

The Effect of Walkability on the Sustainable University Campuses

A comparison between the old and new campuses of Sulaimani University

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Abstract— Sustainable universities campus design needs comprehensive planning that considers universities' campus as a whole: buildings and its surrounding environment, and not segmented from the walkability point of view.

This study shows a comparative study of the old and new campuses of Sulaimani University to show the degree of social sustainability from the walkability point of view. In order a university campus design to be sustainable, the three main features of sustainability design which are (Social, environmental and economical) domains must be achieved.

Walkability is assessed according to four points that are; connectivity, accessibility, safety/security and comfort. For the limitation of the study, connectivity and accessibility criteria have been studied and assessed in both Campuses of Sulaimani University to show the social sustainability in each campus. The aim is to achieve social sustainable design from the walkability point of view in university campus as it will be necessary to evaluate present walking conditions and consider these two criteria in designing campus for improving walking condition.

I. INTRODUCTION

The number of students in universities' campus is in an increase which needs careful attention to campus long-term planning and design. Sustainable Campus has been everywhere to encourage the implementation of walkable transportation into the urban planning and design of the university campus to maximize user's health, their economical satisfaction, reduces pollution and expenses in the campus.

Designing and implementing walking transportation into campus planning and design can provide several advantages such as minimizing land used, reducing vehicle reliance, reduced resource consumption and pollution, encourage walking and cycling, increasing accessibility to facilities and service areas, more efficient provision of infrastructure and utilities, and re-develop used area. So, it is of particular concern to design scholars, developers, investors and others interested in sustainable and responsible property investing because of its potential social and environmental benefits. There are several characteristics for designing walkable communities, which were frequently described in many researches, as this paper tries to study sustainability of University campuses from walking perspective.

II. WALKABILITY

A. Selecting a Template (Heading 2)

Walkability is defined as a measure that identifies the perceived friendliness, aesthetics and safety of an urban space. [1], while Southworth study defines walkability as "the extent to which the built environment supports and encourages walking by providing for pedestrian comfort and safety, connecting people with varied destinations within a reasonable amount of time and effort and offering visual interest in journeys throughout the network" [2]. Walkability is a measure of how friendly an area is to walking. Walkability has many health, environmental, and economic benefits. Factors influencing walkability is related to the design of the urban structure which includes the presence or absence and quality of footpaths, sidewalks or other pedestrian rights-of-way, traffic and road conditions, land use patterns, building accessibility, and safety, among others as an important concept in sustainable urban design [3].

With ever increasing globalization, society always seems to be on the move nowadays, more than ever. This is why the ideology behind maintaining a healthy urban environment is important for the society. A healthy urban environment can be coined as environments that are "liveable, equitable and sustainable in which the built and natural environment support health, mobility, recreating, safety, social interaction and a sense of pride and cultural intimacy that is accessible to all the population" [4].

According to Christian's study 2010 [5], walkability is a key factor in having a sustainable transportation network. It measures the friendliness of an area and considers many subjective factors in the process. Walkable areas help promote sustainable transportation, which is a concept that encourages transportation systems that have a low impact on our environment as well as increasing physical health and safety of the community. Therefore, walking is a common form of physical activity, which has both social and recreational impacts. It is studied as a way of achieving sustainability from social activity point of view.

III. SUSTAINABLE DESIGN

Sustainable design is the philosophy of designing physical objects, the built environment, and services to comply with the principles of social, economic and environmental sustainability [6]. Sustainable design must create projects that are meaningful innovations that can shift behaviour. According to Scott Cato 2009, a dynamic balance between economy and society, intended to generate long-term relationships between user and object/service and finally to be respectful and mindful of the environmental and social differences [7].

IV. SOCIAL SUSTAINABILITY

Social sustainability is "a process for creating sustainable, successful places that promote wellbeing, by understanding what people need from the places they live and work. Social sustainability combines design of the physical realm with design of the social world – infrastructure to support social and cultural life, social amenities, and systems for citizen engagement and space for people and places to evolve [8].

According to Saffron's study 2011, social sustainability concerns how individuals, communities and societies live with each other and set out to achieve the objectives of development models which they have chosen for themselves, also taking into account the physical boundaries of their places and planet earth as a whole [9]. In this sense, social sustainability blends traditional social policy areas and principles, such as equity and health, with emerging issues concerning participation, needs, social capital, the economy, the environment, and more recently, with the notions of happiness, wellbeing and quality of life.

