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RESEARCH ARTICLE

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Modifying the walk score based on daily social activities: residential neighborhood in Egypt as a case study

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Abstract

Walkability has been linked to quality of life in many ways. The Walk Score is one of several methodologies aimed at assisting people in evaluating walkability. Despite the validation of this method, the amenity schedule around the day and the occupancy percentage in each amenity are not included in the calculation of the Walk Score, resulting in reduced accuracy. The research aims to improve the Walk Score methodology by inserting the amenity schedule around the day and the occupancy percentage in each amenity in the calculating method of the walk score, as the amenities do not have the same occupancy throughout the day. The research proposes a new method to calculate the Walk Score according to the time and occupancy for each amenity at the residential neighborhood level in Egypt. The research uses Salam New City as a case study to apply the new method to a residential neighborhood using the Urban Modelling Interference (Umi) plugin. Finally, the research proposes the Walk Score Model of Salam New City to calculate the Walk Score around the day. The new Walk Score model helps urban planners improve urban space design and the distribution of amenities.

Keywords Walkability model, Amenities schedule, Walk score, Amenity occupancy

Introduction

Walking is the most common type of physical activity that reduces obesity rates significantly in today's high-consumption societies. The built environment has been identified as an important factor in incorporating physical activity into daily life (Zuniga 2017). Walking can be associated with a variety of built and natural environments. Also, the nature of the walking performed varies according to its type. Walking for transportation purposes is associated with a number of factors, including address density, land-use diversity, street network, and accessibility of daily destinations (such as shops and workplaces), whereas walking for recreation is typically associated with aesthetic quality, sidewalk availability, and streetlamp availability (Gao 2020), (Chum et al. 2019), (Ding et al. 2011), (Jamei 2021).

Between 1977 and 1982, Egypt started building its first new cities. The number of people living in these cities is going down because of how they are built and because they don't have enough services like schools, recreational places, public transportation, sidewalks, etc. (New Cities 2022), (Abdelsalam 2016), (Darwish 2015).

Egypt is now getting ready to build up to 18 new cities in 2017. The government's vision for 2030 is to make new communities that are sustainable, so this study helps urban planners make a city that is good for walking and has well-designed public spaces by creating a new walk score method that works in Egypt. Egypt has

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no regulation or method to calculate the Walk Score in Egyptian communities. Also, measuring or predicting Walk Score is a new concept in Egypt, so this new method helps urban planners and stockholders design Egyptian walkable communities according to the Egyptian style of life. This method also keeps these new cities from failing because it helps designers make cities easy to get around on foot, healthy, and resilient.

The built environment, specifically urban design principles, has emerged as a high priority for promoting walkability (Tochaiwat 2022), (Ledraa 2015). Walk Score is solely concerned with the contribution of convenience (i.e., proximity to appealing destinations) to walkability (Silvennoinen 2022). Walk Score has become increasingly recognized in the study of walkability. The Walk Score algorithm, which generates a score from 0 to 100, computes a Walk Score based on the distance to various categories of amenities (e.g., schools, stores, parks, and libraries), which are weighted equally and summed (Duncan, 2011), (Walk Score 2023).

Walk Score is a type of automated location-based efficiency model. Mike Mathieu, Matt Lerner, Jesse Kocher, and Josh Herst, formerly of Madrona Venture Group, founded Walk Score in July 2007. Redfin, a real estate company, acquired the Walk Score website. This organization utilized the walk score as an apartment search tool that identifies available housing based on travel time to a given location. The application computes commute times for various modes of transportation, including walking, cycling, driving, and public transportation. (Walk Score 2022).

A bibliometric study was conducted to assess the current state of the literature on Walk Score. Figure 1 depicts a visual map of the analyzed aspects of the selected articles. To search for the term "Walk Score," the Scopus database was consulted, with the publication years 2017 to 2022 given precedence. The open-source software VOS viewer was utilized to enter the collected data. Based on 85 studies, the most frequently cited terms in the related literature were: (1) walkability, (2) walking, (3) human, (4) pedestrian, and (5) neighborhood walkability. Various studies are attempting to improve the walk score based on various factors. The previous analysis method was used to search

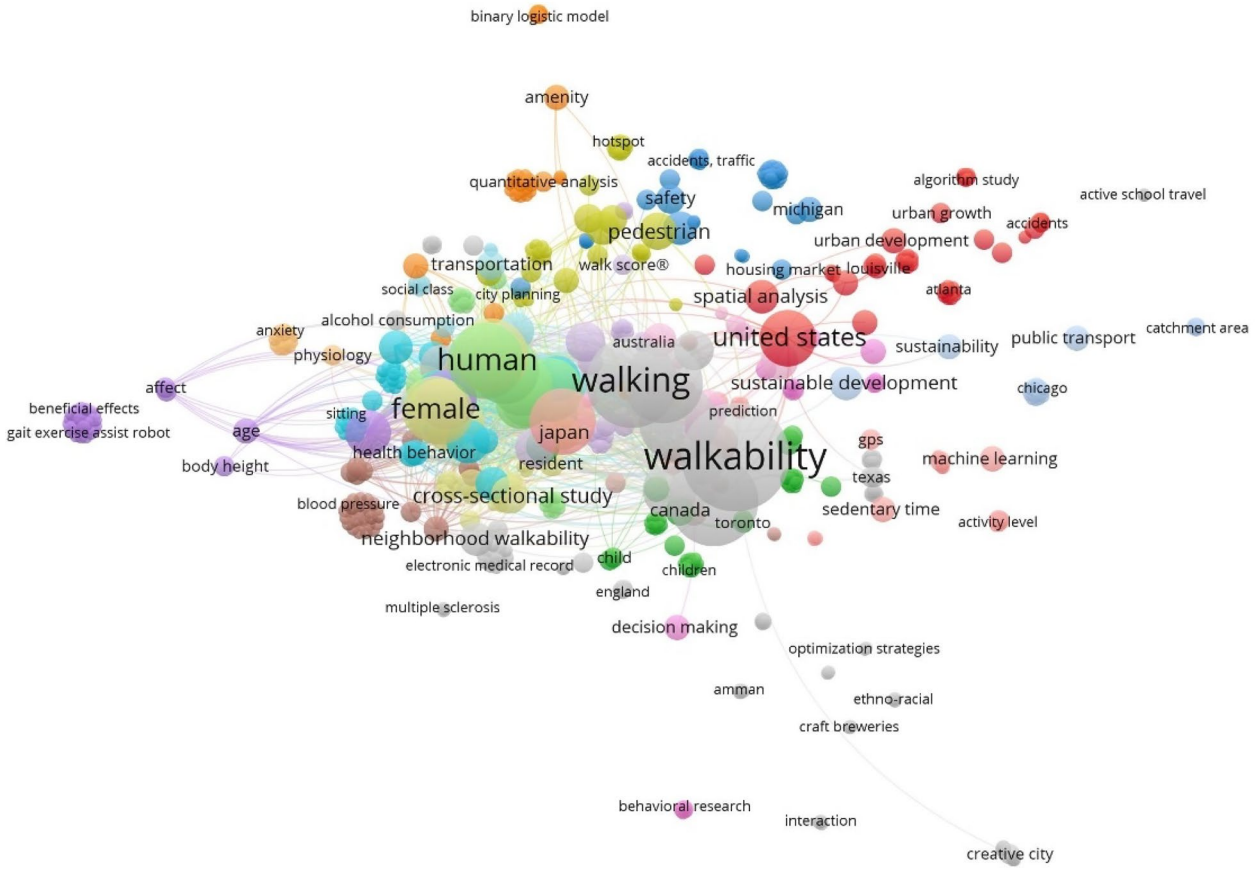


Fig. 1 Visual map where the Walk Score of the selected articles was analyzed. Source: created by Vos viewer retrieved from Scopus data

