attached to an object, building, or place because they hold meaning for people or social groups due to their age, beauty, artistry, or association with a significant person or event or (otherwise) that they contribute to processes of cultural affiliation.

Conclusion

Respondents mostly felt engaged with the E007 and referred to cultural activities and festivals in cultural and social sections. It is relevant to their memories that remind the religious activities in the perception section. Moreover, the color of the local flower and local people's personalities are also attached to participants feeling. Finally, the urban heritage artifacts on every scene could reveal the city's socio-cultural value. The characteristics of this city's historical townscape have been utterly hidden in the people's memory rather than in the physicals that appeared in the sample pictures. It could be assumed that local people recognized the socio-cultural value of each streetscape scene through their personal experiences.

The research study has presented an implementation of how to define a townscape character of Chiang Mai Old City by using social science methodology. This has been informed from an architectural perspective regarding an urban and architectural study that can aid relevant policy development, community plans, infrastructure plans, a project design brief, a visual impact assessment, and place-making. Furthermore, it supports mixed-method development in social science research, consisting of questionnaires, in-depth interviews, PEI, and the Needle method.

Moreover, the suggestion for an appropriate Townscape Character Assessment Policy for Chiang Mai Old City identified by this study suggests the need for close interaction between local people, developers, academics, the Chiang Mai Heritage team, and local authorities. This level of engagement would enable appropriate and sustainable planning to carefully define the heritage in both the nominated places and the historic urban landscape, which includes significant townscape, visual, and streetscape scenes. Comparatively, the townscape character assessment methodology results are

supplemented by several other studies on the procedure identified in this paper. However, townscape character assessment also requires participation from multiple disciplines, such as geology, engineering, ecology, and agriculture. Moreover, this implementation's contribution is to propose a townscape character assessment for any historical cities with townscape visual issues or that remain in the nominating process as World Heritage sites.

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The Effect of Light Shelf and Translucent Ceiling on Daylighting in Office Building in Thailand

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Abstract

Daylight control strategies were a challenge for a high-rise building in terms of saving energy consumption. Light shelf was one of the daylight control systems which was usually horizontal or inclined surfaces, placed on the inner and/or the outer side of windows to reflect sunlight to ceiling and distribute the light deeper into the room. This study aimed to investigate the performance of daylight control strategies in office rooms using a light-self with translucent ceiling. The light shelf, which is typically horizontal or inclined, was placed on the inner or outer side of windows to reflect sunlight and distribute it deeper into the room. The study investigated the effect of type of daylight techniques which are a combination of different light shelves and translucent ceiling on daylighting performance. The illuminance level in an office room was calculated using DIALux 4.13 and was performed for working hours in Bangkok, Thailand. The simulation was performed under clear sky conditions and using real climatic data from four orientations. Five types of daylight techniques, including the existing room, were investigated in terms of illuminance level and uniformity of daylight in the office room. The CIBSE (2015) and IESNA (2011) standards indicate that offices room should have uniformity of at least 0.8 and an illuminance level of 500 lux. Thus, the objective of this research was to determine the best combination of light shelves and translucent ceilings for achieving illuminance and uniformity standards. The results showed that the external light shelf with a translucent ceiling and static louver at 90o (option 4) was the best solution for office rooms, providing average illuminance level 776 lux (above the standard) and uniformity 0.4 (nearly the standard). This conclusion suggests that a light-shelf with a translucent ceiling guides daylight deep into the room but less uniformity.

Keywords: daylight, light shelf, translucent ceiling, illuminance, uniformity

Book Review:
Climate Change 2022

Mitigation of Climate Change: Buildings
The Sixth Assessment Report of the Intergovernmental Panel on Climate Change
2042pp.

Reviewed by
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In climate change mitigation, the building sector is assessed by the Intergovernmental Panel on Climate Change's (IPCC). The Sixth Assessment Report (AR6) is a comprehensive assessment of the current state of knowledge on climate change, including the physical science basis, impacts, adaptation, and mitigation. The IPCC-AR6 emphasizes that the building sector is critical during 2020-2030 to avoid lock-in CO_2 emissions. However, readily available, and highly cost-effective actions that can be undertaken now to reduce CO_2 emissions in the building sector are identified. The sufficiency, efficiency, and renewable (SER) measures must be really designed and effectively implemented to decarbonize the building sector before 2050. The IPCC affirms that we can still secure a safe and livable future if actions are taken now.

Summary

The Intergovernmental Panel on Climate Change's (IPCC) Sixth Assessment Report (AR6) assesses literature on the scientific, technological, environmental, economic, and social aspects of mitigation of climate change. It reflects, among other factors: developments
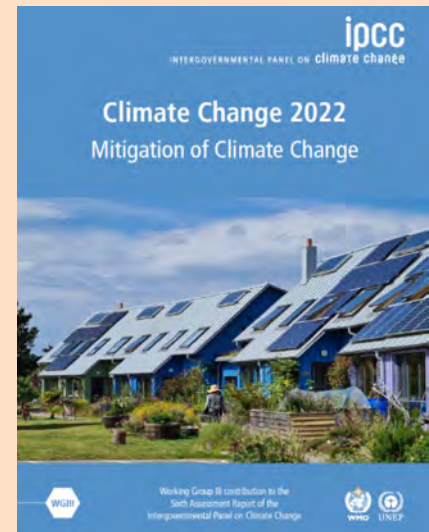
in the UN Framework Convention on Climate Change (UNFCCC) process, including the Kyoto Protocol and the Paris Agreement, and the UN 2030 Agenda for Sustainable Development including the Sustainable Development Goals (SDGs). This paper reviews the assessment in the building sector and its pathways in transition to the net zero emissions under the Paris Agreement. It is found that global decarbonization of buildings is constrained by barriers and obstacles as well as limited finance. The lack of institutional capacity and appropriate governance structures slow down the decarbonization of the building stock. The well-designed and effectively implemented mitigation actions have significant potential for achieving the net zero emissions and the UN SDGs.

Keywords: Climate change, IPCC, net zero emissions, sufficiency efficiency & renewable, buildings

New Developments in CO2 Emission Trends and Drivers

Over the period 1990–2019, global CO2 emissions from the building sector increased by 50%, its final energy demand grew by 38% and its final electricity demand increased by 161%. In 2019, global final energy demand in the building sector reached 128.8 EJ, accounting for 31% of global final energy demand while global electricity demand in the building sector was slightly above 43 EJ and accounted for 18% of global electricity demand. Residential buildings consumed 70% of global final energy demand from buildings. In the same year, global greenhouse gas (GHG) emissions from buildings were estimated at 12 $GtCO_{2-eq}$, equivalent to 21% of global GHG emissions, out of which 57% were indirect emissions from offsite generation of electricity and heat, 24% direct emissions produced onsite and 18% were embodied emissions from the use of cement and steel. More than 95% of GHG emissions from buildings were CO_2 emissions. The share of CO_2 emissions from buildings in global emissions would increase from 21% in 2019 to 31% in 2050.

