Modern Environmental Science and Engineering (ISSN 2333-2581)
April 2018, Volume 4, No. 4, pp. 358-364
Doi: 10.15341/mese(2333-2581)/04.04.2018/008
Academic Star Publishing Company, 2018
www.academicstar.us

Toward the Walkable Campus: Indicators of Design, Density, Diversity, and Climate Conditions at the National University of Laos, Vientiane Capital, Lao PDR

Thanousorn Vongpraseuth, and Soukanh Chitpanya
Faculty of Architecture, National University of Laos

Abstract: Within the last few years, Lao government has announced to develop the National University of Laos (NUOL) toward the "Green Campus". Based on the crucial vision of the NUOL, this study aims to explore the key factors of green vision and walkable campus. Data are obtained both primary and secondary data. Relevant studies are basically reviewed. The questionnaire and survey techniques are mainly employed to a pilot block of the Dongdok campus, NUOL. The main indicators are considered crucially within four indicators: 1) design, 2) density, 3) diversity, and 4) climate conditions. In order to identify the relationships between behavior of pedestrians and key indicators, regression model is applied. With regard to the analysis processes, results illustrate the statistical significance association between pedestrian density and physical conditions. In addition, climate condition is also a considerable factor for walkable campus in Laos conditions. These results would be applied as key determinants for the existing and new campus planning and design toward the walkable campus in the future.

Key words: walkable campus, climate condition, design, density, diversity

1. Introduction

Architectural, urban design, and urban planning approaches have been very important in building environment and economic development. Cities of many countries in the world have been developing both physical and non-physical conditions to reach the goal of sustainability. However, those kinds of developed projects would yield with various problems regarding urbanization issues, environmental problems, and social impacts. From these issues, many countries have been identified as developed or least developed nations. Lao PDR (Laos) is stated under the list of least developed countries and in the list of ASEAN countries. The vision of development in Laos has been focusing on new developments with the flows of economic reinforcement and educational promotions. Regard to the educational sector development, the National University of Laos (NUOL) is one of the top university in Laos which has been addressed by Lao government as the main institute for producing qualitative human resources. Therefore, the key target of the NUOL is to promote the first green campus in Laos (NUOL visional report, 2016).

Regarding the long-term vision of the NUOL, this study focuses on investigating and exploring the key walkable factors of National University of Laos, Dongdok campus. The key focused components would be identified for improvement the environment condition in/around central area of the campus toward the green and sustainable campus. Green campus development is a long-term vision of the NUOL. Educational campuses in many countries have been trying to promote the sustainable campus, which consists of physical conditions, green technologies, and

Corresponding author: Thanousorn Vongpraseuth, Ph.D.; research areas/interests: urban and transportation planning. E-mail: loyh.arch@gmail.com.

green mobility. In Laos, NUOL has been a top university with both quantity and quality. Educational environment has been the key components to influence instructors, staffs, students, and residents. This study would be an initiative model for walkability campus and would be an innovative approach for sustainability.

2. Literature Reviews

In this part the study focuses on reviewing some related articles including walking behaviors, important roles of walkability, walkability and density-diversity.

2.1 Walking Behaviors and Its Important Roles

Walking is generally categorized into two patterns: walking for physical activities and walking for transportation. In many cases, walking has been related with people behaviors and health conditions [1]. In terms of health management, walking as physical activity is a trend for urban people [2]. Some studies explained that the condition of accessibility has been the crucial factor of walking for transport [3]. Regarding the walking behavior, places with diverse activities and high density are considered as the variety of uses and users [4]. Higher levels of residential density and suitable distance, levels of land use mix, and street connectivity could be the crucial factors in encouraging pedestrian to walk and ride [5-7].

Since the past decades, land-use mix issue has been continuously considered within the walkability and public transportation. Jane Jacobs (1961) [8] explained that the diversities of building types and activities would induce people to walk and interact with his/her neighborhood. Generally, walking indictors, physical activity, and accessibility matters are mentioned, but not safety from traffic and crime [9]. In this case, Jacobs also mentioned that criminal situation would be reduced with concept of “Eye on the Street”, people walk through the public spaces with livable conditions. Livable indicator has been considered from the diversity, density, and suitable design of street block [4, 8].