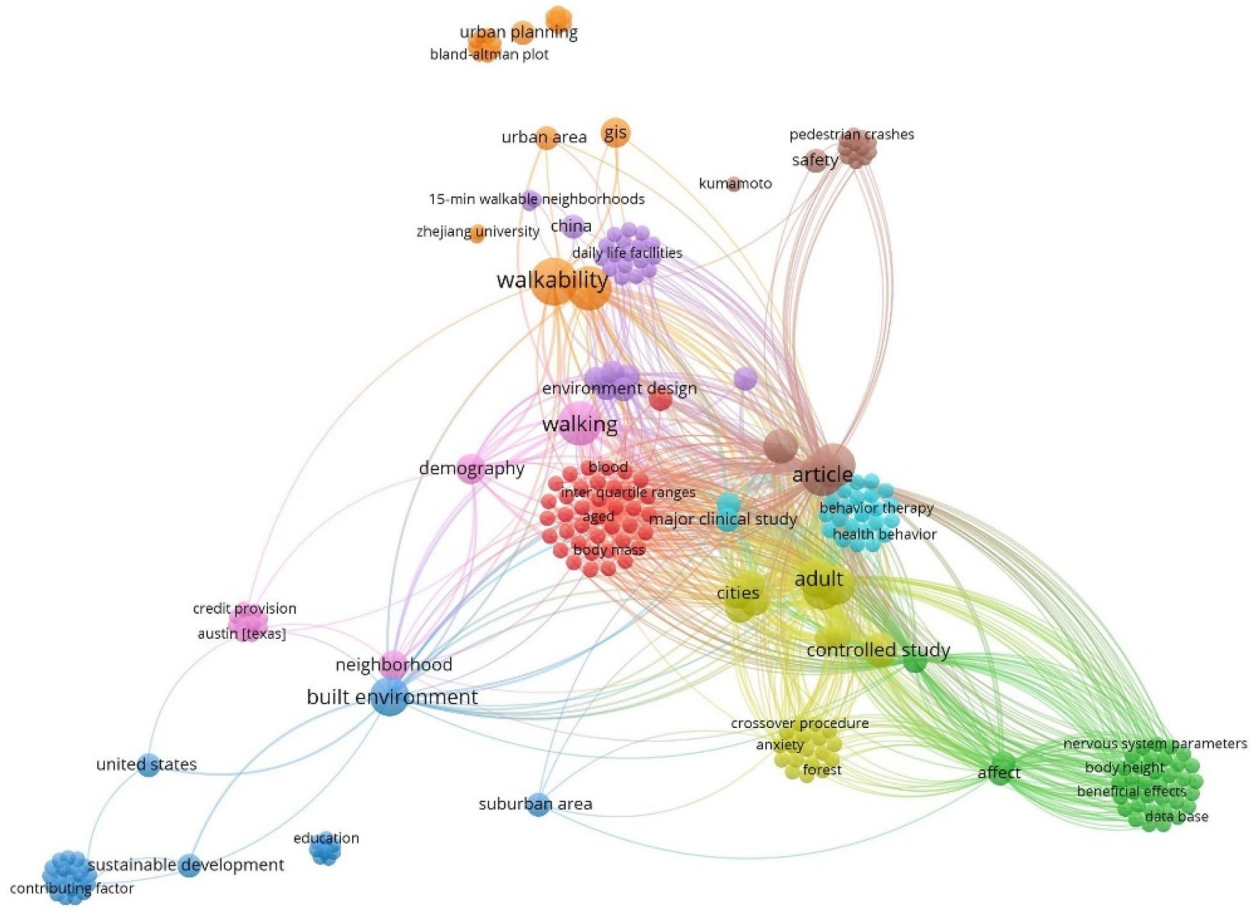


Fig. 2 Various studies related to Walk Score improvement. Source: created by Vos viewer retrieved from Scopus data

Table 1 Different methodologies to calculate walkability

Study/Method	Walk score	Walkshed	PERS
(PaulGalpern 2017)		✓	
(Bradley 2018)	✓		
(C. Michael Hallab 2018)	✓		
(Romain Goldenberg 2018)		✓	
(Sun 2021)	✓		
(Fahim 2021)			✓
(Zhang 2022)	✓		
(Te Mu 2022)	✓		
(Jiri Horak 2022)	✓		

for the term "Walk Score" and improvement. Figure 2 shows various studies that are trying to enhance the Walk Score according to different factors. It was found that the most cited topics in the literature, based on 15 studies, related to the term were: (1) health behavior, (2) built environment, (3) environment design, and (4) daily life facilities. Table 1 contains literature for previous researchers that used Walk Score in their research.

Table 1 contains the most cited research that used different methodologies to calculate walkability from 2017 to 2022.

Table 1 concludes that Walk Score is the most publicly available website that estimates neighborhood walkability.

Table 2 contains the most cited research that tried to improve the Walk Score according to different factors from 2017 to 2022.

Walkability has become a measure of how livable and high-quality a city is. Walking easily over short and reasonable distances to do daily tasks helps people get more exercise and makes places easier to live in. The neighborhood economy benefits when people can get around by walking. Businesses that are near places where people walk have stronger ties to the areas where they are. The people who run shops get to know their customers' names because they see them often. Most of the time,

Table 2 The most cited research that tried to improve the Walk Score

Study/items	Improvement factor	Output for the improvement
(Indraprastha 2019)	Added • Distance decay function • Pedestrian friendliness metric To walk score categories	New model
(Sun 2021)	Street greening as a factor	Index calling green vision index
(KahinaLabdaoui 2021)	Street indicators (orientation, ratio, vegetation)	New index + create new model
(Zhang 2022)	Street perception	Guideline to evaluate urban walkability

property prices stay the same or go up because of nearby economic growth and development. (Yunwon Choi 2020), (Barbulescu 2016), (Tuydes-Yaman 2018).

To create walkable communities in Egypt, the residential neighborhood should contain well-connected streets with frequent intersections and adequately sized blocks, mixed land use with a wide variety of destinations, and easy access to public transportation. An appropriate population density lends itself to an economically vibrant ambiance. This urban vibrancy is echoed in the presence of amenities such as schools, shops, restaurants, offices, parks, and gyms that encourage people to walk in their daily activities. The amenities that are distributed according to their occupancy usually allow pedestrians to take shorter and more direct paths to their destinations. (Abdulla Baobeid 2021), (Abdollahzadeh 2021).

Despite previous attempts to improve the Walk Score methodology, there is a lack of research concerning the schedule for amenities and the percentage of occupancy in each amenity that is used in the current walk score methodology, which reduces the accuracy of the Walk Score value. The amenities do not have the same occupancy throughout the day. To improve the accuracy of the Walk Score, these variables should be accounted for when calculating the occupancy of each amenity based on time and purpose.