V. SUSTAINABLE CAMPUS

Sustainable campus design needs comprehensive planning that considers universities' campus as a whole: buildings and its surrounding environment, and not segmented [10]. Universities with large numbers of academic staff, students, and administrative personnel and a variety of activities (e.g., working, studying, business... etc.) are comparable to small cities. So, walkability in the university campus is very important to help users have a healthy and social lifestyle in the campus. "Universities should encourage people to shift their travel modes from cars to other types of travel, especially walking. So walkability is considered as a foundation for designing sustainable campus.

VI. CAMPUS SOCIAL CONNECTIVITY

Social connectedness is the measure of how people come together and interact. At an individual level, social connectedness involves the quality and number of connections one has with other people in a social circle of family, friends, and acquaintances. Going beyond these individual-level concepts, it involves relationships with beyond one's social circles and even to other communities. This connectedness, one of several components of community cohesion, provides benefits to both individuals and society [11]. Campus climate, an important social environmental factor that has an impact on students' university experiences, has been defined broadly by

scholars. Cress 2002 focused on the interpersonal interaction aspect of campus climate to distinguish it from campus culture. University campuses should possess a good social relationship for the users because campus climate would be the current attitudes, behaviors, standards and practice that employees and students have in an institution, which are usually linked to specific social groups [12].

VII. CAMPUS ACCESSIBILITY

Accessible and universal design, also referred to as "accessibility", generally describes the extent to which elements and activities in the built environment are available to as large a cross-section of users as possible [13]. The term "accessibility" is often used in reference to site, building, facility and other elements that provide access for individuals; here it is intended in the broader sense to include access for both the able-students and physically disabled ones. The University campus is committed to the best practices of accessibility in the design, construction, alteration and repair of spaces for use or occupancy by academic personnel, students, staff and public.

VIII. UNIVERSAL DESIGN CONSIDERATION

As University campuses are comparable to small cities, walking in campuses is an ecological travel mode that is friendly to the environment and the economy can also promote the health of campus' users. "To improve streets and walkways on campus, designers should have a good understanding of the needs of street and path users. In other words, planners should know which street factors affect walking conditions for various types of pedestrians" [14]. Grenis 2009 states that, University policy makers should encourage people to walk to create sustainable campuses with least possibilities of (environmental, economic, and social problems. So, having a walkable-oriented campus should be the main interests of campus designers to help users have a healthy and social lifestyle in the campus [15]. "Universities should encourage people to shift their travel modes from cars to other types of travel, especially walking. Providing walking facilities in addition to other effective policies (e.g., restricting automobile traffic within a campus and limiting automobile parking spaces on campus) can encourage the large number of students and users of the campus to walk to their destinations.

Designing university campuses without socially walkable-oriented design encourages automobile transportation system inside the university campus which in result maximizes air pollution, high daily expenses and unhealthy transportation. A key foundation of sustainable campus design would lose when university campuses are not designed according to social and walkable criteria. The research hypothesizes that; **"The increase length of street inside university campus, will reduce the students' social connectedness and walking accessibility that refer to social interaction as indication to social sustainability"**.

IX. THE CASE STUDY

In 1968, the first university in Iraqi Kurdistan was founded and named the University of Sulaimani. It was the first university ever opened in the Kurdistan region of Iraq. University of Sulaimani is a public university located in the city of Sulaymaneyah in Kurdistan Region - Iraq. It is one of the important scientific and cultural centers in Kurdistan region. University of Sulaimani has two campuses; the old campus was founded in 1968 which is located in a central part of Sulaymaneyah city, while the new campus of the university is located at the outskirts of Sulaymaneyah city, the new campus officially opened in 2012, and it is designed and constructed by an international company.

X. METHODOLOGY OF THE STUDY

The case study is a comparison study of the old campus and the new campus of Sulaimani University to show the social sustainability at each campus according to social connectivity of students (gathering activity) and walking accessibility from campuses' entrances to the buildings. The old campus of the university is designed on (175000m²) area where 8000 students are studying in 2015-2016, while the new campus is designed on (1927500 m²) area and 16500 students are studying in 2015-2016. The study has taken photographs of each campus at same times in the same days of a week to conclude the gathering activity of students to show the degree of social connectivity of students which will indicate the degree of social sustainability inside the campuses. This study also takes surveys of streets length and density inside both campuses to show the distances that students have to walk from gates to the public spaces inside each campus to show the degree of social accessibility in each campus.

