第 49 卷 第 3 期
2022 年 3 月

湖南大学学报（自然科学版）
Journal of Hunan University (Natural Sciences)

Vol. 49 No. 3
March 2022

Open Access Article https://doi.org/10.55463/issn.1674-2974.49.3.19

Walk Score Assessment using Urban Modeling Interface in Mahachai City, Thailand

Kongkoon Tochaiwat[1], Suttamas Poochai[1], Damrongsak Rimchumphu[2,3,*], Chakorn Suttiwongpan[3], Winai Raksuntorn[4], Boonsap Witchayangkoon[4,*], Nareenart Raksuntorn[5]

[1] Faculty of Architecture and Planning, Thammasat University, Bangkok, Thailand

[2] Faculty of Engineering, Chiang Mai University, Chiang Mai, Thailand

[3] City Research and Development Center, Faculty of Engineering, Chiang Mai University, Thailand

[4] Department of Civil Engineering, Thammasat School of Engineering, Thammasat University, Bangkok, Thailand

[5] Faculty of Industrial Technology, Suan Sunandha Rajabhat University, Thailand

Abstract: The objectives of this study were to exhibit walk scores in the Mahachai sub-district, Mueng District, Samut Sakhon Province, Thailand, and build and construct acceptable models for diverse problem circumstances. The 3D physical model and walk score simulations were examined utilizing an urban modeling interface (UMI) plug-in, a part of a comprehensive modeling method in Rhinoceros computer-aided design software. The algorithm evaluates the proximity of points of interest to amenities of grocery stores, restaurants, shopping malls, coffee shops, banks, schools, bookstores, and entertainment. The simulation results show that the average walk score of the existing urban context is 87 points, according to the walkable city. However, the trial of new amenities added to the urban context by the same amenity type can change the score to 88 points, which would not significantly improve the score. The score increased to 93 points when adding the different amenities to the area. These reflect the need for urban amenities variety can improve the walkable quality in the city. The research proves the ease of using the UMI plug-in associated with the Rhinoceros software. Moreover, the results are necessary to guide urban designers to create walkable cities in the future.

Keywords: urban design, walk score, walkability, simulation, amenity, urban modeling interface.

在泰国玛哈猜市使用城市建模界面进行步行分数评估

摘要：本研究的目的是展示泰国龙仔厝府孟区玛哈猜街道的步行分数，并针对不同的问题情况建立和构建可接受的模型。使用城市建模界面插件检查 3D 物理模型和步行分数模拟，这是犀牛计算机辅助设计软件中综合建模方法的一部分。该算法评估兴趣点与杂货店、餐馆、购物中心、咖啡店、银行、学校、书店和娱乐设施的距离。模拟结果表明，现有城市文脉的平均步行得分为 87 分，根据可步行城市。但是，通过相同的便利设施类型在城市环境中添加新便利设施的试用可以将分数更改为 88 分，这不会显着提高分数。为该地区添加不同的便利设施时，得分增加到 93 分。这些反映了对城市便利设施多样性的需求，可以提高城

Received: 23 December, 2021 / Revised: 07 January, 2022 / Accepted: 24 February, 2022 / Published: 28 March, 2022

About the authors: Kongkoon Tochaiwat, Suttamas Poochai, Faculty of Architecture and Planning, Thammasat University, Bangkok, Thailand; Damrongsak Rimchumphu, Faculty of Engineering, Chiang Mai University, Chiang Mai, Thailand; City Research and Development Center, Faculty of Engineering, Chiang Mai University, Thailand; Chakorn Suttiwongpan, City Research and Development Center, Faculty of Engineering, Chiang Mai University, Thailand; Winai Raksuntorn4, Boonsap Witchayangkoon4, Department of Civil Engineering, Thammasat School of Engineering, Thammasat University, Bangkok, Thailand; Nareenart Raksuntorn, Faculty of Industrial Technology, Suan Sunandha Rajabhat University, Thailand

Corresponding authors Damrongsak Rinchumphu, damrongsak.r@cmu.ac.th; Boonsap Witchayangkoon, wboon@engr.tu.ac.th

市的步行质量。研究证明了与犀牛软件相关的城市建模界面插件的易用性。此外，这些结果对于指导城市设计师在未来创造可步行的城市是必要的。

关键词：城市设计、步行分数、步行性、模拟、舒适性、城市建模界面。

1. Introduction

For decades, developers or city planners have disregarded pedestrian access to the neighborhood; most individuals prefer to travel by car than walking [1, 2]. Pedestrian-friendly cities have sprouted up worldwide to meet the needs of city dwellers who no longer require the same amount of room for car travel [3]. Walking is an excellent mode of transportation. It may claim that walking is required to establish a livable city [2]. Moreover, it is one of the aspects that influences people's health and well-being [4, 5].