The research aims to improve the Walk Score calculation method by incorporating the daily amenity usage schedule and occupancy percentage scenarios. This method improves the accuracy of predicting the walkability of a residential neighborhood, resulting in better amenity distribution and outdoor space design to enhance the social life in the new communities.

The paper begins with a literature review of the methodology behind calculating a Walk Score, splitting up the amenities into categories based on their intended use, their relative importance, and the distance to the nearest one. This study employs a questionnaire-based methodology to reveal the routines and routine activities of neighborhood residents. By assuming a schedule and occupancy percentage for the amenities according to their use through the Egyptian day, the research suggests a new way to calculate the walk score according to the time and the occupancy for each use at the residential neighborhood level. The study then uses Salam's new city in Port Said as a case study to implement the model in an existing residential area using the Urban Modelling Interference (Umi) plugin as a simulation tool. The study concludes with a new model for the walkability score and an explanation of its diurnal variation. According to the study's findings, the Walk Score ought to be at least 40/8 all through the day.

Walk Score® definition

The Walk Score® is one of the popular indices that objectively measures neighborhood walkability, considering the accessibility of amenities in the vicinity (e.g., grocery stores, restaurants, shopping centers, coffee shops, parks, and schools) (Kim 2020). The mission of Walk Score® is to promote walkable neighborhoods. The Walk Score® methodology combines three components: the shortest distance to a set of pre-selected destinations (such as public transportation, restaurants, shopping, parks and green spaces, and schools), the block length, and the intersection density around the origin. The Walk Score® metric combines a gravity-based metric (distance accessibility) with a topological metric (street connectivity), as measured by two complementary indicators that act as penalties in the final score (in the range of 0–100). (Halla 2018), (Nihal 2017), (Ariffin 2021) Walk Score® was launched in 2007, and it was hailed as a big advance for pedestrians and urbanists. For the first time, you could type in an address anywhere in the world. Walk Score® began as a small-scale project with the mission "to promote walkable neighborhoods." It proved highly successful because it is useful for real estate marketing, research, and journalism. I have used it extensively in my writing, but always with a grain of salt. In 2014, Walk Score® was purchased by the national real estate brokerage Redfin, and it lost its public-spirited mission. That year, the US EPA launched the National Walkability Index (NWI) as an alternative. (Steuteville 2019). The Walk Score® formula combines the length of the surrounding block, the number of nearby intersections, and the proximity to a

set of predetermined destinations (such as public transportation, restaurants, shopping, parks and green spaces, and schools). The Walk Score® metric is a hybrid between a gravity-based metric (distance accessibility) and a topological metric (street connectivity), with the latter measured by two complementary indicators that serve as penalties in the final score (in the range of 0–100). (Halla 2018), (gesana 2012).

The Walk Score® calculation methodology

In amenity categories where variety is important, the current Walk Score® considers multiple amenities in each category. Each category's importance is weighed. The base score of an address is determined by the distance to a location, counts, and weights, and then multiplied by a constant factor. (Walk Score 2011), (Walk Score 2023). Table 3 shows the weight for each amenity that is used in the current Walk Score® methodology.

According to Table 1, The numbers following a category indicate the weight and number of counts assigned to that amenity. More than one number indicates that more than one count of that amenity is included, with the weight of the second number going to the next closest amenity of that type. According to available research, the amenity categories are of high, medium, or low importance to walkability. This is reflected in the category weights. Grocery stores and restaurants and bars have three total category weights, while shopping and coffee shops have two, and the other categories have one. (Walk Score 2011) Grocery stores bear the most weight because they are major drivers of walking. (Lee 2006) as well as the most common walking destination in surveys. (Cerin 2007), (Koschinsky 2013), (Zhen et al. 2021) The distance decay function calculates the percentage of a full score that a category will receive based on the distance between the address under consideration, known as the origin, and the location of an amenity. The original calculation method for Walk Score® uses a polynomial distance decay function to return a full or near-full score for amenities located within 0.25 miles from the origin. Following that, scores decrease gradually with distance. Amenities receive only about 12% of the score they would have received if they were directly adjacent to the origin after one mile. Scores decrease less rapidly with increasing distance after one mile until they reach 1.5 miles, at which point they are no longer counted towards the final score. The sum of the above-mentioned weights is 15. In contrast, the Walk Score® is linearly expanded to range from 0 to 100. This means that the base of an amenity score must be multiplied by 6.67 (100/15) after calculating its weight and distance from the address in question. (Walk Score 2011), (Walk Score 2023) Fig. 3 conceptualizes the calculation method for the current Walk Score® methodology.

The research methodology

As depicted in Fig. 4, the research begins with a literature review of the current Walk Score® methodology and a definition of the calculation method for the current methodology. The research also examines the daily lives of neighborhood residents. The research selects the most efficient and vital amenities based on the previous literature review. The research creates a questionnaire to survey the residents' day-to-day activities in their residential neighborhood. The research suggests a new occupancy percentage schedule for each amenity throughout the day. From the previous research sequence, a new calculation method for the walk score is proposed. The study concludes by developing a new model for calculating the Walk Score of residential neighborhoods around the day in Egypt.

Table 3 The amenity weight and number of counts. Source: adapted by the researcher retrieved from (Walk Score 2011), (Walk Score 2023)

The amenities	Weight
Grocery	3
Restaurants	0.75, 0.45, 0.25, 0.25, 0.225, 0.225, 0.225, 0.225, 0.2, 0.2
Shopping	0.5, 0.45, 0.4, 0.35, 0.3
Coffee	1.25, 0.75
Banks	1
Parks	1
School	1
Book store	1
Entertainment	1

