How Far People Walk During Lunchtime: Comparing Actual and Perceived Walking Distances in the Central Business District of Bangkok, Thailand

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ABSTRACT

Walking has long been considered a significant factor in wellness. Previous studies have indicated 400-500 meters as a standard of the "acceptable walking distance" as compared to driving or other forms of transportation. However, "acceptable walking distance" and a "distance that one chooses to walk" are two different matters. More importantly, the distance people *perceive* for a trip can be one of the deciding factors in determining whether they are willing to walk, decide not to walk, or shift to other transportation modes. This research aims to define the optimal walking distances of office workers by measuring the discrepancy between their estimated and actual walking distances in the Central Business District of Bangkok during lunchtime, their most extended break during the day. The descriptive statistic shows that the average walking distance is 302.39 meters, but most workers walked shorter distances since the median distance is 211.66 meters. Nevertheless, these office workers, on the whole, significantly miscalculated their walking distances, with an average over-estimation of 191.45 meters. Regression analysis shows that, when walking for distances up to 380 meters, most workers overestimated the distance they walked, but that, when walking beyond that distance (that is, 380 meters), they estimated correctly, which indicates the maximum actual length they choose to walk.

Keywords: walking distance, central business district, lunchtime, Bangkok

INTRODUCTION

Walking behavior is central in studies of various disciplines. For example, many studies of walking behavior in management and social science focus on the recovery effects of walking on working readiness, or on walking limits due to the constraints of everyday activities (Demerouti et al., 2009; Saswattawong, 2009; Takahashi et al., 1998). Walking boosts energy recovery, and has been found to increase workers' performance readiness when they return to work, which is crucial for their productivity during a working day (Demerouti et al., 2009; Trougakos et al., 2014). In preventive medicine, and in environmental and behavioral sciences, studies focus on the effects of walking on physical health and mental issues (Alfonzo, 2005; Brown et al., 2007; Lindelöw et al., 2014). In landscape architecture, urban planning, and transportation, most research and practice use the concept of an "acceptable walking distance" as a criterion in their planning and design. Widely recognized acceptable walking distances range from 400 m. to 800 m. (Kelbaugh, 1989). This distance might be suitable for places with comfortable climatic conditions, but for cities with a tropical climate, acceptable walking distance is not yet well defined.

Although, in general, walking behavior is determined by the physical environment, demographic factors, and purpose (Nuzir & Dewancker, 2016), people's decisions about walking are shaped by perception (Alfonzo, 2005; Arellana et al., 2020; Mehta, 2008; Vichiensan & Nakamura, 2021), and distance is one of the key factors taken into consideration when people choose to travel by foot (Janpathompong & Murakami, 2021). In many studies, distances to destinations affect the choice to walk (Black et al., 2001; Southworth, 1997). However, there is a question of whether the perceived walking distance is the same as the actual walking distance; it may or may not be. More importantly, the perception of walking distance influences satisfaction on accessibility, according to Alfonzo (2005). It is one of the factors affecting the mode choice between "to walk" or "not to walk" (Alfonzo, 2005).

This study focuses on the distances walked by office workers during lunchtime in Bangkok because office workers choose a lunch venue themselves based on their preferences, but restricted by a fixed timeframe during the lunch break. The walking distance during lunchtime reflects the distance that people are generally willing to walk, and may be a better indicator of optimal distance than the walking distance from pre-determined origins & destinations of commuting trips.

Bangkok is one of the major cities located in a tropical climate. Its central business district (CBD) is always crowded during rush hours and at lunchtime. In Bangkok, a lunch break is, in fact, not only the time for a meal, but also a time to be away from the working routine. Office workers can spend their time to recover and recharge their energy by relaxing and enjoying some time away from the office. Since lunchtime is a relatively short period, one dominant activity is walking to selected lunch venues. However, very little is known about office workers' walking behavior with respect to the walking distance.

Every day, office workers choose from among their favorite foods or restaurants, of which are plenty within the CBD. An office worker might choose a specific or an alternative path to his or her destination due to the impact of environmental constraints. Although today's technology can accurately measure the actual distance walked, different persons could feel differently about walking the exact same distance. For example, some people might choose a restaurant based on familiarity; they don't know or really care how far they walk – they simply feel that the restaurant is a walkable distance. In this case, "acceptable walking distance" and a "distance that one chooses to walk" are two different matters.

The logic of comparing the actual and perceived walking distance is that pedestrians judge walking distance by their perception, which may be far different from reality. For this reason, perceived distance is important – possibly more important than actual distance. It is this perception of walking distance that reveals the optimum distance people feel comfortable traveling by foot.

Although other physical environment factors such as pedestrian facilities, proximity, and safety can significantly contribute to perceptions of the walking environment (Ariffin & Zahari, 2013), the core of this study is focused on the perception of

the optimum distance office workers walk. To a considerable extent, the lunchtime walking distance of office workers in the CBD of Bangkok could be representative of the behavior of residents of emerging economy cities in other tropical or hot-humid climate countries. As such, the research questions are as follows:

- Within the 60-90 minutes available at lunchtime, how far do office workers travel to their out-of-office lunch places, and what is the average walking distance?