2.2 Diversity-density and Walkability

Diversity and pedestrian volume are two associated factors that would be supported each other. Many studies of walking behavior and built environment have been discussed in diverse viewpoints. Some studies asserted that walking activities were affected by the conditions of surrounding environment. Both positive and negative impacts have been revealed from the physical condition to users or pedestrians. Regard to the positive factors that influence pedestrian behavior, many researchers have been clarified that street connectivity, diverse level of land-use mix, and residential density. From the previous studies, which were focused on diversity and walking behavior, mostly proved that positive impacts of diversity associated directly with suitable physical environment for pedestrian [3, 5, 10, 11]. Cevero (1995) [4] explained in a case of America, reducing private transportation would be perceived by planning with high density of retail activities and other land-use mixture.

According to the aforementioned reviews, this study would be learned and modified from those experiences. In Laos, there would illustrate different situations and conditions from the USA and other European countries. However, some key variables would take into account in collecting data and analyzing processes of this study.

3. Methodology and Variables

3.1 Survey Methods

This study focused on the determinants of walkability at the National University of Laos (NUOL), Dongdok campus. NUOL consists totally of thirteen faculties, ten faculties are located in Dongdok campus and others are located in the other campuses. Dongdok campus has been planning with the area of 300 ha in 2015. The plan has been set as master plan for future development. In fact, the present condition of Dongdok campus is totally unplanned campus. Regarding the huge and fragmented of each faculty in Dongdok

campus, this study focused only the central part of built-up area. Primary and secondary data are processed in this study. Primary data is collected using both survey and questionnaire techniques. Regarding the insufficiency of existing data, the physical conditions and information of pedestrians are collected randomly within 203 samples initiatively. In order to collect the data, this study has been focused on seven significant observed points around/inside Dongdok campus with special characteristics (Fig. 1). The radius of buffered areas are 300 meters as the suitable accessibility in Laos. Questionnaire and survey techniques were provided to pedestrians who walk through each mentioned seven observed points. Based on the insufficiency of data set, both objective and subjective surveys had been conducted.