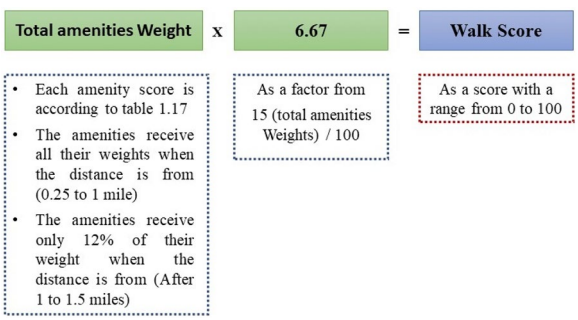


Fig. 3 The equation for current Walk Score® methodology

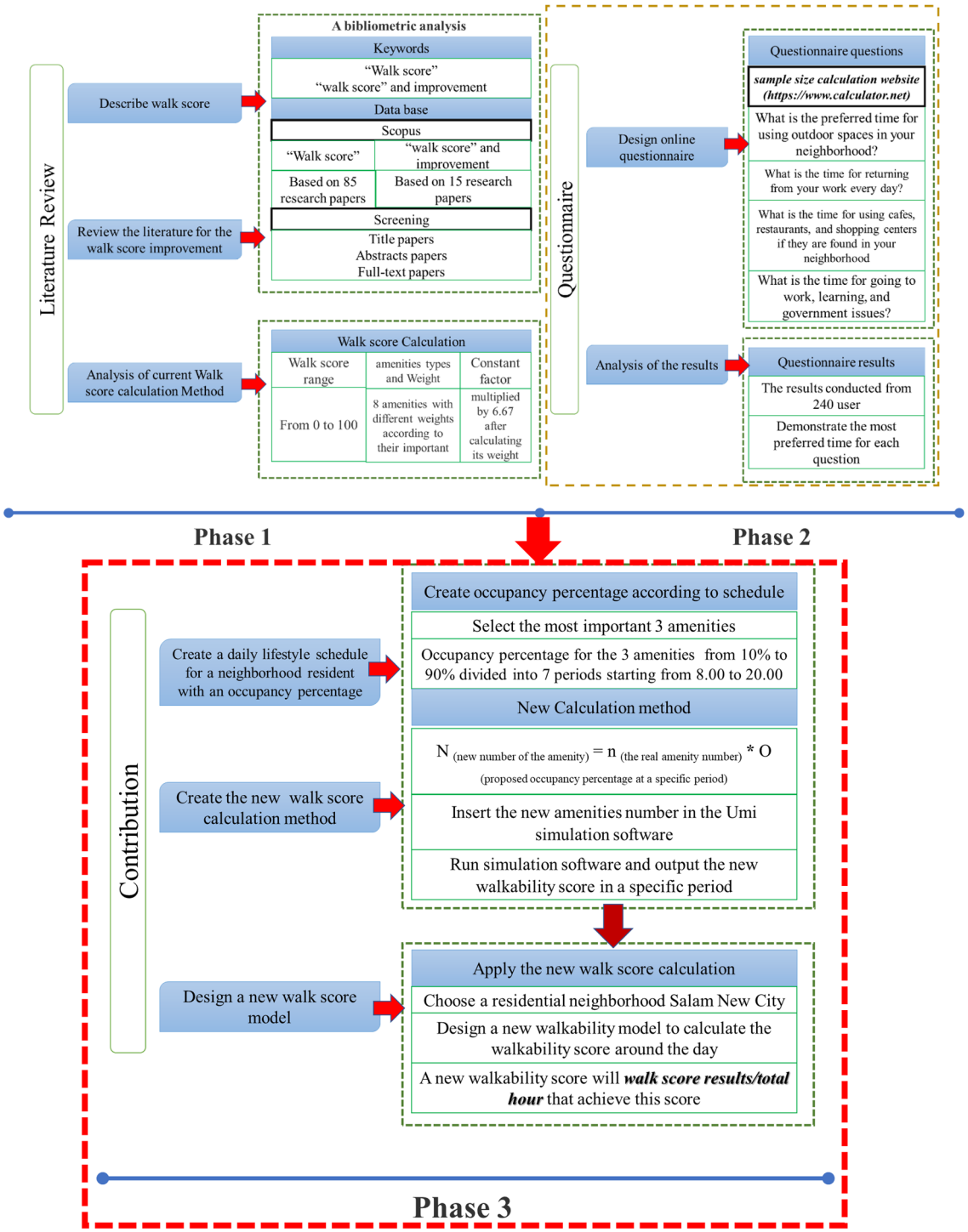


Fig. 4 Research methodology

Improving walkability score in Egypt

Egypt's overpopulation has made it difficult to enjoy a safe walking experience in much of the city. The city faces challenges such as vehicle congestion and other mobility issues. The construction of more roads, tunnels, and bridges is the planning paradigm used in Cairo in response to traffic congestion that causes mobility issues. Alternative modes of transportation, such as walking

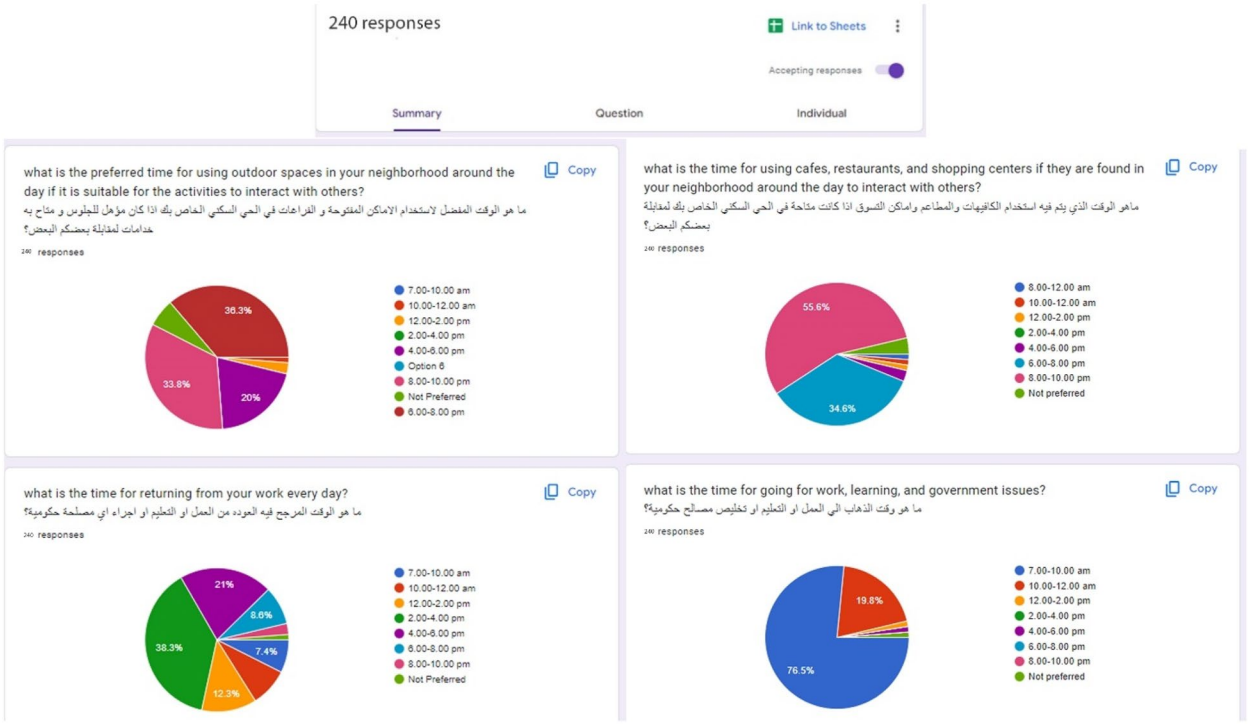


Fig. 5 The results analysis for each question

and cycling, must be encouraged to gradually replace the increasing number of vehicles on the roads that harm the environment and people. (Ghandour 2017), (Elzeni 2022) (Basaly 2021) Transportation has gotten to be an issue for creating walkable communities, so this problem must be addressed by the Egyptian government. This needs full bolstering from local and non-government organizations to make sure it can succeed. The lack of walkable components has influenced the behavior of walking among the citizens. The Egyptian cities are now car-dependent communities, which conflicts with the new theory that encourages walking over driving by limiting the use of cars. (Abdullah 2019), (EL-Zemrany, 2019), (Press 2019).

This research focuses on the case of Egyptian communities (Residential neighborhoods), especially the new communities that will be created. The proposed scenario for the occupancy percentage and schedule mainly focuses on the use of the outdoor spaces in a residential neighborhood and the most popular uses in the neighborhood (shopping categories, coffee shops, and Restaurants and bars) during the day.