In contrast, one of the most frequently considered factors is the livability of cities requiring a standardized indicator of walking difficulties [6, 7]. Cities all over the world may see it. It does not differ for those who live in Tokyo, London, or Portland [8]. These are all cities where most people commute by walking or cycling to provide people with a good standard of living. Moreover, it reduces the harmful effects of urban living on citizens' health, such as obesity, hypertension, diabetes, and new diseases brought on by temperature variations [9], including stress-related disorders, which are becoming more prevalent among today's metropolitan dwellers [5].

Furthermore, encouraging pedestrians makes the city a more pleasant place to live. Finally, it is the foundation for the creative economy's continued development. For example, real estate companies have discovered the capacity to access services in numerous countries using walkability as a marketing technique [1, 10].

Additionally, research in the United States has discovered that land with high walking scores has a higher land value than land in the same city area [1]. Americans use it to check the city's walking scores to gauge the livability of many homes they want to buy and apartments to rent. These show alertness to make complex lifestyle changes less difficult [11].

Calculating the walking score is a globally known measure that assesses the effectiveness of urban design and planning for pedestrians [12] - using a method for calculating the walking score based on real-world walking experience. The grading system is based on the physical qualities of each city or surrounding area component. The potential of future community design and planning may be measured using pedestrian levels[8, 10]. According to a real estate survey conducted in Jefferson County, Alabama, land with a high walk score improves in value. Business centers tend to have higher walk scores than the national average. However, there is significant controversy about whether regions outside the corporate hub are walkable.

Furthermore, walking ability has no bearing on the land's value. The data from over 94,000 real estate transactions in 15 major housing markets have been examined. The degree of local walkability is strongly related to the value of properties in 13 of them [1]. It also found that having a walking area adds value to residential real estate and adds more space to the home's rooms and other amenities, even during the economic downturn. In other words, the customer establishes the monetary worth of living comfort by buying a walking location with various places [13].

Many proponents of concepts for predicting tools assess city walkability and emphasize quantitative research. Modeling, for example, may be used to forecast consumer happiness or quality. They consider the physical qualities of urban design, particularly pedestrian pleasure in urban design. Handy et al. [11] was carried out to evaluate the link between pedestrian traffic choosing behavior and the influence of the community's built environment using a regression analysis approach and the empirical method of the city of Northern California, USA. The behavior of walkers is influenced by the distance between the house and the nearest shop.

Dyck et al. [4] used multiple regression analysis to develop a model to predict adult community members' happiness with walking. The findings are being utilized to help the planners for increase foot traffic. Space Syntax is a perspective of the network of areas embedded in the urban structure through a network of traffic, based on the natural movement theory, which states that each space has distinct possibilities. Because each location desires autonomous pedestrian access that varies depending on the area's topology compared to the city, the number of people wandering in the area changes. The way each place uses its terrain is also unique.

A computer program's network analysis of public places is the first phase of the space syntax and gathering empirical data on local use [14]. Mansouri & Ujang [13] presented a straightforward relationship between the values obtained from actual tourist observations and the values obtained in simulations using measurements under space syntax. It can also apply the residents' walking habits to the tourist context. Garau et al. [6] calculated the space syntax. They then processed it with other variables to further impact walking in urban areas, which is another point in favor of the application strategy.

However, the urban modeling interface (UMI) plug-in of the Rhinoceros computer-aided design software has been introduced to calculate the walk score by the concept of distance decay function [15]. It will be estimated the score from the density and variety of urban amenities such as grocery stores, restaurants, shopping malls, coffee shops, banks, schools, bookstores, and entertainment within walking distance of 800 meters. The users have praised this tool as the most accessible tool to support the urban designer practices to make a wonderfully walkable city [15, 16].

For proving those concepts, this research randomly chose Mahachai Subdistrict, Mueang District, Samut Sakhon Province (called Mahachai city) to use for the experiment site. The results will present the existing walk score of Mahachai city compared to the possible alternative scenarios. Furthermore, using the tool will be proved and used as the reference case for other project research and urban development practices in the future of Thailand.