XI. SOCIAL CONNECTEDNESS

Each campus of Sulaimani University was observed to know the social connectedness of students at three days of the week (Sunday, Tuesday and Thursday) concerning the beginning, medium and end days of the week at three times (10:00-10:30, 12:00-12:30 and 16:00-16:30) concerning three times of students' rest where the photos are taken in spring season known as the best season for student gathering in public spaces. Photographs of public sitting and gathering spaces are taken inside each campus to know the number of student grouping which is the main aspect of social connectedness inside university campus. Three public spaces are determined on the site plan of the old campus shown in Fig. 1 and Fig. (2, 3,4 and 5) are sample of photos taken at these spaces within the specified days and times. At the same times and dates photographs shown in Fig. (7, 8, 9 and 10) are sample of photos taken in three public spaces inside the new campus of the University of Sulaimani where the public spaces are determined on the new campus site plan in Fig. 6.

Table (1, 2 and 3) show the density of student grouping in the three public spaces of the old campus determined in Fig. 1. The density of students group for each public space is calculated as following:

$$\gamma = \frac{b}{a} \quad (1)$$

Where; (γ) is group density for the students in public spaces
 (b) is the number of student groups
 (a) is the area of the public space

TABLE (1)

Days	Group density in 1 st Public Space1 (S1)					
	Student group No. at (10:30)	Grouping density in (S1) at (10:30)	Student group No. at (12:30)	Grouping density in (S1) at (12:30)	Student group No. at (16:30)	Grouping density in (S1) at (16:30)
Sunday	35	0.0125	28	0.0100	25	0.009
Tuesday	19	0.0068	13	0.0046	22	0.008
Thursday	26	0.0093	7	0.0025	16	0.006

Number and Density of students' groups in the first public space (S1) where (Area of S1 = 2810m²)

TABLE (2)

Days	Group density in 2 nd Public Space1 (S2)					
	Student group No. at (10:30)	Grouping density in (S2) at (10:30)	Student group No. at (12:30)	Grouping density in (S2) at (12:30)	Student group No. at (16:30)	Grouping density in (S2) at (16:30)
Sunday	2	0.0023	7	0.0081	5	0.0058
Tuesday	4	0.0047	5	0.0058	7	0.0081
Thursday	5	0.0058	4	0.0047	10	0.0116

Number and Density of students' groups in the second public space (S2) where (Area of S2 = 860 m²)

TABLE (3)

Days	Group density in 3 rd Public Space1 (S3)					
	Student group No. at (10:30)	Grouping density in (S3) at (10:30)	Student group No. at (12:30)	Grouping density in (S3) at (12:30)	Student group No. at (16:30)	Grouping density in (S3) at (16:30)
Sunday	5	0.0025	2	0.0010	2	0.0010
Tuesday	4	0.0020	0		3	0.0015
Thursday	4	0.0020	5	0.0025	1	0.0005

Number and Density of students' groups in the third public space (S3) where (Area of S3 = 1975 m²)

Table (4, 5 and 6) show the density of student grouping in the public spaces of the new campus determined in Fig. 6.

TABLE (4)

Days	Group density in Space1 (S1)					
	Student group No. at (10:30)	Grouping density in (S1) at (10:30)	Student group No. at (12:30)	Grouping density in (S1) at (12:30)	Student group No. at (16:30)	Grouping density in (S1) at (16:30)
Sunday	5	0.0008	3	0.0005	2	0.0003
Tuesday	4	0.0006	2	0.0003	2	0.0003
Thursday	3	0.0005	4	0.0006	2	0.0003

Number and Density of students' groups in the first public space (S1) where (Area of S1 = 6142 m²)

TABLE (5)

Days	Group density in Space1 (S2)					
	Student group No. at (10:30)	Grouping density in (S2) at (10:30)	Student group No. at (12:30)	Grouping density in (S2) at (12:30)	Student group No. at (16:30)	Grouping density in (S2) at (16:30)
Sunday	2	0.0002	4	0.0004	6	0.0006
Tuesday	2	0.0002	3	0.0003	4	0.0004
Thursday	3	0.0003	4	0.0004	4	0.0004

Number and Density of students' groups in the second public space (S2) where (Area of S2 = 9400 m²)

TABLE (6)

Number and Density of students' groups in the third public space (S3) where (Area of S3 = 20000 m²)

Days	Group density in Space1 (S3)					
	Student group No. at (10:30)	Grouping density in (S3) at (10:30)	Student group No. at (12:30)	Grouping density in (S3) at (12:30)	Student group No. at (16:30)	Grouping density in (S3) at (16:30)
Sunday	5	0.00025	4	0.0002	2	0.0001
Tuesday	2	0.0001	3	0.00015	0	0
Thursday	1	0.00005	0	0	0	0