Everyday life scenario

The local way of life is divided between school, work, and family. Residents notice them walking around together, dining at restaurants, and even walking in the open spaces with their friends. They go to a coffee shop in the afternoon to drink tea or coffee and smoke shisha. It's an opportunity for them to spend quality time together away from work and school. (Hooshmand 2022), (Lifestyle in Egypt 2016) The government has released a new law for closing shops and malls at 10 p.m., resulting in the end of the day at this time except for urgent uses like hospitals, pharmacies, and groceries. (News and Details 2021) The researcher uses a questionnaire methodology to make a survey about how the residents spend their time on each activity during the day. The questionnaire is in an online Google Form to reach more people in the selected neighborhood categories. The results of this questionnaire are analyzed using the Google Form results, as shown in Fig. 5.

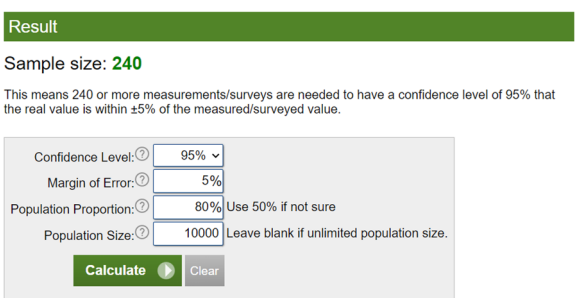


Fig. 6 Sample size calculation according to website

The questionnaire is based on 240 users responding in a residential neighborhood in Port Said according to the sample size calculation website (https://www.calculator.net), as shown in Fig. 6. The following Table 3 concludes the questionnaire conditions:

The questionnaire includes a question about the daily routine, such as time for going to work, returning home, staying in cafes, etc. Table 4 contains the questionnaire conditions. The answer to these questions is multiple choices for the daytime. Table 5 contains the questions for the questionnaire and the questionnaire results.

The results are based on the responses of 240 users to the previous survey. The previous results indicate a high percentage of outdoor entertainment use between the hours of 6–8 pm (32.1%) and 8–10 pm (37.2%), particularly between 6–8 pm (37.2%). In addition, the results indicate that a high percentage of people frequent cafes, shopping centres, and restaurants between 8 p.m. and 10 p.m. (55.7%). 75% of the occurrences of going to work, learning, and dealing with the government occur between 8 a.m. and 10 a.m. The percentage of individuals returning home from work peaks between 2 p.m. and 4 p.m. (39.2%).

8 a.m. to 10 a.m. is the main period of low occupancy for a neighborhood's services. 6–8 p.m. and 8–10 p.m. are the two most popular times for utilizing the amenities. Between periods of high and low occupancy percentages, occupancy percentages fluctuate at medium levels.

The proposed schedule in the residential neighborhood around the day

In Egypt, the day begins at 8:00 a.m. for essential activities such as work, education, and government-related matters. Typically, the social scene in a residential neighborhood begins around 10 a.m. and takes place outdoors. Some residents who go shopping or grocery shopping consume coffee in a café or eat breakfast in a restaurant. According to the questionnaire, the gathering time to interact with each other begins at 10 a.m. The occupation of the various uses in the neighborhood varies according to work, break, and leisure hours.

The researcher can conclude a day scenario for the residential neighborhood from 10 a.m. to 10 p.m. based on the previous questionnaire. The proposed period, according to the previous questionnaire, is depicted in Fig. 7.

Table 4 The questionnaire conditions

Condition	Description
Neighborhood population	10,000 Person
Age for users	18–40 years (Youth age)
Sex for users	Male and female
Neighborhood according to age and sex	8000 person (80% of the total population)

The proposed new calculation method for Walk Score in Egypt

The urban amenities that are used in the Walk Score calculation are grocery stores, restaurants, shopping malls, coffee shops, banks, schools, bookstores, and entertainment according to their weight and count, as shown in Table 3. The new schedule will be for the three most important amenities (shopping category, coffee shops, and Restaurants and bars). The reasons for selecting these categories to apply the schedule to them are: (Walk Score 2011), (Walk Score 2023).

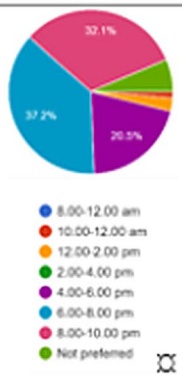
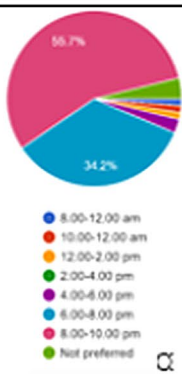
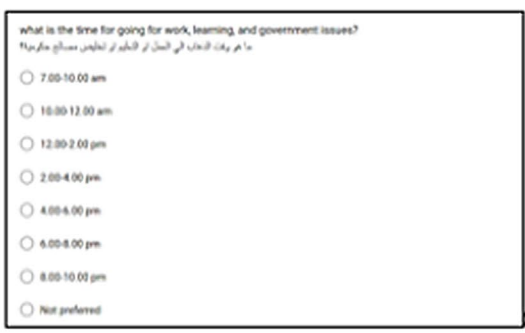
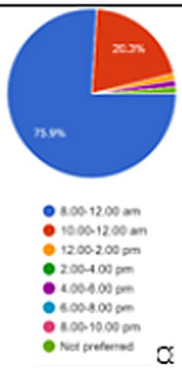
- Restaurants are found to be some of the most frequent walking destinations. (Berke 2006) So, this category has a combined total weight of 3.
- Consumer retail businesses in the shopping category include clothing, shoes, gift shops, specialty food stores, children's stores, and so on. Shopping and retail are popular walking destinations, are frequently used categories in the research literature, and are found to increase walking. (Cerin 2007), (Lee 2006)
- For coffee shops, variety is also important, but not to the same degree that it is for restaurants and shopping. Coffee shops are found by both (Cerin 2007) and (Lee 2006) to be important destinations, and the presence of nearby coffee shops indicates an area's overall walkability.

The other amenities (Banks, Parks, schools, Book stores, Entertainment, and Grocery stores) are constant without any change throughout the day. These amenities do not need a schedule as they have no occupancy scenario according to their use. The neighborhood will be satisfied with one amenity from each of these amenities. The proposed scenario will modify the Walk Score calculation according to time and occupancy, as shown in Table 6.

From Table 6, the proposed scenario will be divided into 7 periods from 10 a.m. to 10 p.m., and the occupancy percentage scenario will also be divided into 7 different percentages from 10 to 90%. The method to calculate the new score is:

- Determine the total categories and amenities that will be found in the neighborhood.
- Insert all the amenities except the most important (shopping, coffee shop, and restaurant).