In the Intergovernmental Panel on Climate Change's Sixth Assessment Report (IPCC-AR6), drivers of GHG emissions in buildings were assessed using the SER (Sufficiency, Efficiency, Renewables) framework. (see Figure 1) Sufficiency measures deal with avoiding energy demand and materials needed over the buildings' lifecycle to reduce energy consumption and GHG emissions. Then, the emissions are decomposed into four driving factors: population (*Pop*), Sufficiency (*Suff*), Efficiency (*Eff*) and Renewables (*Ren*). (see Equation 1)

$$CO2_{total}^{k} = Pop \times \frac{m^2}{Pop} \times \frac{EJ}{m^2} \times \frac{Mt_{CO2}}{EJ} = Pop \times Suff \times Eff \times Ren \qquad \text{Eq.(1)}$$

The superscript k stands for the case, defined by the period and scenario of the emissions used by the International Energy Agency (IEA). The zero carbon buildings could be achieved when the remaining global carbon budget, and its target for distributional equity, sets the upper limit, while requirements for living standards define the minimum level of sufficiency. The concept of sufficiency introduced to buildings includes the optimization of building operation, repurposing unused buildings, prioritizing multi-family homes over single-family buildings, and adjusting the size of residential buildings by downsizing dwellings. (see Figure 2) The crucial benefit of sufficiency is described by providing an opportunity to avoid lock-in emissions. In general, building services include shelter, nutrition, sanitation, thermal, visual, and acoustic comfort, communications, illumination etc. When designing building services, density, compacity, building typologies, bioclimatic design, multi-function space, circular materials, thermal mass, shared space, are the sufficiency actions worldwide employed in leading cities.
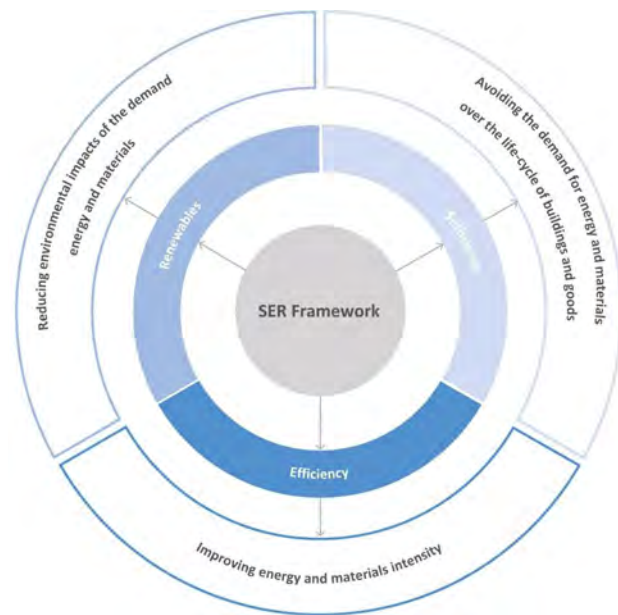
Figure 1 SER framework adopted in the building sector.
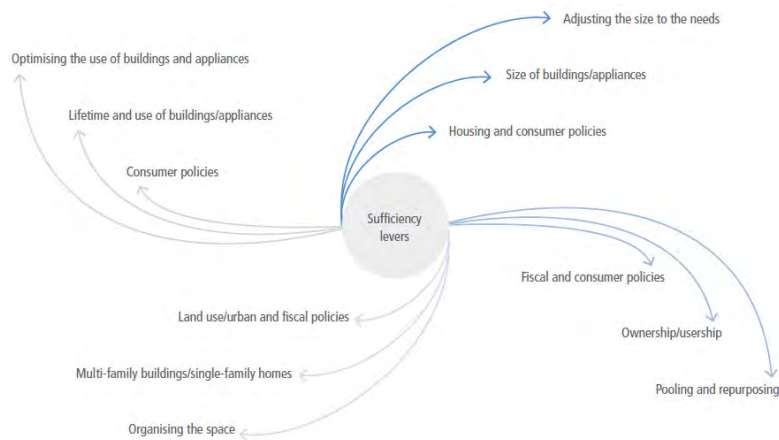
Figure 2 Sufficiency interventions and policies in the building sector.
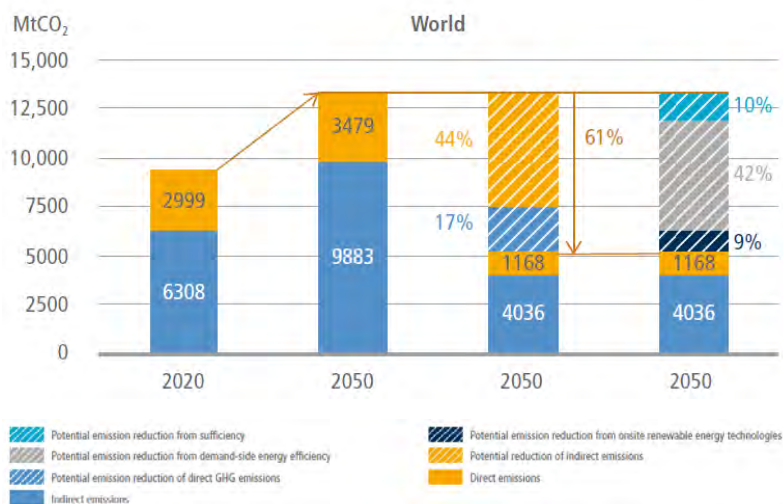
Figure 3 Global estimates of GHG emissions in the building sector in 2020 and 2050.

Efficiency is the short-term marginal technological improvements in operation of buildings. Historical improvements in efficiency have been matched by growth in floor area per capita, particularly in developed countries, reduces the dependence of climate mitigation on technological solutions.

The IPCC-AR6 concludes that the main drivers of emissions in the building sector in the future at the global level include (i) population growth, (ii) increase in per capita floor area, (iii) the inefficiency of the newly constructed buildings, and the low renovation rates and ambition level, (iv) the increase in use, number and size of appliances and equipment, especially information and communication technology (ICT) and cooling, driven by the growing welfare/income, and (v) the continued reliance on fossil fuel-based electricity generation and slow decarbonization of primary energy supply in countries.

GHG Emissions and Mitigation Potentials in the Building Sector

The IPCC-AR6 reviews worldwide bottom-up studies in the building sector. Results show a mitigation potential up to 85% in Europe and North America and up to 45% in Australia, Japan, and New Zealand, compared to the baselines by 2050. In developing countries, bottom-up studies estimate the potential of up to 40–80% in 2050, as compared to sharply growing baselines. The aggregated energy demand from all bottom-up studies translates into a global mitigation potential by 2050 of at least 8.2 $GtCO_2$, which is equivalent to 61% of the baseline scenario. (see Figure 3).

Figure 4a shows scenarios of global energy demand by end-use types and Figure 4b shows scenarios of regional energy demand by end-use types under the two international energy agency (IEA) scenarios (sustainable development, and net zero emissions), Integrated Model to Assess the Global Environment (IMAGE) Lifestyle-Renewable scenario and Resource

a)

Historical scenarios

Energy demand per end-use (EJ yr⁻¹)

Categories along x-axis: Historical (1990, 2000, 2010, 2019); 2019 Current policy scenario (2020, 2030, 2040, 2050); IEA Sustainable and Development Scenario IEA-WEO 2020 (2020, 2030, 2040, 2050); IEA Net-zero Emissions Scenario IEA-WEO 2020 (2020, 2030, 2040, 2050); IMAGE Lifestyle and Renewable scenario (2020, 2030, 2040, 2050); LED Scenario (2020, 2030, 2040, 2050)

b)

Historical scenarios

Final energy demand per fuel (%) — Total (EJ yr⁻¹)

Panels: Africa; Australia, Japan and New Zealand; Eastern Asia; Europe and Eurasia; Latin America and Caribbean; Middle East; North America; South East Asia and Pacific; Southern Asia

x-axis categories: Historical; 2019 Current policy scenario; 2020 Sustainable and Development Scenario; IMAGE Lifestyle and Renewable scenario; RECC LED and 2°C policy