Fig. 1. Photo taken at 16:30 at S1 on Sunday



Fig. 2. Photo taken at 10:30 at S1 on Tuesday



Fig. 5. Site plan of the old campus showing the three Public Spaces S1: 1st Public Space, S2: 2nd Public Space S3: 3rd Public Space G1: Main Gate G2: Secondary Gate



Fig. 6. Photo taken at 10:30 at S1 on Sunday



Fig. 3. Site plan of the new campus of Sulaimani University. S1: 1st Public Space, S2: 2nd Public Space, S3: 3rd Public Space, G1: Main Gate and G2: Secondary gate



Fig. 7. Photo taken at 12:30 at S1 on Sunday



Fig. 4. Photo taken at 10:30 at S1 on Sunday



Fig. 8. Photo taken at 12:30 at S1 on Sunday



Fig. 9. Photo taken at 16:30 at S1 on Sunday



Fig. 10. Photo taken at 16:30 at S1 on Sunday

XII. WALKING ACCESSIBILITY

Since walking accessibility is related to the walking activity of students, it is related to the distance travelled by students with walking. In order to assess this criterion of social sustainability, streets inside each campus have been measured to know the distance which students have to travel walking. Comparison has been made for walking accessibility for both campuses of the University of Sulaimani. The two main gates of each campus are taken as the main references, then the density of streets to the three public spaces determined on the site plans of each campus as shown in Fig. 1 and Fig. 6 are found for both campuses and then compared. The density of streets for each public space is calculated as following:

$$\alpha = \frac{d}{a} \quad (2)$$

Where; (α) is street density, (d) is street length from gates to the public spaces and (a) is area of public spaces.

Table (7 and 8) show the street density and length of streets from campus gates to the public spaces of the old and new campuses shown in Fig. 1 and Fig. 2.

TABLE (7)

Campus Gates	Street Density length & Density					
	Street length (m) to (S1)	Street density for (S1) Area S1= (2810m ²)	Street length (m) to (S2)	Street density for (S2) Area S2= (860m ²)	Street length (m) to (S3)	Street density for (S3) Area S3= (1975m ²)
From Gate 1	75	0.027	200	0.232	180	0.091
Fro Gate 2	125	0.045	60	0.070	285	0.144

Street density and length of the distance from main gates to the public spaces (S1, S2 and S3) – Old Campus

TABLE (8)

Campus Gates	Street Density length & Density					
	Street length (m) to (S1)	Street density for (S1) Area S1= (6142m ²)	Street length (m) to (S2)	Street density for (S2) Area S2= (9400m ²)	Street length (m) to (S3)	Street density for (S3) Area S3= (20000m ²)
From Gate 1	150	0.024	165	0.0175	1185	0.060
Fro Gate 2	950	0.155	1200	0.128	360	0.0180

Street density and length of the distance from main gates to the public spaces (S1, S2 and S3) – New Campus

XIII. RESULTS

According to the results of the calculations from the tables (1,2, ...8), we can compare the followings;

- Student grouping density in the first public space (S1) in the old campus has the highest density on Sunday at 10:00am which is (0.0125) groups per the space area which is (2810m²).
- While the student grouping density in the first public space (S1) in the new campus has the highest density on Sunday at 10:00am which is (0.0008) groups per the space area which is (6142m²).

Comparing social connectedness in both campuses of Sulaimani University; grouping density in the public spaces of the old campus is nearly 16 times more than the grouping density in the public spaces of the new campus.

- The street density for the first public space (S1) of the old campus of the University has the least density which is (0.027) per the space area (2810 m²) and the students need to walk (75m) to reach (Space1) from (Gate 1) and (125m) from (Gate 2).
- While the street density for the second public space (S2) of the new campus of the University has the least density, which is (0.0175) per the space area (9400 m²) and students need to walk (165m) to reach (Space2) from (Gate 1) and (950m) from (Gate 2).

Comparing social accessibility in both campuses of Sulaimani University; street density for the public spaces of the old campus is 1.6 times more than the street density in the

public spaces of the new campus, but students need to walk (682 m) in average from gates to (S2) in the new campus, while students have to walk only (100 m) in average from gates to (S1) in the old campus. So, students in the new campus of the University have to walk 6.8 times more than students walking in the old campus. Concluding the results, the old campus of Sulaimani University has less street length and more students grouping density which increased students' social connectedness and social accessibility which refer to social sustainable design of the old campus compared to the new campus of Sulaimani University.