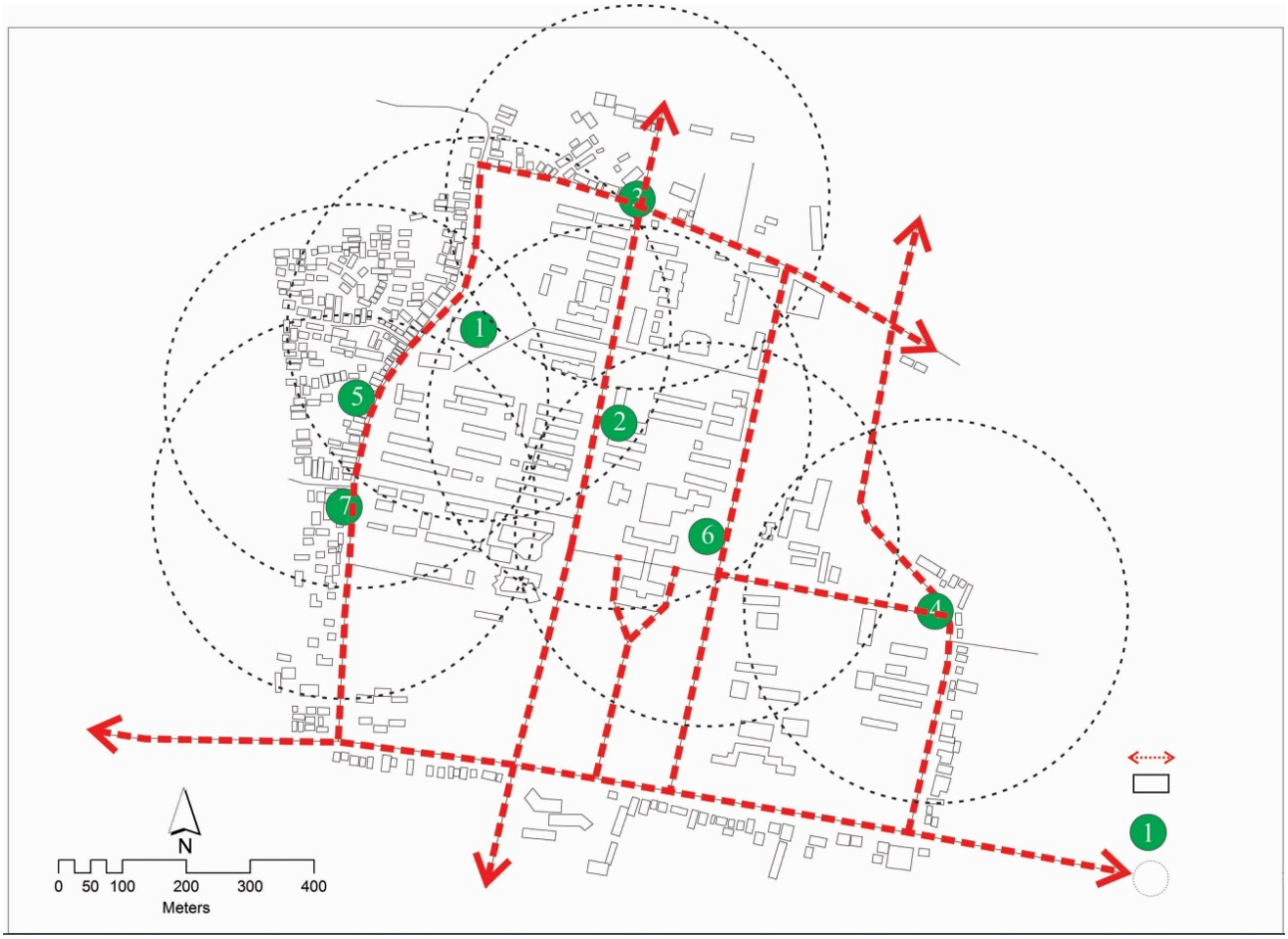

Fig. 1 Map of survey points (Central Dongdok campus, NUOL).

3.2 Variables

Assessing the walking behavior at the educational campus, the study assessed four related key components of walkability on campus development directions: 1) density, 2) diversity, 3) design, and 4) climate conditions, the pedestrian density was set as dependent variable. The details of all variables (key and controlled variables) are presented in the Table 1 with some explanation and coding approaches.

4. Results

Regarding the data from site, descriptive analysis and regression model are employed to find the characteristics and relationship between pedestrian volume (pedestrian density) and physical environment in/surrounding Dongdok campus. As the samples of this study were randomly selected at the studied site,

Table 1 Variables and explanations.

Variable		Explanation	Identification
Dependent variable (pedestrian density)	Pedestrian density	Volume of pedestrians of seven survey points within 300 m	Numeric value
Socio-economic	Age	Age group of pedestrians within survey areas (300 m)	Dummy (by groups)
	Gender	Gender of pedestrians within survey areas (300 m)	Dummy (by groups)
	Occupation	Jobs of pedestrians within survey areas (300 m)	Dummy (by groups)
	Housing type	Housing types of pedestrians within survey areas (300 m)	Dummy (by groups)
	Walking purpose	Walking purposes of pedestrians within survey areas (300 m)	Dummy (by groups)
	With vehicle	Vehicle owner status of pedestrians within survey areas (300 m)	Dummy (yes or no)
	Vehicle type	Transport mode of pedestrians within survey areas (300 m)	Dummy (by groups)
Design	Road width	Design standard and accessible conditions of street within observed points	Numeric value
	Sidewalk size	Design standard of sidewalk within observed points	Numeric value
Density	Building density	Building density within 300 m buffered areas	Numeric value
Diversity	Land-use mixture	Level of land-use mix within 300 m	Numeric value
Climate condition	Obstacle/climate condition	Testing on walking behavior and climate conditions	Dummy (by groups)
	Walking time	Time to walk in weather conditions	Numeric value
	Sidewalk with tree	Environment and waking behavior in weather conditions	Dummy (yes or no)

Table 2 Descriptive analysis.

Variable		Obs	Mean	Std. Dev.	Min	Max
Walking density (person/day)		203	647.71	388.67	150	1500
Age (15-20)	21-30	203	0.34	0.47	0	1
	31-40	203	0.01	0.10	0	1
	>40	203	-	-	-	-
Gender (female)		203	0.39	0.49	0	1
Occupation (student)	Officer	203	0.01	0.12	0	1
	Shopkeeper/retailer	203	-	-	-	-
	Others	203	0.04	0.21	0	1
Housing type (dormitory)	House owner	203	0.52	0.50	0	1
	Rental status	203	0.21	0.41	0	1
	Others	203	0.02	0.16	0	1
Walking purpose (shopping)	Finding restaurant	203	0.35	0.48	0	1
	Walk through	203	0.34	0.48	0	1
	Other	203	0.15	0.36	0	1
Vehicle owner (no)		203	0.57	0.50	0	1
Obstacle (hot weather)	No sidewalk	203	0.19	0.39	0	1
	No interesting places	203	0.04	0.21	0	1
	Others	203	0.04	0.20	0	1
Walking time (minute)		203	7.25	3.50	2	17
Road width (meter)		203	8.91	2.24	7	12
Sidewalk tree (no)		203	0.66	0.47	0	1
Sidewalk size (meter)		203	0.75	0.80	0	1.6
Building density		203	0.34	0.26	0.11	0.55
Land-use mixture		203	0.46	0.21	0. 25	0.73