2. Research Method

This research has two simple steps, starts at Step 1 by collecting the top view satellite image of the Mahachai city (presented in Fig.1), then checking data on the field survey for creating the 3d model of the city with exiting location of the selected eight types of the urban amenity (grocery stores, restaurants, shopping malls, coffee shops, banks, schools, bookstores, and entertainment).

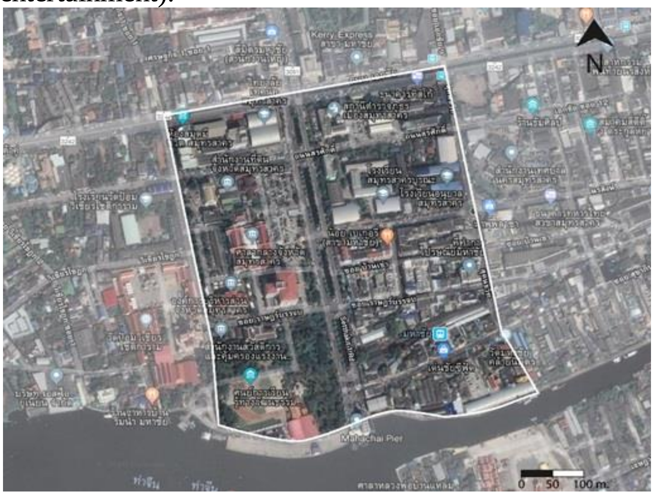


Fig. 1 Top view satellite image of Mahachai city and the scope area

For step 2, the model was created in Rhinoceros software using the UMI 2.0 plug-in to calculate the walk score. The research process is presented in Fig. 2 below.

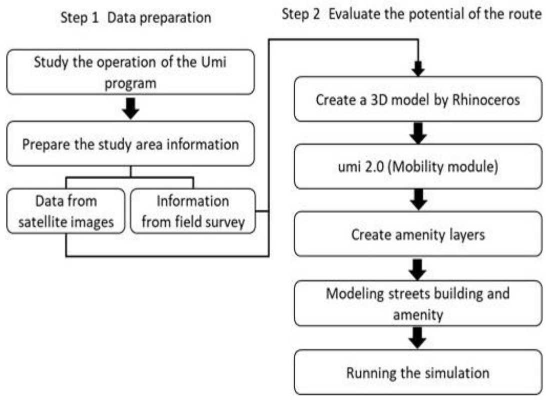


Fig. 2 Research process

The Rhinoceros software has been adopted to create the 3D physical model. The user interface is present in Fig. 3, which can freely download the UMI 2.0 plug-in from the website of the Sustainable Design Lab at MIT (https://web.mit.edu/sustainabledesignlab/projects/umi/index.html), the toolbar window, and command-tab of the UMI 2.0 in the Rhinoceros software are also presented in Fig. 4 below.