- Is there a discrepancy between perceived and actual walking distances?
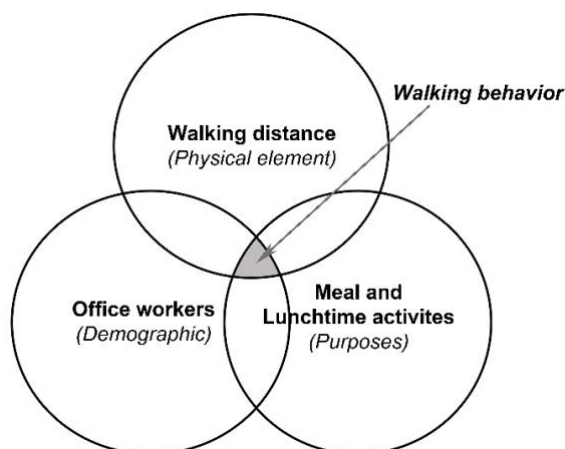
LITERATURE REVIEW

Walking is a factor in wellness. Walking as a recovery activity has been found to be important in improving work readiness, and it is crucial for health and well-being (Demerouti et al., 2009). However, the constraints of daily life restrict walking behavior (Lindelöw et al., 2014). Physical environments are arguably one of the most influential aspects in determining the nature and extent of outdoor activities in rural, suburban, or urban areas. As evidenced in the literature, key attributes of walking behavior are walkability, spatial planning and design features, pedestrian facilities (hard or soft), neighborhood livability, traffic safety, and environmental quality (Nuzir & Dewancker, 2016). Furthermore, parameters that are likely to affect the "willingness to walk" of pedestrians are factors such as walking distance, walking time, and trip purpose (Sukor & Fisal, 2018). Therefore, the conditions and quality of the physical environment can encourage or discourage walking (Brown et al., 2007).

Nuzir and Dewancker (2016), in seeking to assess walking phenomena, developed a framework consisting of pedestrian profile or demographics, pedestrian activity or purposes, and pedestrian environment. Demographics relate to preferences toward the physical environment (Lindelöw et al., 2014; Nuzir & Dewancker, 2016; Sapawi et al., 2013; Saswattawong, 2009); purposes are influenced by physical aspects (Demerouti et al., 2009; Gehl, 2011; Takahashi et al., 1998), and the physical environment impacts people's perceptions and preferences toward their outdoor surroundings (Appleyard, 1981; Brown et al., 2007; Cervero et al., 2009; Gehl, 2011; Horning et al., 2008; Mehta, 2008; Sukor & Fisal, 2018; Villaveces et al., 2012). Since this study concentrates on the walking distances of office workers during lunchtime, the three key elements adapted from the Nuriz & Dewancker framework are office workers (demographics), meal and lunchtime activity (purpose), and walking distance (physical element).

Figure 1

The Three-Element Conception

Note. Adapted from "Redefining place for walking: A literature review and key-elements conception," by F. Nuzir and B.J. Dewancker, 2016, *Theoretical and Empirical Researches in Urban Management, 11*(1), pp. 59–76. Copyright 2016 by Fritz Akhmad Nuzir and Bart Julien Dewancker.

Although previous research and studies investigated the concept of "acceptable walking distance," the results have varied. In one study, eight hundred meters (or half a mile) was set as a criterion to understand walkable density (Cortright, 2020). The "walking shed" or distance to a transit-oriented development) (TOD) area is thought to be about 400 m., or a quarter-mile, according to another study (Kelbaugh, 1989; National Economic and Social Development Council [NESDC], 2018). In Brisbane, Australia, a study showed that the median distance people walk from home to other places is 780 m., with the 85th percentile being 1.45 km, while from home to other public transport stops, the distances are 600 m. and 1.30 km., and from public transport stops to end destinations, the distances measure 470 m. and 1.09 km., respectively (Burke & Brown, 2021). However, a review of van Soest et al. (2020) found varying results in walking distance to transit, ranging from 170 m. to a bus stop, to 1.39 km. to a transit station. Hence, the acceptable distance in U.S. studies of 400 m. and 800 m. to bus and rail transport is inconsistent with many other studies and contexts.

One significantly different context is topical climate, where temperature and humidity create environmental conditions that may change people's perceptions of "acceptable walking distance." On Penang Island, Malaysia, where the climate is similar to the southern part of Thailand, people walk about 20 minutes on average to a bus stop, a distance of 200-400 m., while the minimum and maximum distances are 3 and 90 minutes, and 50 and 2,000 m., respectively (Sukor & Fisal, 2018). This study is one of the research studies that focuses on the spatial-time relationship.

In Bangkok, average walking speeds around transit stations for males, females, students, and the elderly are 8.2 meters per minute (m/m), 7.79 m/m, 8.18 m/m, and 6.59 m/m, respectively (Ozawa et al., 2021). For 10 minutes of walking, the distances traveled, then, would be 820 m., 779 m., 818 m., and 659 m., respectively. From a study of Bangkok residences located within 1,000 m. of a transit station, the two modes of travel used by 85% of residents are motorcycle taxis and walking (Pongprasert & Kubota, 2017). However, only 25% of residents walk to a transit station located at a distance of 500-1,000 m. The other 75% use other modes of transport; among this group, 65% use a motorcycle taxi, car, taxi, or a jitney bus (Pongprasert & Kubota, 2017). The choice of travel mode is related to travel distance. Several aspects of the physical environment influence the walking distance itself; they include the weather or season, region, urbanization level (Yang & Diez-Roux, 2012), condition and accessibility (Addy et al., 2004; Bourdeaudhuij et al., 2003; Brownson et al., 2002; Duncan & Mummery, 2005; Janpathompong & Murakami, 2021; King et al., 2003), obstructions, traffic safety, grade changes, and security (Appleyard, 1981; Buchanan, 1963; Untermann, 1984; Villaveces et al., 2012), and thermal comfort associated with walking comfort (Janpathompong & Murakami, 2021; Koerniawan, 2014).

In addition, walking infrastructure, equipment, and the surrounding environment are major physical elements causing problems in the walking environment in Bangkok (Ozawa et al., 2021). From a study by Alfonzo (2005) on the hierarchy of willingness to walk, seen from the perspective of urban design, feasibility, accessibility, safety, comfort, and pleasure – all physical environment qualities -- are factors determining whether "to walk" or "not to walk."

In this research, the focus is on determining, by considering all current factors and conditions combined, the acceptable walking distance, or how far people are willing to walk rather than shift to other modes of transportation; it is not concerned with an evaluation of the walking environment itself.