Legend:
- Coal
- Oil
- Gas
- Electricity
- Commercial heat
- Bioenergy
- Solar thermal
- Geothermal
- Traditional use of biomass
- Hydrogen
- Total energy demand (secondary y axis)

Figure 4 End-use energy demand: historical based on IEA data and future emissions based on two IEA scenarios (sustainable development, and net zero emissions), IMAGE Lifestyle-Renewable scenario and Resource Efficiency and Climate Change-Low Energy Demand scenario (RECC-LED).
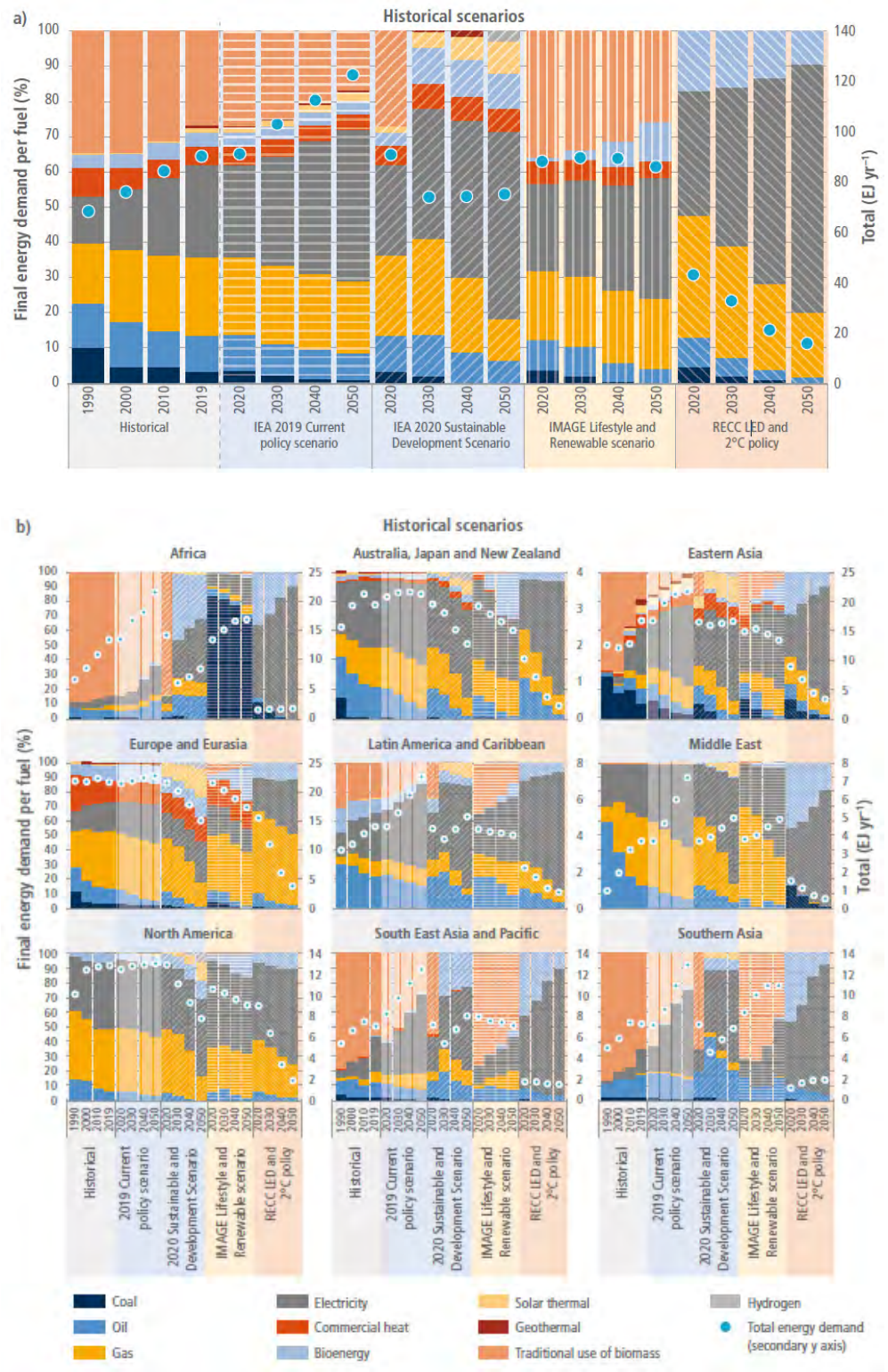
Figure 5 Shares of final energy demand by fuel types: historical based on IEA data and future emissions based on two IEA scenarios (sustainable development, and net zero emissions), IMAGE Lifestyle-Renewable scenario and Resource Efficiency and Climate Change-Low Energy Demand scenario (RECC-LED).
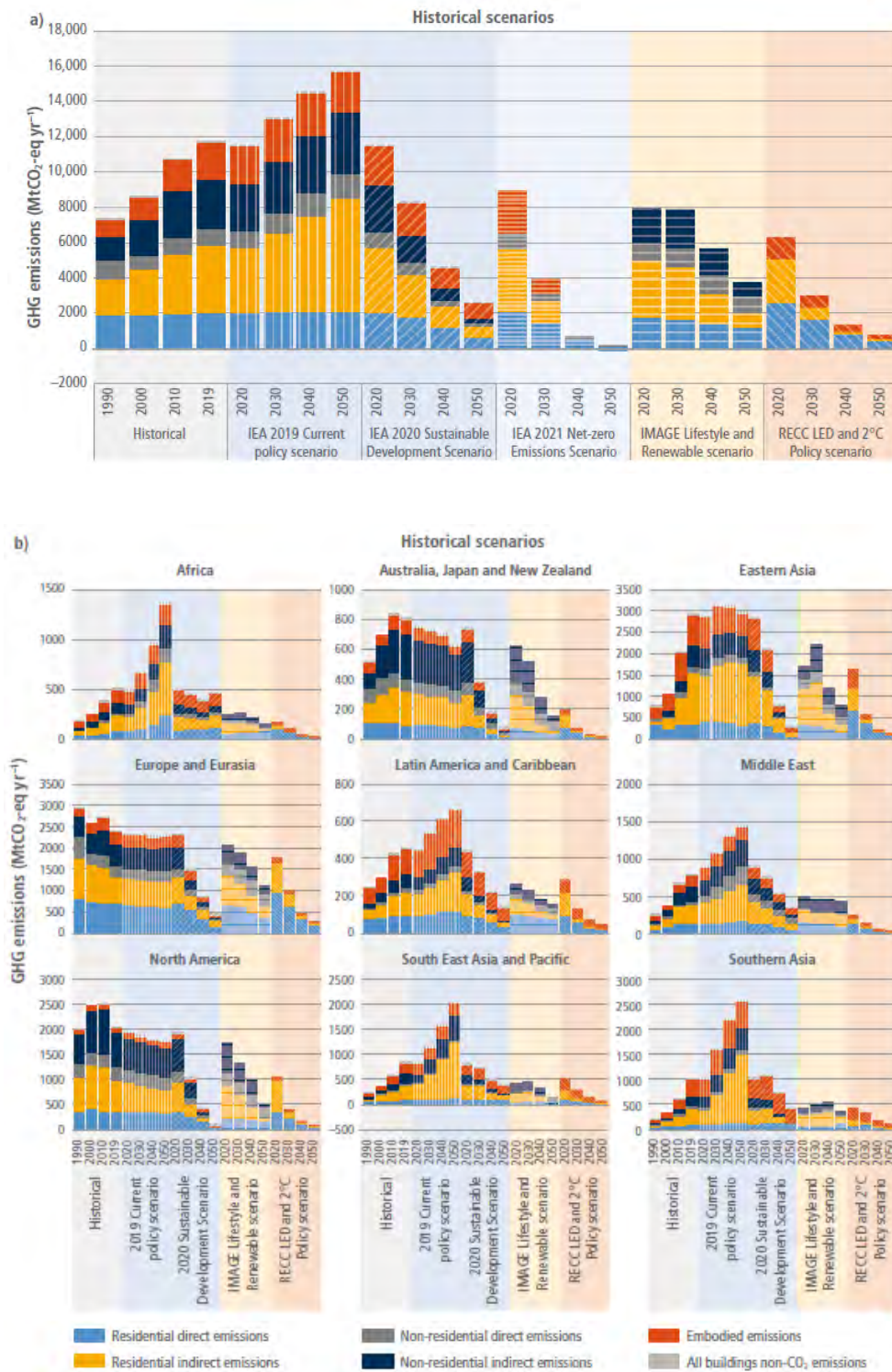
Figure 6 Global and regional building GHG emissions: historical based on IEA data and future emissions based on two IEA scenarios (sustainable development, and net zero emissions), IMAGE Lifestyle-Renewable scenario and Resource Efficiency and Climate Change-Low Energy Demand scenario (RECC-LED).