were from each faculty in Dongdok campus. The volume of pedestrian (pedestrian density) during day and night-time are obviously different based on the physical characteristics of places and weather conditions. Between weekdays and weekends, pedestrian density at each survey point illustrated different levels and groups of users. Within seven significant survey points, some indicated points showed low magnitude of pedestrian density in the weekends, indicating that places would lack of attractive environment and/or low value of diversity.

However, some survey points identified high density of pedestrians both weekdays and weekends. Table 2 shows the characteristics of data from 203 samples. This table illustrated both main and controlled variables. From seven observed points with 300 meters buffered areas, land-use mix variable shows medium level with only one or two functions of activities: residence and retails or restaurants. These components have been developed themselves without planning. In addition, lacking of shades, trees, and other spaces could support the walking behaviors. In order to clarify the relationship between pedestrians and existing environment, this study has utilized the multiple regression model.

Table 3 shows the results from multiple regression model. Results revealed some significant levels both main and controlled variables with the level of R-squared = 0.96, indicating that high level in model fitting. Primarily, age variable shows statistically significant within the highest per cent, indicating that

Table 3 Multiple regression model for the pedestrian density.

Independent variable		Coef.	t	Sig	VIF
Age (15-20)	21-30	-48.41	-3.90	0.000***	1.18
	31-40	-18.44	-0.30	0.767	1.29
	> 40	-	-	-	-
Gender (female)		10.14	0.82	0.416	1.26
Occupation (student)	Officer	30.25	0.60	0.546	1.24
	Shopkeeper/retailer	-	-	-	-
	Others	83.29	2.74	0.007***	1.33
Housing type (dormitory)	House owner	12.63	0.70	0.482	2.74
	Rental status	-18.17	-0.98	0.330	1.94
	Others	-9.37	-0.25	0.806	1.19
Walking purpose (shopping)	Finding restaurant	-7.26	-0.36	0.716	3.08
	Walk through	13.78	0.77	0.440	2.45
	Other	55.56	2.60	0.010***	1.97
Vehicle owner (no)		59.30	4.31	0.000***	1.58
Obstacle (hot weather)	No sidewalk	-6.77	-0.46	0.646	1.13
	No interesting places	-43.76	-1.57	0.118	1.12
	Others	-8.22	-0.27	0.786	1.18
Walking time		-0.30	-3.71	0.000***	1.12
Road width		40.66	44.56	0.000***	4.00
Sidewalk tree (no)		-306.72	-46.88	0.000***	3.69
Sidewalk size		299.37	24.28	0.000***	3.31
Building density		-87.06	-35.45	0.000***	4.16
Land-use mixture		1002.10	51.80	0.000***	6.71
Cons		-13010.26	-47.07	0.000	-
N		203			
R-squared		0.96			

Note: Inside parentheses are reference variables, significant value are *p < 0.1, **p < 0.05, ***p < 0.01.

the age range of 15-20 associated with pedestrian group rather than other groups. In the same direction, public spaces in/around Dongdok campus have been occupied/accessed not only students, staffs, and instructors, but the residents who reside in/surrounding this area also access frequently both optional and necessary activities.

Regarding the main variables: walking time reveal negative association between walking time and pedestrian density, indicating that short duration of time would encourage people to walk; huge sidewalk size and high level of land-use mixture show very important role in walking environment, inducing pedestrian to walk with comfort and safe perceptions. As the aforementioned variables, the result illustrated similar with other USA and European cases. However, some variables result opposite perception such as road width shows positive relationship with walking density and building density results as negative impact on pedestrians. This phenomenal would interpret under the environment and people behavior. From Table 4, the unplanned approach for interacting with climate conditions presents negative views from pedestrians. The simple text classifying method indicated that high temperature and heavy raining during each season affected the walking activities naturally. This finding would be identified that with unplanned campus, people have dialed and suffered with climate condition, complicated walking direction (built environment) and just walking to the intended destinations. Therefore, it is very interesting to identify with huge number of samples in the further research.