With respect to methodology, several ways of obtaining data have been used across disciplines. In social sciences and medicine, literature reviews and interviews are widely used. In urban planning, observation, documentation, mapping, interviews, and questionnaires have often been employed. For transportation, interviews, questionnaires, GIS or remote sensing, and inventories are frequently utilized. In the management field, observation, interviews, and questionnaires comprise typical methodology. Engineering usually relies on observation, GIS, mapping, simulation, or other measuring equipment (Table 1).

Overall, these methods can be grouped into three categories: (1) objective - measurement of

physical elements (2) subjective - users' opinion surveys, and (3) expert field studies - expert observations or opinions are gathered directly (Sabzali Yameqani & Alesheikh, 2019). However, the relationship between the subjective aspects resulting from public opinion and objective physical data measurements is complicated (Sabzali Yameqani & Alesheikh, 2019). To investigate the walking distance specifically, the character and quality of the physical environment along the walking route should be incorporated.

Table 1

Review of Methodology in Research Studies Related to Walking Behavior in Various Disciplines

Methods	References	Disciplines				
		Medicine-social science	Urban planning	Transport	Manage	Engineer
Observation/ audit	Adkins et al. (2012); shaaban (2019); Mehta (2008); Brown et al. (2007); Bosselmann et al. (1999); Appleyard (1980); Trougakos et al. (2008); Tipakornkiat et al. (2012)	✓	✓✓✓✓		✓	✓
Literature review	Saelens and Handys (2008); Nuzir and Dewancker (2016); van Soest et al. (2020); Alfonzo (2005); Owen et al. (2004)	✓✓✓		✓	✓	
Documentation/ diagram/ photographs/ VDO/ mapping	Adkins et al. (2012); Appleyard (1980); Trougakos et al. (2008); Tipakornkiat et al. (2012)		✓✓✓		✓	✓
Interview	Kelly et al. (2011); Villaveces et al. (2012); Yang and Diez-Roux (2012); Mehta (2008); Bosselmann et al. (1999); Cervero et al. (2009)	✓	✓✓✓	✓✓		
Travel diary	Burke and Brown (2007)			✓		

Table 1 (Continued)

Methods	References	Disciplines				
		Medicine-social science	Urban planning	Transport	Manage	Engineer
Questionnaire	Kelly (2011); Adkins et al. (2012); Lindelöw et al. (2014); Ariffin and Zahari (2013); Burke and Brown (2007); Sukor and Fisal (2018); Horning et al. (2008); Sapawi et al. (2013); Trougakos et al. (2008), Cervero et al. (2009)	✓✓✓✓	✓✓✓	✓✓✓	✓	
Rating/ score	Ariffin and Zahari (2013); Shaaban (2019)	✓	✓			
GIS/ remote sensing/ aerial photographs	Burke and Brown (2007); Srivanit et al. (2012)			✓		✓
Inventory	Burke and Brown (2007); Yang and Diez-Roux (2012); Burke and Brown (2007)	✓	✓	✓✓		
Computer simulation	Koerniawan (2014)					✓
Pedometer/ other equipment	Koerniawan (2014); Tipakornkiat et al. (2012)					✓✓

THE CENTRAL BUSINESS DISTRICT OF BANGKOK

The CBD of Bangkok was chosen as the site for the study because of its concentration of social and economic activities. The CBD encompasses three locations, which are in close proximity to each other: Silom-Sathorn, Ploenchit, and Asoke. It is the central area that offers services most advantageous to trade and commerce, and focuses on internal activities that contact surrounding areas (Hartman, 1950). In comparing walking distance, time, and speed, Azmi et al. (2012) found slight differences between urban and rural areas. Thus, an urban area is an appropriate site for investigating walking distance.

Silom-Sathorn, Ploen Chit, and Asoke were selected as the study areas due to their fundamental characteristics of having a high concentration of offices, financial institutions, high density and high-rise buildings, high land
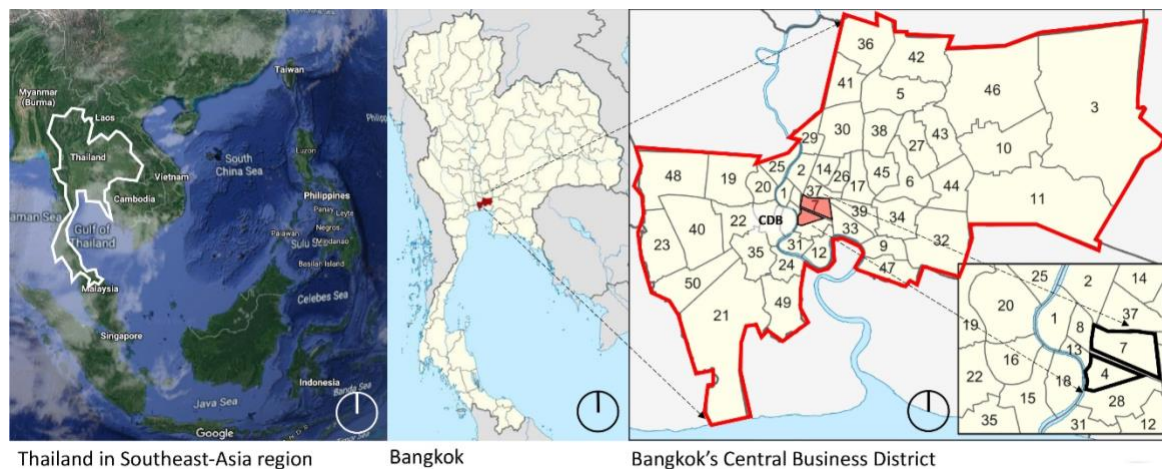
values, major department stores, and multi-story garages (Design Building, 2020). These areas are also highly accessible by vehicles and mass transit systems. Therefore, convenient walking distances from and to these systems encompassing these urban areas can be effectively considered (Figure 2 and Figure 3).