Table 5 The questionnaire design and the results

The Designed questions and their format	The results
Q1		
Q2		
Q3		
Q4		

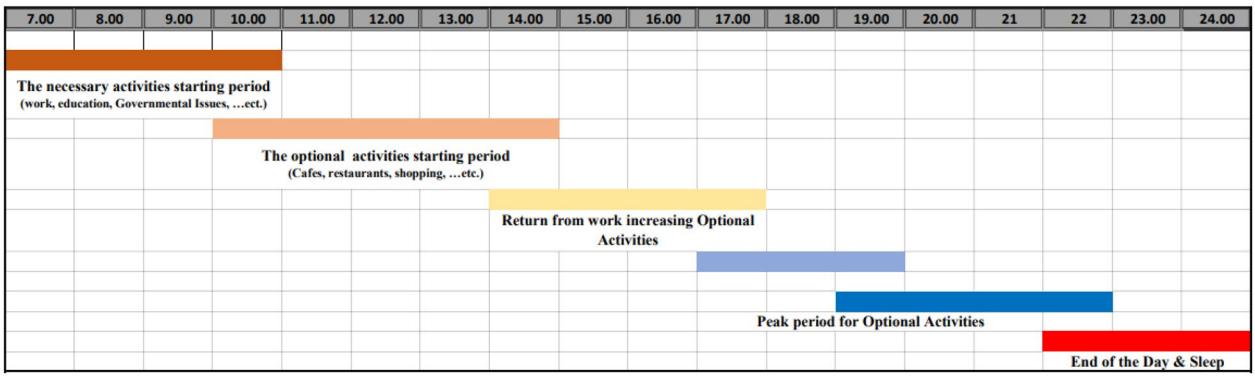


Fig. 7 The resident's lifestyle during the day at the neighborhood level. Source: proposed by the Researchers retrieved from the previous questionnaire

Table 6 The proposed Scenario for the schedule and the occupancy percentage. Source: designed by the researchers retrieved from the previous questionnaire

Time	Occupancy percentage	Occupancy percentage cause
8.00–10.00	10	The occupancy is low at this period as a large percentage is doing the necessary activities such as work, education, governmental issues, etc
10.00–12.00	20	
12.00–14.00	30	
14.00–16.00	40	The occupancy is medium as a medium percentage of residents return from work
16.00–18.00	50	
18.00–20.00	70	During this period, the occupancy is high, as this is the entertainment time for the residents in the neighborhood
20.00–22.00	90	

- The total number of residents in each important category will multiply the occupancy percentage according to time.
- The number of the selected category that will be multiplied by the occupancy percentage will be the number that will be inserted to calculate the walk score at the selected time.
- For example, the total number of restaurants in a neighborhood is eight. The number that will be used for calculating the walk sore at periods (4–6 pm) is (8 * 0.50 = 4 restaurants).
- The occupancy percentage of 100% is neglected as it is not going to happen except in the peak times around the year at the festivals, so it isn't a percentage to build a new methodology on.

Generally, the new modification will be as:

$$N_{(\text{new number of the amenity})} = n_{(\text{the real amenity number})} * O_{(\text{proposed occupancy percentage at a specific period})}$$

Residential neighborhood as a case study in Port Said New City

The study areas will be chosen as medium-sized areas for a residential complex for a social housing project, which is the prevailing model for the implementation of social housing projects at the Egyptian Republic level. All study areas are nearly finished but have not yet been inhabited or handed over to their beneficiaries. The case study will have chosen Port Said City, Salam New City, one of the cities in the Suez Canal region, which is currently regarded as one of the most important areas and contains numerous development projects. It includes a new neighborhood dedicated to social housing, which includes a group of residential buildings and a service center. A portion of that residential complex will be chosen, with an area of approximately 306659 m^2 and a total number of buildings of approximately 190 residential buildings with an area of 289 m^2 per building, and this portion includes a central service center. Figure 8 shows the master plan for the selected neighborhood with the neighborhood center. The amenities of the selected neighborhood are located in the center as shown in figure 10. (Mohamed 2022).

Fig. 8 The layout of the neighborhood in Salam New City (Second Residential District). Source: (http://www.newcities.gov.eg/ Accessed 05 June 2021)

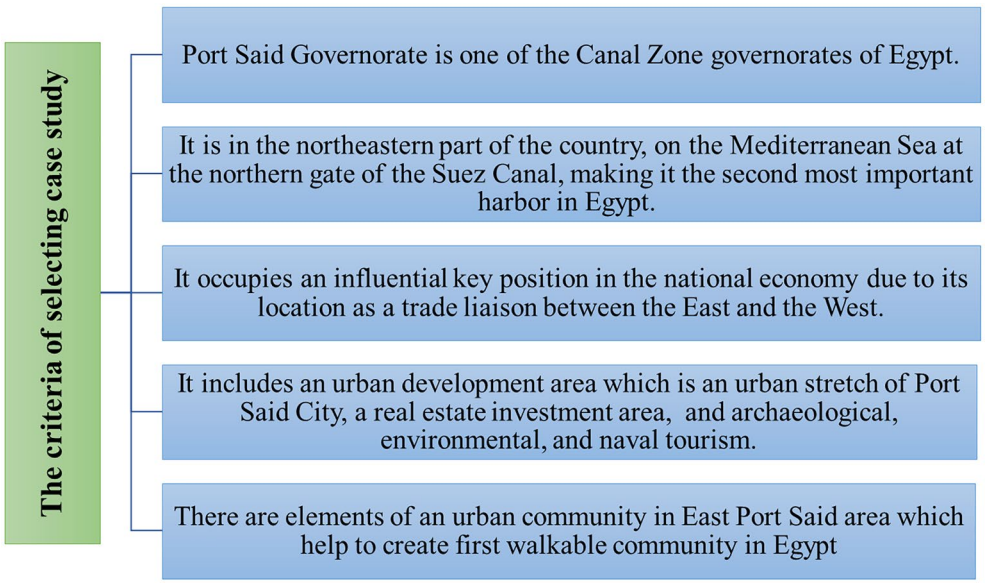


Fig. 9 The criteria of selecting the case study

Figure 9 shows the criteria for selecting the case study. The selection of this case study was made according to its importance in Egypt and according to the government's development vision. The research also selects Port Said New City as it is under construction and will be the first new city to apply the new walk score methodology in Egypt to its housing projects.

To calculate the Walk Score using the distance decay function concept, the research uses the Rhinoceros computer-aided design software's urban modelling interface (UMI) plugin. The score will be determined by the density and variety of urban amenities such as grocery stores, restaurants, shopping malls, coffee shops, banks, schools, bookstores, and entertainment within

Table 7 The current amenities for the selected neighborhood

Amenities	Amenities count
Grocery shop	1
School	1
Restaurant	3
Coffee shop	3
Shopping	1
Banks	1
Entertainment	1
Book store	1

Table 8 The difference between the current methodology and the proposed methodology for Walk Score. Source: Umi simulation software retrieved from the new calculation method

The walk score with the current methodology		The walk score with the proposed methodology	
Time	**Walk sore**	**Time**	**Walk score**
Around the whole day with (100% occupancy all the time)	43	8.00–10.00 (10% occupancy)	8
		10.00–12.00 (20% occupancy)	8
		12.00–14.00 (30% occupancy)	17
		14.00–16.00 (40% occupancy)	17
		16.00–18.00 (50% occupancy)	30
		18.00–20.00 (70% occupancy)	36
		20.00–22.00 (90% occupancy)	43

Fig. 10 The location of the amenities in the selected neighborhood. Source: adapted by the researchers retrieved from http://www.newcities.gov.eg/ Accessed 05 June 2021

800 m. This tool has been praised by users as the most accessible tool for assisting urban designers in creating a wonderfully walkable city. (Tochaiwat 2022).