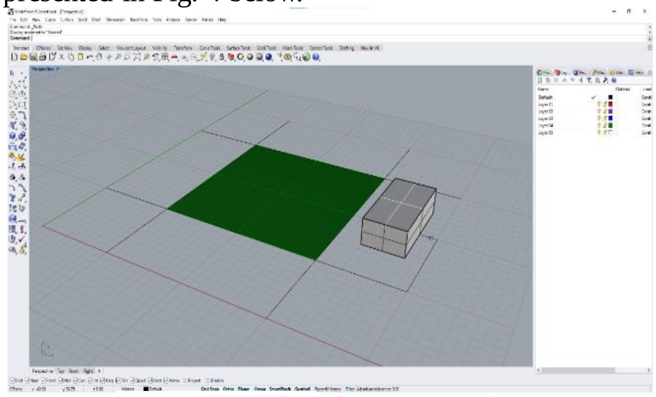


Fig. 3 User interface of Rhinoceros software

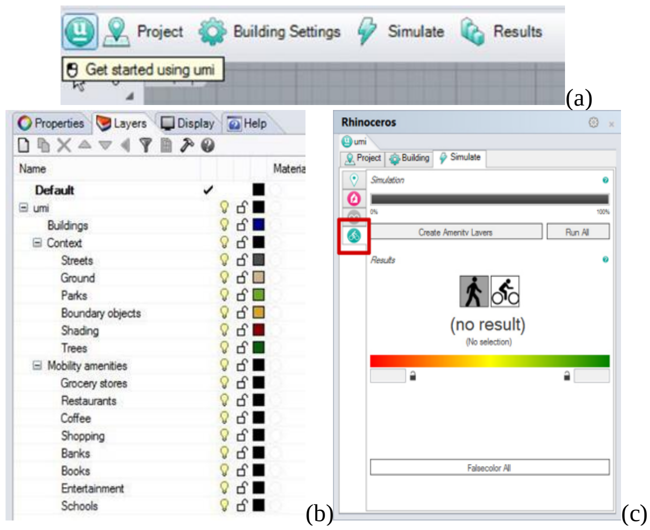
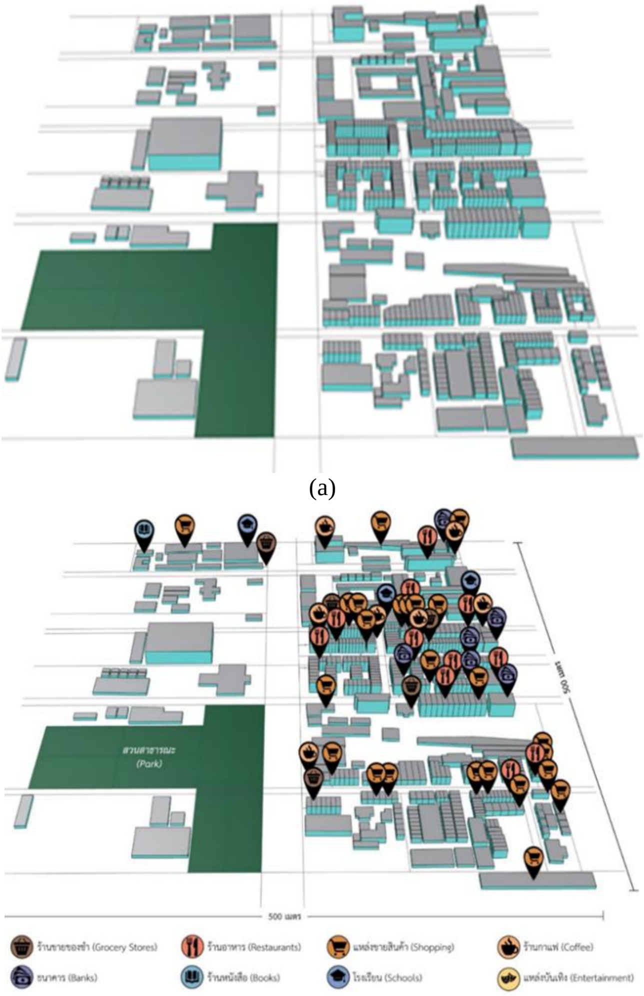


Fig. 4 The window tab (a), commands set (b), and running interface (c) of the UMI 2.0 plug-in

A 3D physical model which includes several buildings, roads, walkways, and parks has been created. Then, the model will be processable by the UMI plug-in in Rhinoceros software. Finally, base-case exiting 3D physical model presented in Fig. 5 (a), the existing amenities are collected and located on the map in Rhinoceros, illustrated in Fig. 5 (b) below.



(a)

(b)

Fig. 5 The 3D physical model (a) and the amenity types and location (b) of the study area

The UMI plug-in has mandated the types of amenities into eight categories: 1) grocery stores, 2) restaurants, 3) shopping malls, 4) coffee shops, 5) banks, 6) schools, 7) bookstores, and 8) entertainment, which is located and displayed in the program. The study area has almost all types of facilities specified by the data layer, only lacking entertainment sources.

Next, there will be tested two alternative scenarios. Both will add more amenities to the base-case urban context scenario. Scenario-1 aimed to add new-same-type amenities close to the existing one, such as adding a new grocery store next to the existing one. Conversely, Scenario-2 increases new-difference-type amenities to the existing urban context, such as a new restaurant next to the current grocery store. The two alternative scenarios will be used to calculate the walk score in the UMI plug-in, then compared to the walk score of the exiting urban context from the base-case scenario.

3. Result

The 3D physical model of Mahachai city was developed in Rhinoceros computer-aided design software and using the UMI plug-in in the walk score assessment. The results can be presented in two parts: the walk score from the existing urban context as a base-case study and the walk score from two alternative scenarios after the urban context improvement. The average walk score of the base-case scenario was 87 points, demonstrated in Fig. 6.

Fig. 6 Walk score of the base-case scenario

According to the walk score point and its interpretation presented in Table 1, the average walk score of the existing urban context of Mahachai city can be interpreted as the area of good walking access (score range 70 – 89 points) [17].