The sidewalks of the Bangkok CBD, however, may not be pedestrian-friendly because they

need to accommodate, not only the flow of pedestrians, but also other facilities and modern utilities like electric poles or cabinets, which may in turn, obstruct walking paths (Janpathompong & Murakami, 2021). Moreover, the pavement conditions are typically uneven; thus, walking is often considered challenging, but little is known, from a research standpoint, about walking in the CBD of Bangkok.

Figure 2

Regional Location of Thailand, the City of Bangkok, and Bangkok's Central Business District

Thailand in Southeast-Asia region   Bangkok   Bangkok's Central Business District

Note. Adapted from *Thailand Map*, by Google Earth, 2022. Copyright 2022 by Google LLC.

Figure 3

Location of Bangkok's Central Business District and Its Main Areas, Silom-Sathorn, Ploenchit, and Asoke

Note. Adapted from *Bangkok's Central Business District*, by Google Earth, 2022. Copyright 2022 by Google LLC.

METHODOLOGY

Observations, questionnaires, and GIS mapping were used for this research. Observations were used to identify the micro-level characteristics of the physical environment, and to record office workers' behavior at the initial stage. The results of observation were also used for constructing the questionnaire, which was used to collect data regarding office workers' behavior and perceptions. Furthermore, GIS mapping was used to find the distribution of office workers' workplaces and their lunch places, and then to calculate the actual walking distances.

Sample Survey & Data Collection

Population

In this research, the walking behavior of office workers from three densely populated areas, Silom-Sathorn, Ploenjit, and Asoke, was studied. Information about actual population numbers for these three areas is not available. Although the number of residents registered in each area is available, the actual size of the latent population and number of office workers in the areas during working days are not available. Therefore, a method of calculating the sample size without knowing the actual number was used; the author opted for Cochran's method for an unknown population (Israel, 1992).

According to the Cochran's method, the sample size should be at least 386 observations for a 95% confidence level. In this study, from the total of 536 observations collected from all three areas in the CBD, 430 observations indicated walking as the mode of choice; thus, the sample size is considered to be adequate.

Questionnaire Survey

The questions were divided into three parts: the demographic profile, the purposes of the lunchtime trips, and the perceived walking distance. The demographic profile collected data about age, education, gender, income, occupation, and job position. The choices of purpose, which are the reasons for going out of the office in the Bangkok CBD, consisted of: having a meal, changing the environment or energy recovery, socializing, shopping, or doing business errands. For the perceived walking distance, the estimated distance from the workplace (origin) to the lunch place (destination) was asked for in the questionnaire. Office workers were also asked to identify the street address of their workplaces and lunch places. These locations were registered using GPS to calculate the actual distances.

The questionnaire was distributed in the three study areas by focusing on workplaces, walking paths, and lunch places.
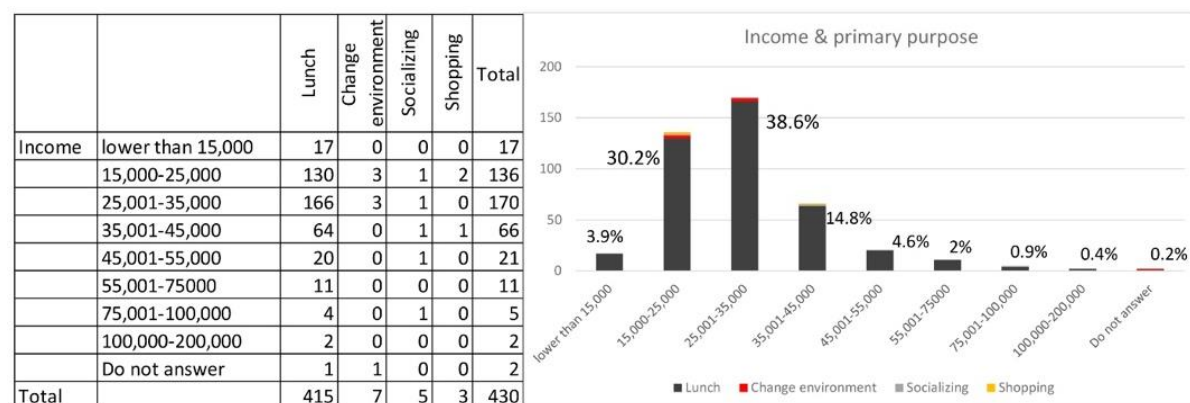
Calculating actual walking distances

The one-way analysis of variance (ANOVA) was used to indicate significant values from the demographic profile. Results from the questionnaire regarding the geographic locations of origins, walking routes, and destinations were mapped, and the actual distances were calculated in the Geographic Information System. The perceived walking distance obtained from the questionnaire was calculated using descriptive statistics, histograms, and scattered plots. Also, a quadratic regression analysis was used to create a regression line determining the character and relationship between the error with respect to perceived distance and the actual distance.

RESULTS

The questionnaires were distributed, and 536 were returned with valid results. Four hundred thirty responses indicate walking as the mode of travel. Although the study focuses on walking distance, demographic factors were also analyzed. The result shows that the relationship between income and the primary purpose, a meal, is significant at about 95% confidence level, Sig. = 0.000 (Table 2).