Efficiency and Climate Change-Low Energy Demand scenario (RECC-LED). The end-use devices are classified by activities. They are space heating, water heating, space cooling, cooking, lighting, small appliances, cleaning appliances, and refrigeration. Different end-use devices need different fuels such as coal, oil, gas, electricity, bioenergy, and solar etc. The assessment of end-use activities results in final energy demand by fuel types. Figure 5s shows scenarios of shares of global final energy demand by fuel types and Figure 5b shows scenarios of regional shares of final energy demand by fuel types.

Figure 6s shows global GHG emissions from buildings and Figure 6 shows regional GHG emissions from buildings under the two IEA scenarios, IMAGE Lifestyle-Renewable scenario and RECC-LED scenario. In addition to the four decarbonization scenarios, the 2019 current policy scenario is also assessed and presented. (see Figures 4, 5, and 6)

These bottom-up studies reveal that zero carbon buildings are possible under implementation of policy packages in sufficiency, efficiency and renewable (SER) framework. It is noted that these mitigation potentials are based on actions taken during 2020-2030. Any delays in the implementation of measures in the building sector result in lock-in emissions in the midcentury.

Mitigation Costs in the Building Sector

The IPCC-AR6 reveals the mitigation costs in the building sector. By 2050, the construction of high-performance buildings will become a business-as-usual (BAU) technology with costs below USD20 per tCO_2 in developed countries and below USD100 per tCO_2 in developing countries. The building sector is critical between 2020 and 2030 in accelerating the learning of knowledge and skills to reduce the costs and remove constraints for achieving high efficiency buildings. The deep decarbonization of the building sector is constrained by multiple barriers and obstacles as well as limited flow of finance. Global investment in the decarbonization of buildings was estimated at USD164 billion in 2020, which is not enough to close the investment gap.

CO$_2$ Mitigation Options and Strategies Towards Zero Carbon Buildings

The strategies to achieve zero carbon buildings are highlighted. Policy packages based on the SER (Sufficiency, Efficiency, Renewables) framework is suggested to grasp the full mitigation potential of the global building stock.

(see Figure 7) It concludes that low ambitious policies will lock buildings in carbon for decades. Building Energy Codes (BECs) measure is the key regulatory instrument to reduce emissions from both new and existing buildings. The advanced measures that contribute to fostering decarbonized buildings include market-based instruments such as carbon taxes with recycling of the revenues and personal or building carbon allowances.

It also highlights embodied energy and embodied emissions. Buildings are recognized as built following five building frames: concrete, wood, masonry, steel, and composite frames. The embodied carbon can be calculated using the lifecycle assessment (LCA) methodology with different boundaries. (see Figure 8) Steel represents the materials with higher embodied energy, and higher embodied carbon. However, due to different boundaries and assumptions used in LCA such embodied emissions from different studies could not be directly compared and concluded.

The IPCC-AR6 concludes that the bottom-up studies, nearly zero energy (NZE) buildings or low-energy buildings are possible in the relevant climate zones, in Europe and north America (See Figure 9). NZE buildings are possible for new and retrofitted buildings, but different envelope design and advanced technologies need to be employed on the site specifically, depending on the climate and the building shape and orientation.