XIV. CONCLUSION

1. The results show the difference between both campuses design where the old campus has been designed with more gathering spaces that encourages social connectedness and the compact design typology of the old campus also encourages optimum walking distance while the linear design typology of the new campus has discouraged the social connectedness since gathering areas are far from students teaching buildings which are not in walking distance range.
2. The old campus of Sulaimani University is designed more according to humanization standards, where walking activity is normal inside the campus as the design is a clustered design and all buildings, service buildings and public spaces are located on a main street inside the campus. While the new campus is designed on a large area and has a linear design that maximized the street lengths where walking is very difficult inside the campus and students prefer to stay within their buildings layouts.
3. In the old campus, public spaces are designed in central points between teaching buildings so that during the rests of students, most gathering and social connectedness of students occur which are key factors of social sustainability. While in the new campus public spaces are distributed according to the linear design where space is near to a building but far from other buildings which reduces social connectedness and gathering of students inside public spaces.
4. In the old campus, public spaces are designed in balanced distances between the two gates to achieve social accessibility which is a key factor to achieve social sustainability. While in the new campus public spaces are of a moderate distance from a gate but so far from the other due to the design type of the campus, which reduces the social accessibility to the public spaces.

XV. RECOMMENDATIONS

The study recommends the following points:

1. Encouraging Universities campus planners and designers to design campuses according to sustainable design criteria, especially social sustainable design since university

campuses show cultural and social interactions between students and other users of the campuses.

2. Maximizing the walkability process inside university campuses which can be achieved only during the design process to perform social connectedness and social accessibility of students and other users.
3. Promoting walking transportation instead of car transportations inside university campuses during design process through achieving walkable campus design to result healthy, economical, social and recreational campus design for students and other users.

REFERENCES

- [1] Alix Tier, Carly Wiitala, Szeren Domokos, **Walkability on University Avenue** 2014
- [2] Southworth, M. 2005, **Designing the walkable city**, Journal of Urban Planning and Development, 131(4):246-257.
- [3] S. Grignaffini, S. Cappellanti, A. Cefalo, "**Visualizing sustainability in urban conditions**", WIT Transactions on Ecology and the Environment, Vol. 1, pp. 253-262, 10 Jun 2008
- [4] Perrotta, K., Campbell, M., Chirrey, S., Frank, L. and Chapman, J. (2012). The walkable city: Neighbourhood design and preferences, travel choices and health. Toronto Health.
- [5] Stephanie Christian, Shea Cochrane, Michael Creelman, Lesley d'Apollonia, Geoff Talbot, Marci Wiggins, Studley Campus Walkability Assessment, 2010, Dalhousie University
- [6] J. F. McLennan, (2004), The Philosophy of Sustainable Design.
- [7] Scott Cato, M. (2009). Green Economics. London: Earthscan, pp. 36–37. ISBN 978-1-84407-571-3.
- [8] Colantonio, A. and Dixon, T. (2009) Measuring socially sustainable urban regeneration in Europe, Oxford Brookes University: Oxford Institute for Sustainable Development (OISD)
- [9] Saffron Woodcraft, Tricia Hackett & Lucia Caistor-Arendar, Designing for Social Sustainability, A framework for creating thriving new communities. 2011
- [10] Mushtaha, Emad S., Status of International Sustainable Campuses Improvement of Walkability as a Prerequisite for Sustainability at University of Sharjah, 2015
- [11] Diego Zavaleta, Kim Samuel, and China Mills, 2014, Social Isolation: A conceptual and Measurement Proposal. Oxford Poverty & Human Development Initiative WORKING PAPER NO. 67
- [12] Cress, C. M. (2002). Campus climate. In A. M. Martinez, & K. A. Renn (Eds.), Women in higher education: An encyclopedia (pp. 390–397). Santa Barbara, CA: ABC-CLIO Inc.
- [13] Henry, Shawn Lawton; Abou-Zahra, Shadi; Brewer, Judy (2014). "The Role of Accessibility in a Universal Web". Proceeding W4A '14 Proceedings of the 11th Web for All Conference Article No. 17. ISBN 978-1-4503-2651-3.
- [14] Asadi-Shekari, Zohreh et al. (2014) A pedestrian level of service method for evaluating and promoting walking facilities on campus streets. Land Use Policy, 38.
- [15] Grenis, B., (2009). Crosswalk Installation and Modification Guidelines. University of Iowa Campus.