Table 2

The Results from One-Way ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
Age	Between Groups	3.490	3	1.163	1.568	.196
	Within Groups	316.001	426	.742		
	Total	319.491	429			
EDU	Between Groups	1.906	3	.635	1.786	.149
	Within Groups	151.557	426	.356		
	Total	153.463	429			
Sex	Between Groups	.889	3	.296	.994	.396
	Within Groups	127.074	426	.298		
	Total	127.963	429			
Income	Between Groups	1178.226	3	392.742	9.426	.000
	Within Groups	17750.148	426	41.667		
	Total	18928.374	429			
Job	Between Groups	3.691	3	1.230	2.317	.075
	Within Groups	226.227	426	.531		
	Total	229.919	429			
Pos	Between Groups	3.978	3	1.326	.481	.696
	Within Groups	1173.874	426	2.756		
	Total	1177.851	429			

Figure 4

Income and the Primary Purpose of Office Workers During Their Lunchtime

		Lunch	Change environment	Socializing	Shopping	Total
Income	lower than 15,000	17	0	0	0	17
	15,000-25,000	130	3	1	2	136
	25,001-35,000	166	3	1	0	170
	35,001-45,000	64	0	1	1	66
	45,001-55,000	20	0	1	0	21
	55,001-75000	11	0	0	0	11
	75,001-100,000	4	0	1	0	5
	100,000-200,000	2	0	0	0	2
	Do not answer	1	1	0	0	2
Total		415	7	5	3	430

Drawn from the significant relationships between the income and purposes (Table 2), the results were further elaborated using crosstab analysis and a stacked column chart. It was found that, among the majority of pedestrians who went out for the primary purpose of having a meal, 83.6% have income between 15,000 – 45,000 Thai Baht (THB) per month. This group comprises three income categories: 15,000-25,000 THB at 30.2%; 25,001-35,000 THB at 38.6%; and 30,001-45,000 THB at 14.8% (Figure 4). Therefore, most office workers (83.6%) who walk for their lunch have income in the low-middle range.

The spatial distribution of workplaces in the three areas shows that most offices and workplaces are spread along the main roads. However, the lunch places in Silom-Sathorn and Asoke tend to be clustered together, while the lunch places in Ploenchit stretch across a wider area, similar to the distribution of its workplaces (Figure 5). The survey also recorded the paths that the respondents took, as shown in Figure 6. These paths highlight the walking routes frequently taken by office workers.

Figure 5

The Spatial Distribution of Workplaces and Lunch Places

Note. Adapted from *Bangkok's Central Business District*, by Google Earth, 2022. Copyright 2022 by Google LLC.

Figure 6

Walking Routes and Density in the Three Districts, Silom-Sathorn, Ploenchit, and Asoke

Note. Adapted from *The Three Districts, Silom-Sathorn, Ploenchit, and Asoke*, by Google Earth, 2022. Copyright 2022 by Google LLC.

The walking distances, both actual and perceived, were calculated using ArcGIS and interpreted by descriptive statistics. The mean actual walking distance was 302.39 m.; the distance range was from 22.94 m. to 1,359.79 m. The mean perceived distance was 329.27 meters; the perceived distance range was from 2.00 m. to 1,000.00 m. The mean error was 191.45 m. (Table 3). Samples of walking routes indicate over- and under-estimated walking distances, shown in Figure 7.
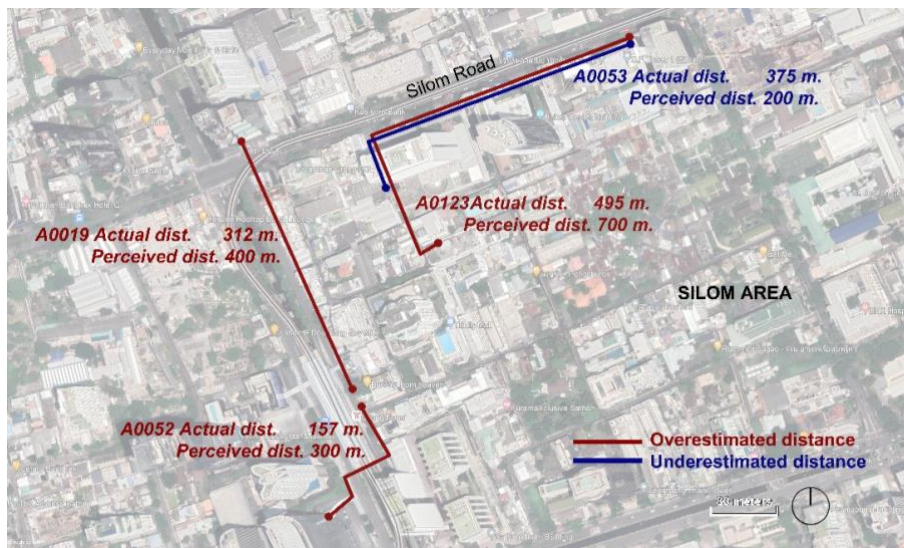
Table 3

Descriptive Statistic; the Actual Distance and Perceived Distance

	Minimum	Maximum	Mean	Std. Deviation
Actual Distance	22.94	1,359.79	302.39	246.40
Perceived Distance	2.00	1,000.00	329.27	229.77
Differences (Perceived – Actual)	0.42	787.17	191.45	168.01

Figure 7

Samples of Walking Routes Indicate Over and Underestimated Distance

Note. Adapted from *The Silom Area*, by Google Earth, 2022. Copyright 2022 by Google LLC.