Links to Adaptation and Sustainable Development

Finally, mitigation of climate change in the building sector shows links to adaptation and sustainable development goals. Actions are needed to adapt buildings to future climate. The expected heatwaves will inevitably increase cooling needs to limit the health impacts of climate change. Global warming above 1.5 degrees Celsius drastically impacts not only cooling and heating needs but also the performance, durability, and safety of buildings. Adaptation measures in the building sector to cope with climate change may increase the energy demand and low carbon materials leading to increasing GHG emissions. Sufficiency measures such as bioclimatic design of buildings, which consider the expected future climate, and includes natural ventilation, white walls, and nature-based solutions such as green roofs will decrease the demand for cooling. Shared cooled spaces with highly efficient cooling solutions are among the mitigation strategies which can limit the effect of the expected heatwaves on people's health. It is concluded that sufficiency, efficiency, and renewable energy (SER) can be designed to reduce buildings' vulnerability to climate change impacts.
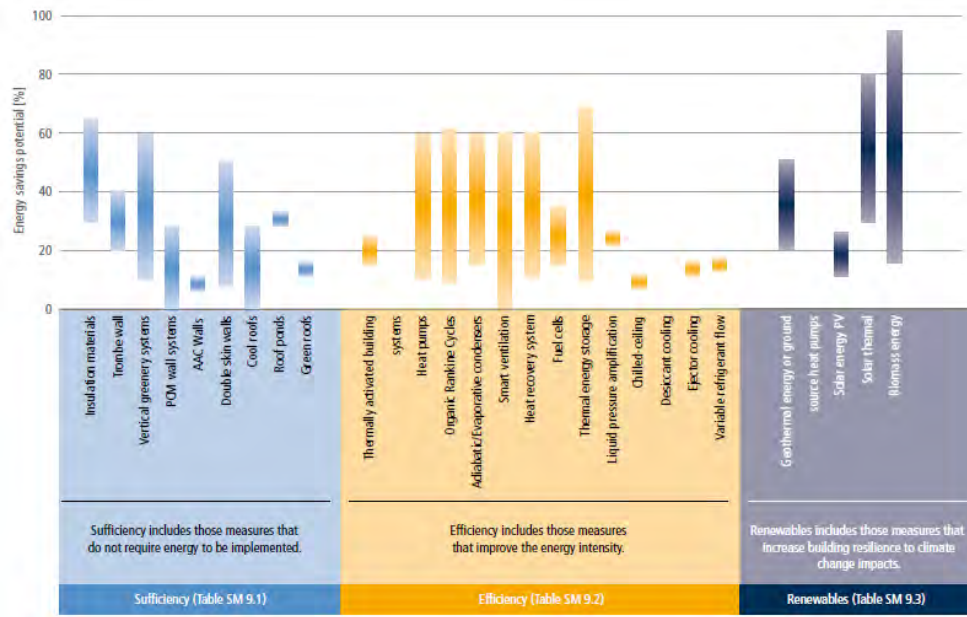
Figure 7 Energy savings potential of technology strategies for climate change mitigation in buildings.
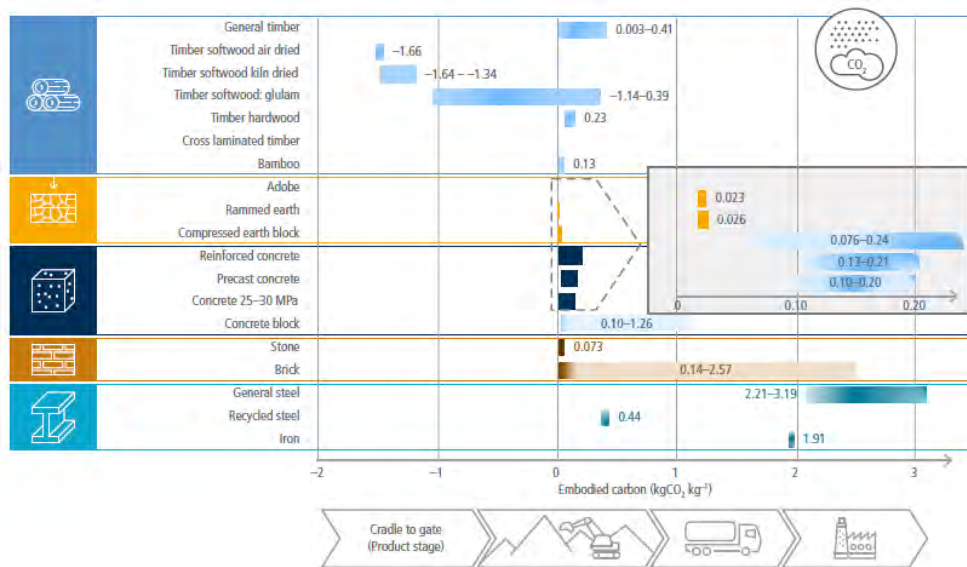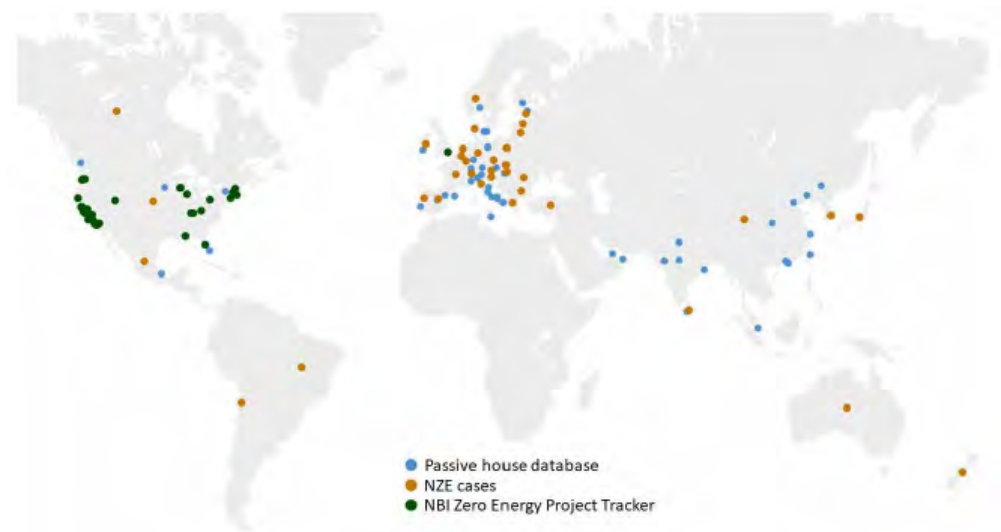

Figure 8 Embodied carbon in building materials

Figure 9 Regional distribution of documented low-energy buildings

These well-designed and effectively implemented mitigation actions in the buildings sector have significant potential for achieving the United Nations Sustainable Development Goals.

Conclusions

Low ambitious policies will lock-in carbon emissions from the built environment for decades. Existing buildings, if retrofitted, and buildings yet to be built, are projected to approach net zero emissions in 2050 if sufficiency, efficiency, and renewable (SER) measures are effectively implemented and barriers to decarbonization are removed.

The 2020-2030 decade is critical for accelerating knowledge, building the technical and institutional capacity, setting the appropriate governance structures, ensuring the flow of finance, and developing the skills needed to fully capture the mitigation potential of buildings. In addition to SER, several studies show that demand-side measures can reduce global GHG emissions in end-use sectors by 40-70% by 2050 compared to baseline scenarios.

Reference

Intergovernmental Panel on Climate Change. (2022). *Climate change 2022 Mitigation of climate change* (Working group III contribution to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change). https://www.ipcc.ch/report/ar6/wg3/downloads/report/IPCC_AR6_WGIII_FullReport.pdf

1. Introduction

Daylighting in high-rise buildings is challenging due to the lack of standard requirements for illuminance, especially in office spaces. Daylight was revealed by many studies that it brings comfortable into indoor environment, provide a great chance for energy saving in building, decrease HVAC (Heating, Ventilation, Air-Conditioner) cost, protect user in building from eyestrain and reduce stress (Burmaka et al., 2020). Moreover, the human body synthesizes vitamin D from sunlight, therefore having access to daylight is also important for overall health and wellbeing (Wacker & Holick, 2013). The system to control daylight are light well, atrium, clear story, light shelf, roof monitor, external reflector, reflective louvers, and more (Peter Tregenza, 2011). Light shelves are control daylighting techniques that reflect sunlight to the ceiling, increasing daylighting and reducing heat (Mesloub et al., 2020). Thus, the light shelf provides uniform of light, increases daylighting to presentation in space and shades un-desirable heat from direct sunlight (Kontadakis et al., 2017). As the literature review of case study in Thailand, double cure light shelf can increase illuminance but low uniformity (Sok, 2018) while in Italy, light shelf can increase daylight illuminance back of the room (Berardi & Anaraki, 2015). In USA, Japan, and Korea, curve light shelf improve indoor uniformity (Lee et al., 2019). Also, in Malaysia, light shelf with horizontal light pipe system increases illuminance at the deep of the room (Sern et al., 2022). Moreover, in Poland, light shelf with translucent ceiling provides daylight going deep to the room, improves uniformity which bring a comfortable, and WELL standard to the employee (Brzezicki, 2021). As mentioned, not a few authors have researched the light shelf in Thailand. Moreover, a new method, light shelf with translucent ceiling, hasn't been inspected in Thailand yet, while it seems to be successful in Poland by author (Brzezicki, 2021).

From above reason, this research will explore the effect a light shelf with a drop-light translucent ceiling in an office building on daylighting performance with a real data climate in Bangkok. Five types of daylight techniques were explored in terms of illuminance level and uniformity of daylight in the office room in clear sky condition. The computer software DIALux 4.13 was used to simulate the illuminance and uniformity compared to standard daylighting requirements. The results of this study could serve as design guidelines for daylighting in office rooms and other buildings with similar characteristics such as their openings, room dimension and finishing, and furniture arrangement.

2. Material and methods

2.1 Recommend illuminance and uniformity level for office room

The office space is usually designed with the illuminance value of 300-500 lux. However, the modern technology office building with the computer and electronic equipment, the illuminance level increases from 300 lux to 500 lux (CIBSE, 2015 ; Issarasak, 2020). Moreover, according to CIBSE, minimum uniformity should not be less than 0.8. Therefore, the study used 500 lux as illuminance standard and 0.8 as uniformity standard. And if there are many options that pass the illuminance standard, the study will use the highest uniformity as a criterion for the best option.