Table 1 Walk score and the interpretation

Walk Score	Description
90 – 100	Walking is a great option. Do not rely on a car to get about
70 – 89	Good walking access
50 – 69	Accessible by moderate walking
25 – 49	Most of them use cars for traveling
0 – 24	When traveling, almost usually utilize a car

Next, the result of Scenario-1 from “adding the same type of amenities into the urban context” can be presented in Fig. 7 (a) below. Fig. 7 (a) presents the alternative of adding several amenities to the model; new amenities have a green dot underneath the pin mark. The average walk score of this scenario is 88 points. Therefore, it can interpret the same walk score level as the base-case scenario, “Good walking access”. Then, Fig. 7 (b) presents the result of Scenario-2 by “adding the different types of amenities into the urban context".

(a)

(b)

Fig. 7 Walk score of the Scenario-1 (a) and Scenario-2 (b)

The variety and differentiation of the urban amenities show a significantly different walk score from the same amount of the new amenities added. The average walk score of Scenario-2 is 93 points, which can interpret as "Walking is a great option. Do not rely on a car to get about".

4. Discussion

The trial process outcomes from the base-case scenario, Scenario-1, and Scenario-2, were found. The type of amenity significantly affects the walk score compared to the numbers. These can be presented in the comparison between the walk score of Scenario-1 is slightly increased from the base-case scenario. Meanwhile, the score from Scenario-2 is getting significantly higher. To support this finding, creating an area with two or more amenities increases the urban walking potential [16]. The variety of amenities has possibly changed the ability to get to the location by walking well without relying on automobiles. Adding amenities that are not already accessible in the region changes the way people move in the area, from reaching the place by walking to getting to the site by car. The location is easily accessible without relying on automobiles, which is supported by the idea in previous research [17].

Moreover, the mixed-use area within walking distance of various services will impact the higher walking potential. The walking potential will serve as a barometer for the livability of crucial locations. It can pique developers' attention to the value of walking, which is also related to the previous research [1, 10]. It is increasing walking possibilities and making the region more habitable. People already have a high standard of living will make real estate more valuable. The walking score may help choose the best site for various projects, such as one with a short walking distance or one close by, as well as using the ability to walk in multiple services as a marketing tactic to attract project customers [18, 19]. In addition, the project can use the software to decide where stores and other facilities should be located to attract and increase walking among clients who use the service.

5. Conclusion

This study exhibited walk score modeling in the Mahachai sub-district, Mueng District, Samut Sakhon Province, Thailand, called Mahachai city, aiming to construct acceptable models for diverse problem circumstances. According to the field survey and in-site amenities type and location, the 3D physical model and walk score simulations were examined utilizing an urban modeling interface (UMI) plug-in on Rhinoceros renowned computer-aided software. The evaluation of the walk score is related to the proximity of points of interest to grocery stores, restaurants, shopping malls, coffee shops, banks, schools, bookstores, and entertainment. The walk score is calculated using a distance decay function, which shows how the score decreases as the distance between the starting place and the amenities. Within 0.25 miles, the score can get a perfect score. The score will reduce by 75% if the walking distance is less than haft a mile and drops to 40 % for approximately 1,200 meters. At longer distances, the score will decline to 12.5 % at 1 mile, at 0 at 1.5 miles. The average walk score of the base-case scenario, the existing urban context, is 87 points, interpreting the walkable city. However, the trial of new amenities added to the urban context discovered that the same amenity type would not significantly improve the score. Therefore, the score increases to 93 points when adding the different amenities. These reflect the need for urban amenities variety can improve the walkable quality in the urban. The research proves the ease of use in the UMI plug-in associated with the Rhinoceros software.

However, some limitations of using the UMI plug-in needed to be pointed out. First, the UMI plug-in considers the amenities issues only, not any concerns about the walking quality factors. Next, the UMI plug-in needs the condition of grid models so that the non-grid city pattern might get problems with the modeling simulation. So, the users need to adjust their 3D physical model to meet this limitation. The last point, the walk score from the UMI plug-in, has related to the proper walking distance of the city and cannot be adjusted. If the study area's walking distance significantly differs from the plug-in default, this can generate the wrong results. Therefore, this research still proved the benefit of using the UMI plug-in. The results are necessary guidance for urban designers to create a walkable city in the future.

6. Acknowledgements

This research project is co-supported by the City Research and Development Center, Faculty of Engineering, Chiang Mai University, Thailand, and the Thammasat University Research Unit in Project Development and Innovation in Real Estate Business, Thammasat University. Moreover, the authors also thank Thammasat School of Engineering, Thammasat University.

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