The new method for measuring the Walk Score will be applied by using the previous tool and extracting the new Walk Score for the proposed period around the day. Table 7 below will contain the current amenities for the selected neighborhood.

Table 8 discusses the difference between the walk score results according to the new walk score calculating methodology for each period proposed in this research (Fig. 10).

Table 8 shows the difference between the current walk score methodology and the new methodology. The current Walk Score is constant throughout the day in the selected Area in Port Said city, with no variation throughout the day as the current methodology doesn't consider amenities occupancy as a factor. The new methodology has a different walk score throughout the day. This methodology helps the urban designer design urban open spaces according to the amenities and the occupancy of each amenity throughout the day to increase social interaction by increasing walkability. The new methodology

Current neighborhood amenities		Period	Occupancy %	New amenities Count according to occupancy %		New walkability Score	Indicated Graph
Restaurant	3	9.00 - 10.00	10%	Restaurant	0	8	
				Cafes	0		
				Cafes	0		
		10.00 - 12.00	20%	Restaurant	0	8	
				Cafes	0		
				Shopping	0		
		12.00 – 14.00	30%	Restaurant	1	17	
				Cafes	1		
				Shopping	0		
Cafes	3	14.00 – 16.00	40%	Restaurant	1	17	
				Cafes	1		
				Shopping	0		
		16.00 – 18.00	50%	Restaurant	2	30	
				Cafes	s		
				Shopping	0		
Shopping	1	18.00 – 20.00	70%	Restaurant	2	36	
				Cafes	2		
				Shopping	1		
		20.00 – 22.00	90%	Restaurant	3	43	
				Cafes	3		
				Shopping	1		

Fig. 11 The proposed graph for the new Walk Score model

has more accuracy as the walk score is different around the day and the occupancy percentage is different around the day according to the daily duties of the residents. The following graph (Fig. 11) shows the new method that can be used to analyze walkability in residential neighborhoods.

Figure 11 depicts a low walkability score ranging from 8 to 17 at the beginning of the day. This low rate is a result of the absence of services and the low occupancy rate. To increase the walkability of a neighborhood, the number of amenities should be increased to create more places for interaction. The research recommends a minimum walkability score of 40 for approximately eight hours from the first day, which will increase social interaction and activities to improve the social life in residential neighborhoods and create walkable, attractive, and resilient cities.

Conclusion

At the macro-level of the neighborhood, walkability was found to be related to objective measures including street density, block density, and land use diversity. Urban planning strategies that promote the development of mixed-use neighborhoods may increase transportation-related walking for these people, but they are unlikely to increase transportation-related walking for individuals who spend little time in their neighborhoods. According to the research, the walk score calculation disregards the occupancy schedule and percentage of occupancy for each use. This discrepancy will affect the precision of residential neighborhood walkability values. At the residential neighborhood level in Egypt, this research proposes an improvement to the current Walk Score methodology.

The study proposed a scenario for the day by creating a schedule for the percentage of occupancy during the Egyptian day's active period. Based on a questionnaire with an occupancy percentage scenario (10–90%) for the most important amenities (shopping categories, coffee shops, restaurants, and bars), the schedule starts at 8 a.m. and ends at 10 p.m. In addition, a new graph depicting the various walkability scores throughout the day in a residential neighborhood is created. The research suggests that when designing a residential neighborhood, the walkability should not be less than 40/8 h to improve the social life in the new communities. This value will help to exploit the urban open spaces in residential areas that are designed in the new communities, as these spaces are neglected due to the absence of the walkability concept in Egypt. The research suggests optimizing the newly created walk score by factoring in outdoor thermal comfort. By including outdoor thermal comfort as a significant factor in the calculation of the walk score, the value's precision will increase. Increasing the walkability of new communities contributes to an increase in the social life of new communities and creates healthy, resilient cities.

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Author contributions

[1]Developed the theoretical formalism, performed the analytic calculations, performed the numerical simulations, and wrote the manuscript. [2]Supervised the project. [3]Provided critical feedback and helped shape the research and analysis manuscript. [4]Contributed to the final version of the manuscript and supervised the findings of this work. All authors discussed the results and contributed to the final manuscript.

Availability of data and materials

The data underlying this article will be shared on reasonable request to the corresponding author.

Declarations

Competing interests

Non-financial competing interests include political, personal, religious, ideological, academic, and intellectual competing interests.

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References

Abdelsalam T, Yousry A, Roshdy A (2016) The reflections of smart city approach on new cities in Egypt. J Urban Res 20:79–99

Abdollahzadeh N, Biloria N (2021) Outdoor thermal comfort: Analyzing the impact of urban configurations on the thermal performance of street canyons in the humid subtropical climate of Sydney. Front Archit Res 10:394–409. https://doi.org/10.1016/j.foar.2020.11.006

Abdullah M, Shafik Z, El-Kerdany D (2019) General theory of walkability as criteria for regenerating Maadi as a walkable neighborhood. Eng Res J 162:A60–A75

Baobeid Abdulla, Koç Muammer, Al-Ghamdi Sami G (2021) Walkability and its relationships with health, sustainability, and livability: elements of physical environment and evaluation frameworks. Front Built Environ. https://doi.org/10.3389/fbuil.2021.721218

Al Sabbagh N (2017) Walkability in Dubai: improving thermal comfort. The Open University Architectural Association School of Architecture, London, UK

Ariffin RNR, Rahman NHA, Zahari RK (2021) Systematic literature review of walkability and the built environment. J Policy Gov 1(1):1–20. https://doi.org/10.33002/jpg010101

Barbulescu G, Lafargue R (2016) Improving social sustainability through comfortable outdoor spaces. Transsolar Academy, Constanta, Romania

Basaly LG, Ibrahim MG, Badawy NM, Abdelaaln MRM, Murata R (2021) Improvement of outdoor space microclimate in hot arid regions using solar pavilions. J Urban Plan Dev. https://doi.org/10.1061/(ASCE)UP.1943-5444.0000724

Berke EM, Koepsell TD, Moudon AV, Hoskins RE, Larsonmd EB (2006) Association of the built environment with physical activity and obesity in older persons. Am J Public Health. https://doi.org/10.2105/AJPH.2006.085837