Figure 8
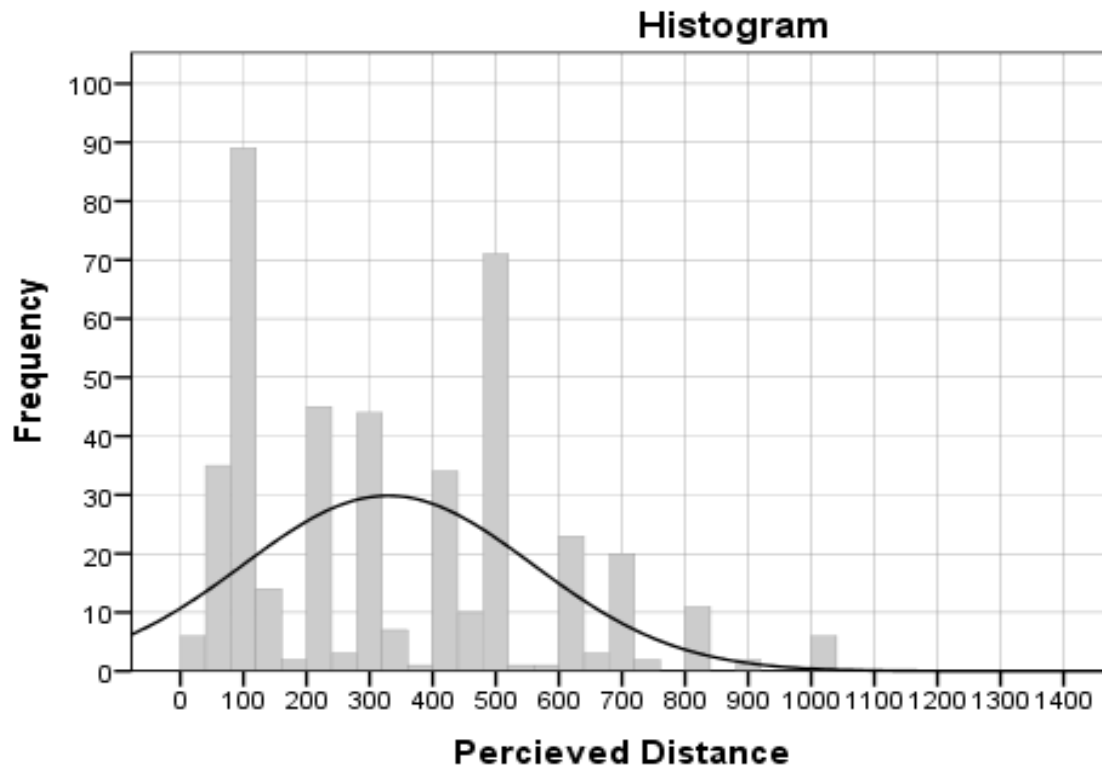
Frequency of Actual Walking Distance

Figure 9

Frequency of Perceived Walking Distance

The other discrepancies between the actual and perceived distance are medians, 211.66 m. and 300.00 m., with a modes of 754.67 m. and 100.00 m., and standard deviations of 246.40 m. and 229.77 m, respectively. The histogram of the actual distance (Figure 8) shows that most office workers walk within a range of 100.00 m. to slightly over 200.00 m. However, regarding the estimated distance (Figure 9), the frequency was scattered more widely, from 100.00 m. to 500.00 m. Therefore, the office workers perceived their walking distances to be different from reality. In addition, even though the mean of the actual walking distance was 302.39 m., it does not represent the distance that most office workers actually walked. As shown in Figure 8, the positively skewed distribution suggests that some office workers walk much longer distances than the average, making the mean higher than the median, meaning that a much higher proportion of office workers walk at significantly shorter distances than the average (Figure 8).

To further understand the differences between the actual and perceived distances, the following scatter plot shows that office workers tend to overestimate the distance when they walk less than 300.00 m. or so, which is close to the average actual distance (302.39 m.). However, beyond the average actual walking distance, the perceived distance appears to often be underestimated as compared to the actual distance walked (Figure 10).

When comparing the actual distance to the error of perceived distance, the results can be seen more clearly. At shorter distances of less than 100.00 m. or so, most office workers overestimated their walking distance. The majority of office workers walk to lunch places that are located within 400.00 m. A smaller number of office workers walked further i.e., between 400.00 and 800.00 m. In rare cases, some office workers walked over 1,000.00 m. (n=6) (Figure 11).

Figure 10

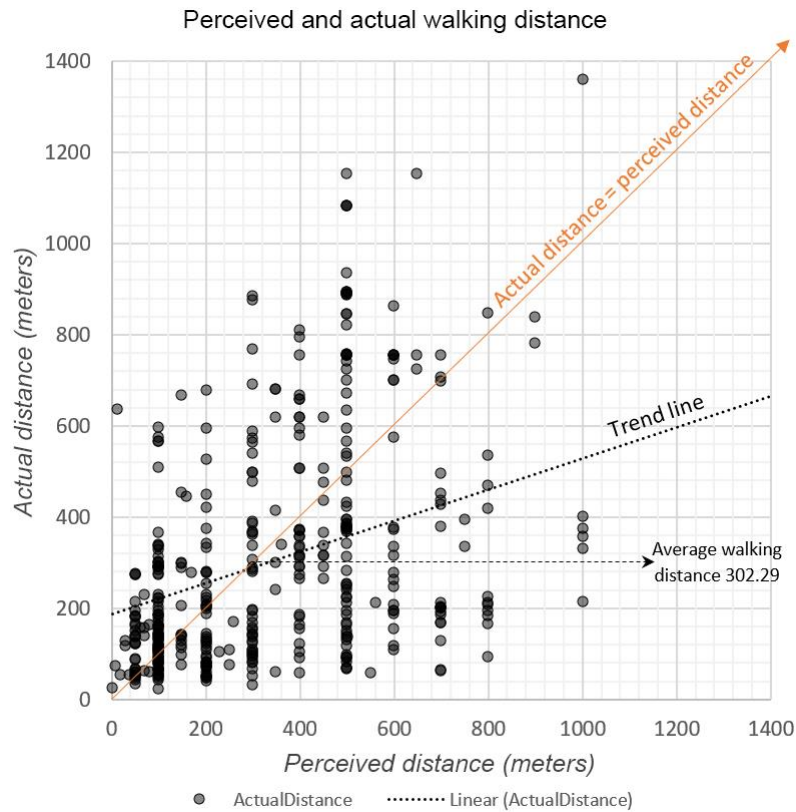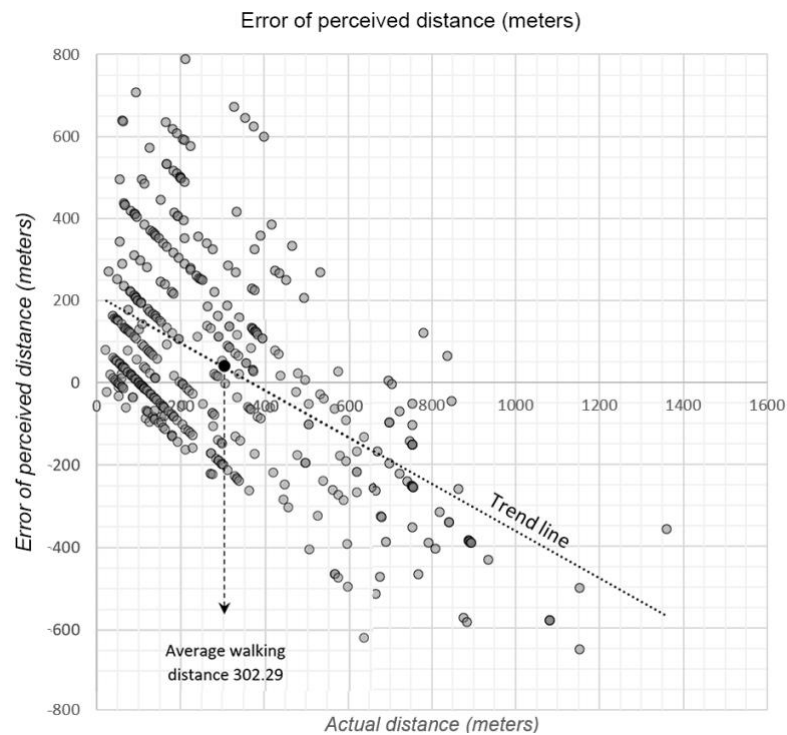*Scattered Plot, the Perceived Distance (X-axis) and the Actual Distance (Y-axis)*