Table 1 Recommended light level from CIBSE (2015) and IESNA (2011)

Areas	Recommended Lux Levels	
	CIBSE	IESNA
General	500	500

2.2 Characteristics of office room

The characteristic of the investigated office room is represented as a normal type office room located in Bangkok, Thailand. The office room has a size of 6 meters wide x 12 meters long and 4 meters high. This room has a glass façade made of transparent glass divided into parts. The bottom part is a window which its geometry is 9.6 meters long and 2 meters high and is located 0.85 meters above the floor level. The upper part has size 9.6 meters long and 1 meter high, located 3 meters above floor level. This room also has reflectance on wall of 80%, floor of 30%, and celling of 100% (represents a translucent ceiling). The reason of this because this is a characteristic of most office room in Thailand.

2.3 Simulation method

This research utilized Dialux 4.13, a public domain program used by interior and exterior designers worldwide, to simulate indoor and outdoor illumination (Ciampi et al., 2015). Sketchup 2022 was used to design office room models with different light shelf characteristics. Five types of daylight techniques were explored: option 1 represents a base case (a glass façade without installing light shelf); option 2 is an office room with external light shelf with translucent ceiling; option 3 is an office room with curve external light shelf inclined 10o with translucent ceiling; option 4 is an office room with external light shelf with translucent ceiling and static

louver at 90°; and option 5 is an office room with curve external light shelf inclined 10° with translucent ceiling and static louver at 90°. Four orientations (east, west, south, and north) were investigated for each option. Three days were simulated, including the equinox, summer solstice, and winter solstice. The annual average illuminance was compared to the standard illuminance in office 500 lux. If multiple options provided the best results for the illuminance levels (above 500lux), the uniformity result was considered to find the best option.

2.4 Office room geometry for simulation

The investigated office room in this study chose one office space and considered only staff working area, which has a width of 6 m., a length of 12 m., and a height of 4 m. as an investigated room. The layout of the room is presented below:
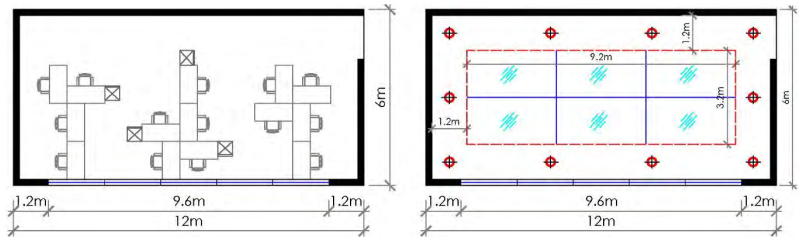
Figure 1. Layout plan and celling plan of the office room

Table 2 Glass geometry

	Type	Size	Thickness	Transmission
Glass facade	Transparent glass	2m x 9.6m	10 mm	100%
Glass ceiling	Translucent glass	9.2m x 3.2m	8 mm	100%

Figure 2. Staff working area room geometry
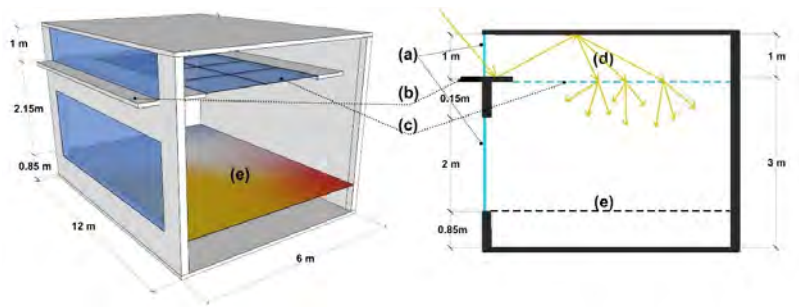
According to the CIBSE recommendation, room reflectance should be considered as follows: walls have reflectance of 80%, floors have reflectance of 30%, and ceilings have reflectance of 80%. However, this investigated office room chooses ceilings reflectance of 100% which represents a translucent ceiling.

This room geometry characteristics:
(a) transparent glass as the glass façade and clearest story window
(b) a light shelf
(c) a transparent ceiling
(d) a daylight distribution plenum and
(e) a working plan as shown in Figure 2.

Following the literature review, five options was created by two independent variables, which are 1) type of external light shelf (the investigated light shelfs was derived from those tested in previous studies) (Brzezicki, 2021; Sok, 2018; Lee et al., 2019) and 2) type of ceiling (opaque or translucent ceiling) for testing as shown in Table 2 below:

3. Results and discussion

3.1 Average annual illuminance and uniformity level in south orientation

Figure 2 shows the average annual illuminance for each option, including the base case (option 1), in the south orientation. The result reveals that illuminances from all options are higher than the office illuminance standard, 500 lux. For the base case, option 1 seems to affect the highest illuminance with a result of 2,017 lux, while options 4 has the lowest illuminance result, which are equal to 684 lux. Therefore, to find the best option for this south orientation, uniformity results need to be considered.
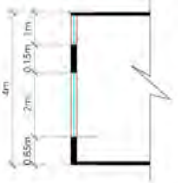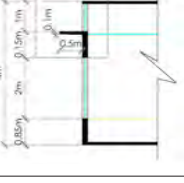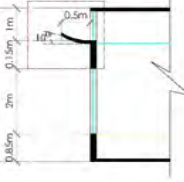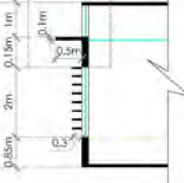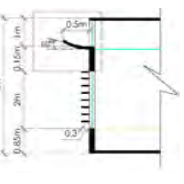
Description	3D View	2D View
Option1: Existing room with glass façade		
Option 2: External light shelf with translucent ceiling		
Option 3: Curve external light shelf inclined 10° with translucent ceiling		
Option 4: External light shelf with translucent ceiling and static louver at 90°		
Option 5: Curve external light shelf inclined 10o with translucent ceiling and static louver at 90°		
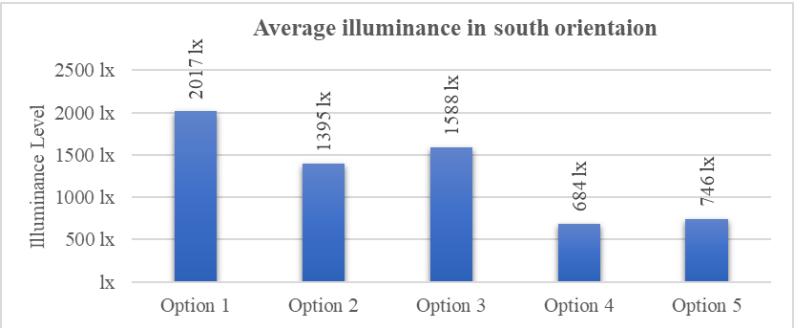
Figure 3 Average annual illuminance for all options in south orientation