Cerin E, Macfarlane DJ (2007) Measuring perceived neighborhood walkability in Hong Kong. Cities 24(3):209–217. https://doi.org/10.1016/j.cities.2006.12.002
Choi Y, Yoon H (2020) Do the walkability and urban leisure amenities of neighborhoods affect the body mass index of individuals? Based on a case study in Seoul, South Korea. Int J Environ Res Public Health 17(6):2060
Chum A, Atkinson P, O'Campo P (2019) Does time spent in the residential neighbourhood moderate the relationship between neighbourhood walkability and transport-related walking? a cross-sectional study from Toronto, Canada. BMJ Open. https://doi.org/10.1136/bmjopen-2018-023598
Darwish MS (2015) Evaluating growth management policies in new urban settlements in Egypt. J Urban Res 15:60–78
Ding D, Sallis JF, Kerr J, Lee S, Rosenberg DE (2011) Neighborhood environment and physical activity among youth a review. Am J Prev Med 41(4):442–455. https://doi.org/10.1016/j.amepre.2011.06.036
Duncan DT, Aldstadt J, Whalen J, Melly SJ, Gortmaker SL (2011) Validation of walk Score® for estimating neighborhood walkability: an analysis of Four US Metropolitan Areas. Int J Environ Res Public Health 8(11):4160–4179. https://doi.org/10.3390/ijerph8114160
El Ghandour S (2017). Towards more Pedestrian-Friendely Street in Cairo. The American University in Cairo, Department of Public Policy and Administration.
EL-Zemrany AM, Kandil RAA (2019a) Quality of life in Egypt: walkability assessment in El-Manshya Square, Alexanderia, Egypt. Coast Cities Sustain Future 188:23–34
EL-Zemrany AM, Kandil RAA (2019b) Quality of life in Egypt: walakability assessment in EL-Mansheya Square Alexandria, Egypt. Coast Cities Sustain Future III 88:23–34. https://doi.org/10.2495/CC190031
Elzeni MM, ELMokadem AA, Badawy NM (2022) Impact of urban morphology on pedestrians: a review of urban approaches. Cities 129:103840
Gao J, Kamphuis CBM, Helbich M, Ettema D (2020) What is 'neighborhood walkability'? How the built environment differently correlates with walking for different purposes and with walking on weekdays and weekends. J Transp Geogr 88:1–9. https://doi.org/10.1016/j.jtrangeo.2020.102860
Hooshmand D (2022) Living in Egypt: a human review. Discover discomfort: https://discoverdiscomfort.com/living-in-egypt-cairo-human-review/. Accessed 23 May 2022.
Indraprastha A, Prantaputra B (2019) Informed walkable City Model. 24th International Conference of the Association for Computer-Aided Architectural Design Research in Asia (CAADRIA) (pp. 161–170). Hong Kong: the Association for Computer-Aided Architectural Design Research in Asia (CAADRIA).
Jamei E, Ahmadi K, Chau HW, Seyedmahmoudian M, Horan B, Stojcevski A (2021) Urban design and walkability: lessons learnt from Iranian traditional cities. Sustainability 13:1–14. https://doi.org/10.3390/su13105731
KahinaLabdaoui SM, Acidi A, Cools M, Moeinaddini M, Teller J (2021) Utilizing thermal comfort and walking facilities to propose a comfort walkability index (CWI) at the neighbourhood level. Build Environ. https://doi.org/10.1016/j.buildenv.2021.107627
Kim EJ, Kim J, Kim H (2020) Neighborhood walkability and active transportation: a correlation study in leisure and shopping purposes. Int J Environ Res Public Health 17(7):2178. https://doi.org/10.3390/ijerph17072178
Koschinsky J, Talen E (2013) The walkable neighborhood: a literature review. Int J Sustain Land Use Urban Plan 1(1):42–63. https://doi.org/10.24102/ijslup.v1i1.211
Ledraa TA (2015) Evaluating walakability at the neighbothood and street levels in Riyadh using GIS and envirnoment audit tools. Emir J Eng Res 2:1–13
Lee C, Moudon A (2006) Correlates of walking for transportation or recreation purposes. J Phys Act Health. https://doi.org/10.1123/jpah.3.s1.s77
Lifestyle in Egypt (2016) https://www.expat.com/en/guide/africa/egypt/14274-lifestyle-in-egypt.html Accessed 05 Mar 2022
Michael Halla C, Ram Y (2018) Walk score® and its potential contribution to the study of active transport and walkability: a critical and systematic review. Transp Res Part D. https://doi.org/10.1016/j.trd.2017.12.018
Mohamed AN, Elmokadem AAE, Ali SM, Badawey N (2022) Improve urban form to achieve high social sustainability in a residential neighborhood salam new city as a case study. Buildings 12(11):1935. https://doi.org/10.3390/buildings12111935
News and Details. (2021). Presidency of the Council of Ministers. https://cabinet.gov.eg/. Accessed by 8 June 2022
Ngesana MR, Karimb HA, Zubirc SS (2012) Human behaviour and activities in relation to Shah Alam urban park during nighttime. Procedia Soc Behav Sci 68:427–438
Press E (2019) Cairo's walkability index and urban history. Enterprise Press: https://enterprise.press/stories/2019/09/30/cairos-walkability-index-and-urban-history/ Accessed 20 June 2022
Saelens BE, Papadopoulos C (2008) The importance of the built environment in older adults' physical activity: a review of the literature. Washington State J Public Health Pract 1:13–21
Silvennoinen H, Kuliga S, Herthogs P, Recchia DR, Tunçer B (2022) Effects of Gehl's urban design guidelines on walkability: a virtual reality experiment in Singaporean public housing estates. Urban Anal City Sci. https://doi.org/10.1177/23998083221091822
Singh R (2016) Factors affecting walkability of neighborhoods. Procedia Soc Behav Sci 216:643–654
Steuteville R (2019) Walkability indexes are flawed. Let's find a better method., from CNU: https://www.cnu.org/publicsquare/2019/01/10/walkability-indexes-are-flawed-lets-find-better-method1 Accessed 12 June 2023
Sun Ye, Wei Lu, Sun P (2021) Optimization of walk score based on street greening—a case study of Zhongshan road in Qingdao. Int J Environ Res Public Health 18(3):1277. https://doi.org/10.3390/ijerph18031277
Tochaiwat K, Poochai S, Rimchumphu D, Suttiwongpan C, Raksuntorn W, Witchayangkoon B, Raksuntorn N (2022) Walk score assessment using urban modeling interface in Mahachai City, Thailand. J Hunan Univ (Nat Sci) 49(3):179–184
Tuydes-Yaman H, Karataş P (2018) Evaluation of walkability and pedestrian level of service. Intelligent transportation and planning. IGI Global, Pennsylvania, pp 264–291. https://doi.org/10.4018/978-1-5225-5210-9.ch012
Walk Score (2011) Walk Score: http://pubs.cedeus.cl/omeka/files/original/b6fa690993d59007784a7a26804d42be.pdf Accessed 20 July 2023
Walk Score (2022) wikipedia: https://en.wikipedia.org/wiki/Walk_Score Accessed 25 Sept 2022
Walk Score (2023) Walk Score: https://www.walkscore.com/methodology.shtml Accessed 03 July 2023
Zayed MAA (2013) The effect of landscape elements on walkability in Egyptian gated communities. Int J Archit Res 10(2):1–16
Zhang Y, Zhang J, Kai Xu, Tang D, Li Y, Wang X, Zhang K (2022) An improved method for urban walk score calculation considering perception of the street environment. Trans GIS 26(3):1399–1420. https://doi.org/10.1111/tgis.12909
Zhen M, Dong Qi, Chen P, Ding W, Zhou D, Feng W (2021) Urban outdoor thermal comfort in western China. J Asian Archit Build Eng 20(2):222–236. https://doi.org/10.1080/13467581.2020.1782210
Zuniga AA, Orr TJ, Gimblett RH, Chalfoun NV, Marsh SE, Guertin DP, Going SB (2017) Designing healthy communities: testing the walkability model. Front Archit Res 6(1):63–73

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