Perceived and actual walking distance

Figure 11

Scattered Plot, the Actual Distance (X-axis), and Perceived Distance Error (Y-axis)

Error of perceived distance (meters)

In the next step, the regression analysis was performed to determine the character of the relationship between the error of perceived distance (Y) and the actual distance (Table 4 and Figure 12). The regression model is defined as follows:

$$DE = \beta_0 + \beta_1 D + \beta_2 D^2 + \varepsilon,$$

Where DE denotes the error of perceived walking distances, i.e., differences between actual walking distances and perceived distances.

D denotes actual walking distances.

D^2 denotes the square of walking distances.

β_1, β_2 denote coefficients of actual walking distances and the square of walking distances, respectively.

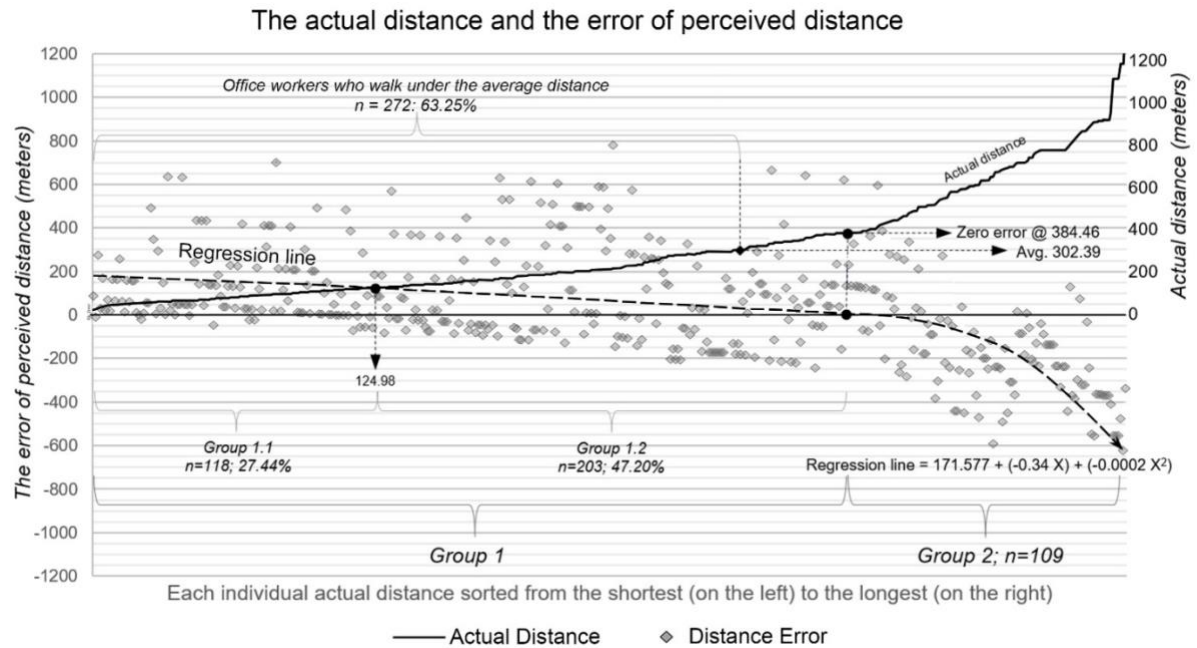β_0 denotes a constant term.

ε denotes the error term.

Table 4

The Regression Analysis of the Error of Perceived Distance and the Actual Distance

Regression Statistics	
Multiple R	0.583
R Square	0.340
Adjusted R Square	0.337
Standard Error	206.331
Observations	430

ANOVA					
	df	SS	MS	F	Significance F
Regression	2	9381527.985	4690763.992	110.1833974	2.60457E-39
Residual	427	18178385.06	42572.33036		
Total	429	27559913.05			

	Coefficients	Standard Error	t Stat	P-value
Intercept	171.5778184	23.10423557	7.426249523	6.12201E-13
Actual Dist.	-0.341122187	0.128673473	-2.65106847	0.008322149
Actual Dist. Sq.	-0.000273307	0.00013188	-2.072393913	0.038828284

Figure 12

The Regression line of the Perceived Distance's Error Compared to the Actual Distance

The actual distance and the error of perceived distance

Results from the regression analysis separated observations into 2 groups: the first group (Group 1) comprises people who overestimate their walking distances, while the second group (Group 2) comprises people who underestimate their walking distances (Figure 12). At 384.46 m., the difference between perceived and actual equals zero, suggesting that 384 m. is the distance people estimated accurately, i.e., they choose to walk, and the perceived and actual distance are the same. However, at distances shorter than 384.46 m., most people perceived a longer distance than they actually walked.