Average uniformity in south orientaion

Uniformity Level

- 0.151 — Option 1
- 0.202 — Option 2
- 0.191 — Option 3
- 0.271 — Option 4
- 0.266 — Option 5
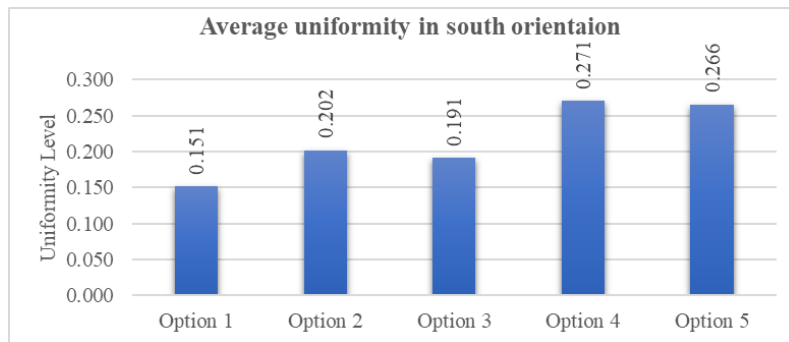
Figure 4 Average annual uniformity for all options in south orientation

Average illuminance in west orientaion

Illuminance Level

- 3462 lx — Option 1
- 2583 lx — Option 2
- 2963 lx — Option 3
- 1174 lx — Option 4
- 1299 lx — Option 5
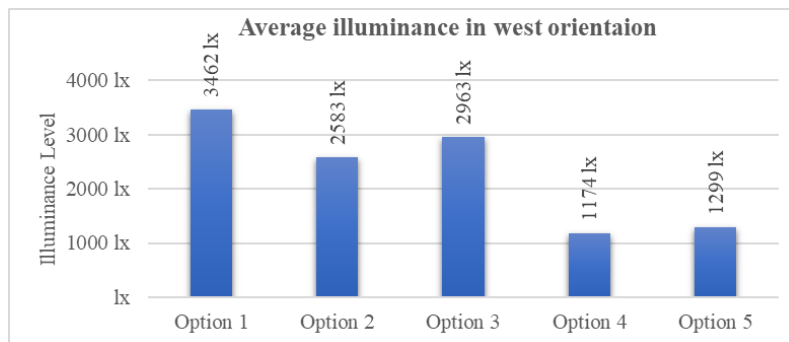
Figure 5 Average annual illuminance for all options in west orientation

Average uniformity west orientaion

Uniformity Level

- 0.161 — Option 1
- 0.198 — Option 2
- 0.187 — Option 3
- 0.250 — Option 4
- 0.246 — Option 5
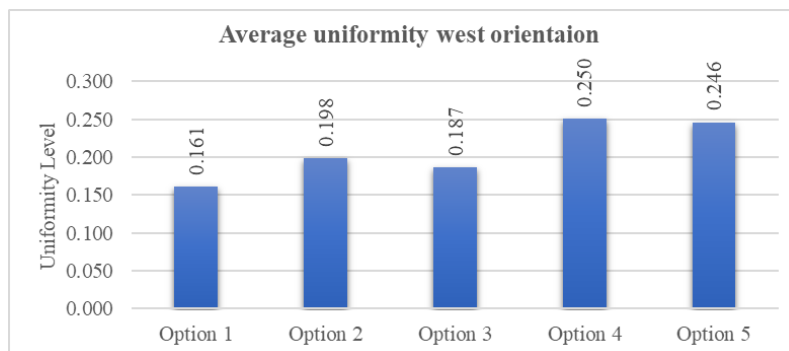
Figure 6 Average annual uniformity for all options in west orientation

Figure 3 illustrates the average annual uniformity for each option in the south orientation. The result shows that for the base option (option 1) without an installed light shelf, the result was very low, 0.151. After the installation of a light shelf with a translucent ceiling, the result in uniformity increased. Compared to other options, option 4 brings the best uniformity with the result equal to 0.271. As mentioned above, all options have illuminance result pass through the illuminance office standard (500 lux). Uniformity result would be a criterion to conclude the best option. Thus, option 4 is the best option in this orientation.

3.2 Average annual illuminance and uniformity level in west orientation

Figure 4 shows the average annual illuminance for all options in west orientation. Result reveals that all options have illuminance result pass through the standard. Option 1 (without installing a light shelf) has the highest illuminance result of 3,462 lux. After installation of the light shelf method, the results reveal that options 4 comes up with the lowest results equal, 1,174 lux. The reason might be because there are static louvers in option 4 underside the light shelf members Thus, they would protect against sunlight to entering the room.

Figure 5 shows the average annual uniformity of all variables in the west orientation. Option 1 is still the option that has the lowest result of uniformity over 0.161. Notice that on option 4, we can assume that this option has the best result of uniformity over 0.250, which is a better result compared to the other 5 options. It could be concluded that option 4 is the best option in this orientation.

3.3 Average annual illuminance and uniformity level in east orientation

Figure 6 summarizes the average annual illuminance in east orientation for all options. Result reveals that all options have

the highest illuminance over the standard (the highest value is 2,546 lux (option 1) and the lowest value is 793 lux (option 4).

Since all options have the result of illuminance pass through the illuminance office standard (500 lux) so uniformity result will show which option would be the best in this orientation. Figure 7 shows the average uniformity for all options in east orientation. The result shows that all options have uniformity result under 0.3. Option 1, the existing room, has a uniformity result equal to 0.172. However, option 4 brings the best result of uniformity, equal to 0.292. It could be concluded that option 4 is the best option in this orientation.

3.4 Average annual illuminance and uniformity level in north orientation

Figure 8 displays average illuminance in north orientation for all options. Compared to the standard illuminance in an office room (500 lux), option 1, 2 and 3 have the illuminance result achieved the standard while option 4 and 5 are lower than the standard.

Average uniformity results is still the criteria to consider which option is the best in this orientation. Figure 9 shows the average annual uniformity in the north orientation. Only option 4, an external light shelf with translucent ceiling and static louver can increase the amount of uniformity which achieve a best result than other options (equal 0.322). Even though option 4 cannot achieve the illuminance standard (500 lux), the result is not much different. Moreover, this option brings a better result uniformity, so this option is still the best option for this north orientation.