Table 4 Text classifying for the climate and environmental issues.

Issue		Point1	Point2	Point3	Point4	Point5	Point6	Point7
Climate condition	Hot	No Tree and Shade	No Shade	No Tree and Shade	No Shade	No Shade	No Shade	No Tree and Shade
	Rainy	No Shade, No Connectivity	No Shade	No Shade, No Connectivity	No Shade	No Shade	No Shade, No Connectivity	No Shade, No Connectivity
Built environment	Dusty	No consideration	No consideration	No consideration	No consideration	No consideration	No consideration	No consideration
	Pathway design	Insufficiency	Existing pathway	Insufficiency	Insufficiency	Insufficiency	Insufficiency	Insufficiency
	Safety condition	No lighting and car-free street	No lighting	No lighting and car-free street	No lighting and car-free street	No lighting and car-free street	No lighting and car-free street	No lighting and car-free street

5. Conclusions

Walking is a green and healthy mode of transportation, help to serve environment and improve health condition. The terms of walkability are also the basic direction of a green, sustainable infrastructure, and further supports an active living with social and economic benefits. Studying on walkability in NUOL Dongdok campus would help classify and grasp the determinants of physical conditions and spaces. Pedestrians are very important actor association with the built environment approach. Regarding the existing data and analysis processes, this study would assert that design and diversity terms play the crucial role in built environment to encourage people in walking activities. However, the climate condition also a hint of indicators that impact the pedestrian density. Pedestrians in/around Dongdok campus mostly are groups that use NUOL's facilities, unfortunately, amenities and public facilities are insufficiency. In the psychological terms, people have to walk with their accurate destination. Therefore, this research would be an initiative step of

creating destinations and spaces for green and sustainable campus in the future.

References

[1] J. E. Manson, F. B. Hu, J. W. Rich-Edwards and G. A. Colditz et al., A prospective study of walking as compared with vigorous exercise in the prevention of coronary heart disease in women, *New England Journal of Medicine* 341 (1999) 650-658.

[2] A. P. Rafferty, M. J. Reeves and H. B. McGhee, Physical activity patterns among walkers and compliance with public health recommendations, *Medicine and Science in Sports and Exercise* 34 (2002) 1255-1261.

[3] L. D. Frank and G. Pivo, Impacts of mixed use and density utilization of three modes of travel: Single-occupant vehicle, transit, and walking, *Transportation Research Record* 1466 (1994) 44-52.

[4] R. Cervero and K. Kockelman, Travel demand and the 3Ds: Density, diversity, and design, *Transportation Research Part D: Transport and Environment* 2 (1997) 199-219.

[5] B. E. Saelens, J. F. Sallis, and L. D. Frank, Environmental correlates of walking and cycling: findings from the transportation, urban design, and planning literatures, *Ann. Behav. Med.* 25 (2003) 80-91.

[6] TRB and I. M., *Does the Built Environment Influence Physical Activity? Examining the Evidence*, Special Report 282, Washington, DC: National Academies Press, 2005, pp. 220-248.

[7] G. W. Heath, R. C. Brownson and Kruger, The effectiveness of urban design and land use and transport policies and practices to increase physical activity: A systematic review, *J. Phys. Act. Health* 3 (2006) (Suppl. 1) S55-S76.

[8] J. Jacobs, *The Death and Life of Great American Cities*, New York Ramdom House, USA, 1961.

[9] N. Humpe, N. Owen and E. Leslie, Environmental factors associated with adults' participation in physical activity: A review, *Am. J. Prev. Med.* 22 (2002) 188-199.

[10] S. Handy, M. G. Boarnet, R. Ewing and R. E. Killingsworth, How the built environment affects physical activity: Views from urban planning, *American Journal of Preventive Medicine* 23 (2002) (2S) 64-79.

[11] S. Handy, Critical assessment of the literature on the relationships among transportation, land use, and physical activity, Draft paper prepared for the TRB and the Institute of Medicine Committee on Physical Activity, Health, Transportation, and Land Use, November 2003.