Office workers tended to overestimate their perceived distances at shorter walking distances, but the opposite was found for longer distances (Figure 11 and 12). There are three essential values to be focused on: (1) the cross point between the regression line of distance error and the actual distance at 124.98 m., (2) the average walking distance at 302.39 m., and (3) the point where the regression line passes from the overestimated to the underestimated distance, at 384.46 m. Detailed observations include the following:

Group 1: (n=312) This group comprises office workers who walked under the "zero error" point of 384.46 m. This group was divided into two sub-groups, with the threshold at 124.98 m.

- Group 1.1 (n=118): When walking less than 124.98 m., more than 95% of office workers overestimated their walking distance.

- Group 1.2 (n=203): When walking between 124.98 m. and 384.46 m., the majority of workers still overestimated the distance walked, but the error was smaller. However, the longer the distance they walk, the smaller the errors are. Among those in this group who walked longer distances (i.e., between 220.00-380.00 m.), distance errors are almost equal in both directions.

Group 2 (n=109): Beyond 384.46 m., most workers underestimated their walking distance. The longer the distance they walked, the greater the error (i.e., the greater the underestimation).

Overall, 27.44% (n=118) of office workers walked under 124.98 m.; 47.20% (n=203) walked between 124.98 m. and 384.46 m, and 25.34% (n=109) walked over 384.46 m. The total percentage of office workers who walked no more than the average walking distance of 302.39 m. was 63.25% (n=272). The total percentage of office workers who walked less than the cross point 384.46m was 74.65% (n=118+203=321).

CONCLUSIONS & DISCUSSION

This study examines suitable walking distances in a tropical climate by measuring actual distances walked by office workers in the CBD of Bangkok, and comparing those distances to compared to the office workers' perception of the distances they walked. Questionnaire surveys and GIS mapping of origins and destinations of respective walking trips were conducted.

The majority of office workers (83.6%) who walk for their lunch have incomes in the low to middle range, i.e., 15,000 THB to 45,000 THB per month. Within the time frame of 60 to 90 minutes allowed for lunchtime, they walked to out-of-office lunch venues at an average distance of 302.39 m. Overall, almost three-quarters of office workers (74.65%) walked less than 384.46 m., and within this group, a quarter (27.44%) walked under 124.98 m. The majority of office workers perceived that they walked longer distances than they actually did. The remaining quarter of office workers (25.35%) walked more than 384.46 m.

Although there is an acceptable standard in U.S. studies of 400.00 m. and 800.00 m. to public transportation (Kelbaugh, 1989), this value may not be appropriate in many cases because the "acceptable walking distance" depends very much on location and circumstances (van Soest et al., 2020). In the context of the lunchtime walking distance, the average distance in this study was 302.39 m., which means that approximately 300 m. is the walking distance that office workers deem acceptable to travel by foot. This finding provides empirical evidence of the optimal walking distance in the Bangkok CBD, which can be applied in urban planning and design for walkable neighborhoods in cities located in tropical climatic conditions like those of central Thailand.

Office workers in Bangkok walked, on average, about 300 m., which is less than the widely

acceptable Western standard. While 384.46 m. is the distance at which office workers accurately estimated distance and chose to walk, that number suggests acceptability rather than preference. In a similar way, as shown in Figure 8, even though the mean of actual walking distance is 302.39 m., the positively skewed distribution shows that most office workers do not walk the average distance, but rather a significantly shorter one. This shorter distance could be a reflection of the constraints in other related factors. These factors include weather or season, region, urbanization level (Yang & Diez-Roux, 2012), conditions and accessibility (Addy et al., 2004; Ball et al., 2001; Bourdeaudhuij et al., 2003; Brownson et al., 2002; Duncan & Mummery, 2005; King et al., 2003), obstructions, traffic safety, grade changes, and security (Appleyard, 1981; Buchanan, 1963; Janpathompong & Murakami, 2021; Untermann, 1984; Villaveces et al., 2012), and thermal comfort associated with walking comfort (Janpathompong & Murakami, 2021; Koerniawan, 2014).

Regarding the perceived and actual distances, there were clear discrepancies, with an average error of 191.45 m. From Figure 12, it can be seen that for distances of no more than 124.8m., over 95% of office workers significantly overestimated their walking distances. When walking between 124.98 and 384.46 meters, where fewer office workers underestimated the distance according to the regression line, the errors fluctuated within a broader range; however, there were still more overestimations than underestimations. Beyond 384.46 m., office workers always underestimated the distance. This error could reflect office workers' perceptions of the physical environment of their chosen walking path. Environmental constraints might be the reason why office workers overestimated their walking distances, especially for journeys of less than 300 m.

The perceived distance is one of the defining factors when walking is chosen since this judgment of the distance becomes part of the choice to walk, not the reality of the actual distance. Since pedestrians choose to walk or not to walk based on perception, in this case, the office workers decided to walk the distance they felt comfortable with, as opposed to the accurately measured distance. Given that they have choices of various restaurants selling different food types around the CBD areas, the walk to a specific lunch place is optional rather than a necessity (Gehl, 2011).

Since the main focus of this study is on walking distance during lunchtime in the Bangkok CBD, the demographic profile is limited to office workers during the period, with their primary purpose of having a meal. However, other physical features—such as the physical environment related to thermal conditions, pavement conditions, sidewalk obstructions, traffic safety, grade changes, and walking distance, should be incorporated in further studies. It is suggested that further research could investigate what physical parameters contribute to the errors in perceived distance. Additionally, more distributed demographics and purpose factors, which also play a vital role, should be integrated to assess walking behavior in a broader context.

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