4. Conclusion and discussion

In conclusion, the results revealed that option without install any light shelf (option 1) gets the highest illuminance and less uniformity. After installation of light shelf and translucent ceiling method, the results in west, south, east, and north
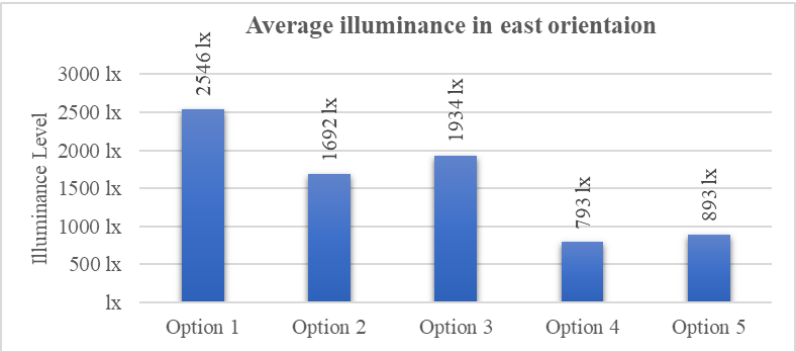
Figure 7 Average annual illuminance for all options in east orientation
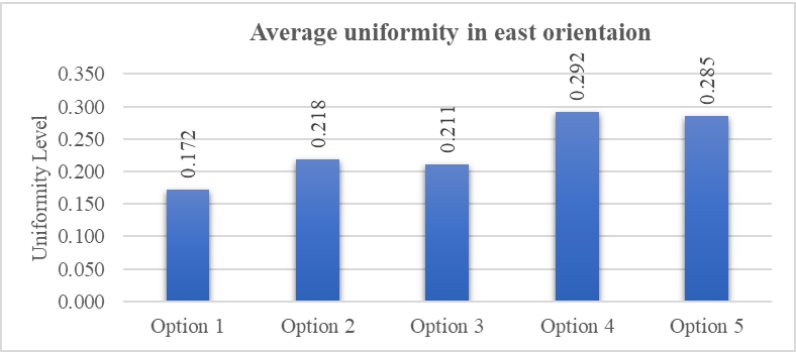
Figure 8 Average annual uniformity for all options in east orientation
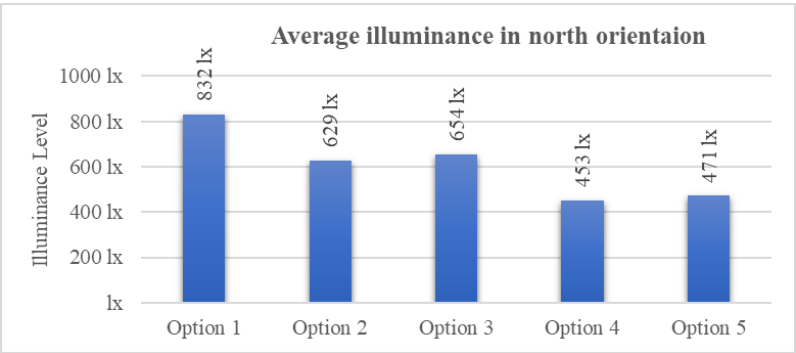
Figure 9 Average annual illuminance for all options in north orientation
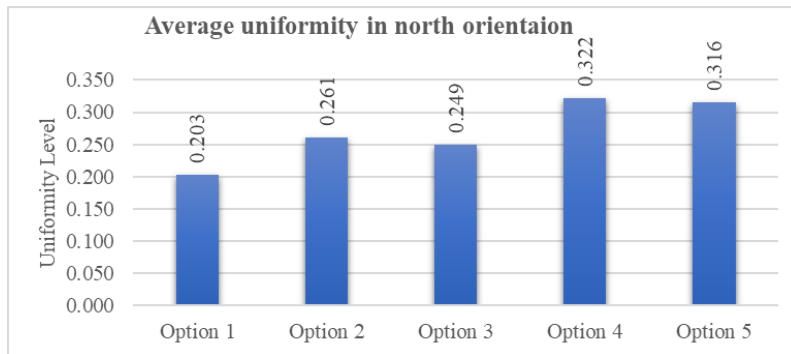
Figure 10 Average annual uniformity for all options in north orientation
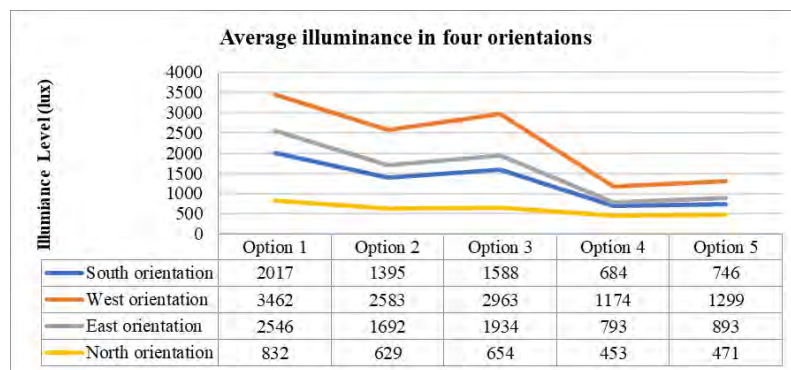
Figure 11 Average illuminance in four orientations
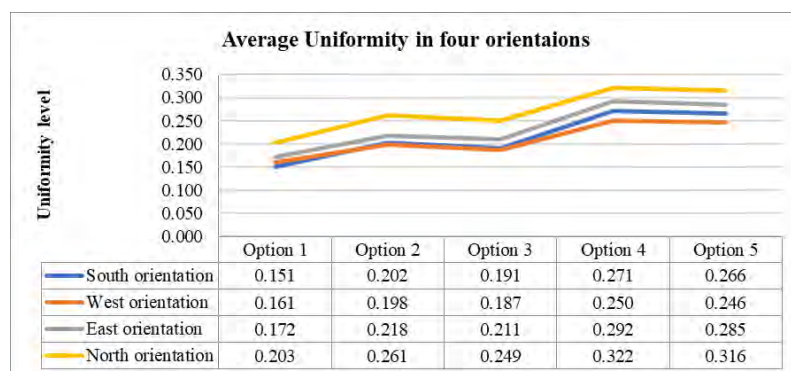
Figure 12 Average uniformity in four orientations

orientation showed that illuminance of all options pass through the standard of 500 lux. It also shows that option 1 gets the highest result and option 4 has the lowest results.

Although the uniformity value of the option 4 still do not reach the standard yet (0.8), the uniformity of this option 4 has a better result than the other options (over 0.3). The finding of this study, thus, yielded the conclusion that option 4 (an external light shelf with translucent ceiling and static louver 90o) is the best option for all orientations. This option has a better result than other options and can bring a good result illuminance and uniformity.

It should be stated that the option 4 is the best solution for this study, where there are static louvers underside the light shelf. Thus, the illuminance nearby the window is not very high. In the practical use of the office room, there should be an installation of artificial lighting at the back of the room to improve the uniformity. Regarding all orientations, Figures 11 and 12 show the average illuminance and uniformity for all options in four orientations. On the west orientation, this room gets a lot more direct sunlight spread into the room than other orientations, but less uniformity. On the contrary, in the north orientation, all options bring the lowest illuminance result, but they provide a better uniformity result than other orientations.

The result of this study correlated to other previous studies (Brzezicki, 2021), which has shown that the combination between external light shelf and translucent ceiling can give a better performance in daylighting in an office room than that without light shelf and having the opaque ceiling. However, the result of this study is contrast to some previous studies in Thailand, which has shown that curve light shelf can give a better daylighting performance than the flat one (Sok, 2018). The reason might be due to the fact that the previous study investigated the

daylighting performance in different context (classroom) and used an opaque ceiling. Therefore, this condition give rise to the lower uniformity result than our study (translucent ceiling may diffuse daylight evenly into the office room space).

To sum up, from the finding of this study and literature review (Brzezicki, 2021; Sok, 2018), external flat light shelf with translucent ceiling design in office room (a size of 72 m^2 and 100% transmission on glass façade and glass ceiling located in Thailand) can provide a good daylighting but less uniformity. Thus, for practical use, this method should combine with designed artificial lighting to increase the uniformity.

5. Limitation and Suggestion for Further study

Due to the limitation of time and suggestion of further study as follows:

Firstly, the result shows a better option for daylighting in an office room in Thailand, but illuminance still much higher than the standard (500 lux). There are two possible reasons, which are 1) glass transmission of ceiling and 2) size of the translucent ceiling. Therefore, to make a better daylight illuminance level in the office room, the next study should be investigate the effect of a decrease in glass transmission façade (from 100% to 80%, 60%, 40%, 20%). Moreover, the next study could be an investigation of the effect of a decrease in size of the translucent ceiling on daylighting level.

Secondly, due to time limitation, this study explored the effect on daylighting in a clear sky only. Thus, the next study would be investigate daylighting performance in other sky conditions.

Lastly, according to (Wolska & Sawicki, 2020) , since the illuminance nearby the window would be glaring, there should be further studies to investigate how to improve the glaring effect from the finding of this study.

6. Conflict of Interest

7. Acknowledgements

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