The Assessment of Pedestrian Walking Environment in Terms of Green Transportation

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Abstract—In the last decades the concept of Green Transportation has become a common topic in architecture literature. Walking as a mode of Green Transportation in universities has been encouraged widely. Based on observation there are crucial issues related to the existing walking environment in Salahaddin University. The objective of this paper is to evaluate the quality of the pathways walking environment of Engineering College, University of Salahaddin in terms of Green Transportation. A survey enhanced by photographic documentations instrument has been conducted as a model of quantitative research method. The measuring scale relies on checklist factors. The findings of this paper indicates that in spite of the poor quality of pedestrian walking environment in Engineering College, University of Salahaddin, but the complex is within the right steps towards Green Transportation.

Keywords: Green Transportation, Walking Environment, Erbil City

I. INTRODUCTION

In recent years there was a strong trend towards sustainability among higher education associations all over the world. The associations have been weighed against another according to their responsibility degree to implement sustainable development approaches. High ranking universities have taken advanced steps to combine sustainability basics in the campus zone. Based on White [1], Haven [2], and Balsas [3] achieving a sustainable campus must take in consideration the approaches of green or sustainable transportation as well as other concepts like environmental planning, land use and open spaces.

Walkability as the most effective mode of green transportation, is related strongly to sustainable development and transportation system, because of its environmental, social, and economical outcomes. Hence researchers have agreed that walkability is a fundamental tool to achieve the strategic plan at green transportation. Planning professionals recognized that the characteristics of the built environment are highly correlated with the tendency of walking, which plays an important role in adding livability to the campus environment. The core of green transportation (pedestrian walkability) will establish a strategic plan to transport ourselves in a safe and clean environment.

The evaluation of the pedestrian walking environment in the college of Engineering complex represents the starting point and the very first step for the university of Salahaddin to achieve a sustainable transportation. Furthermore by continuing to implement the sustainable development principles, the university can leap forward to reach the dream of making the university an example of a sustainable educational institution in the region.

II. TOWARDS GREEN TRANSPORTATION

The higher education institutions started involving in the concept of sustainability in 1970s due to the environmental decline, which turned to a global issue [4]. Within this realm the United Nations World Commission on Environmental and Development (WCED) organized the sustainable development concept in 1987. It was defined as a development that "meets the need of the present without compromising the ability of future generations to meet their own needs" [5]. Since then the concept of sustainable development was widely adapted by all sectors of the community including the universities. The efforts were continuing to implement the principles and practices of sustainable developments in all levels.

The subtopic of sustainable development that is related to the transportation field is Green Transportation. The phrase means using cleaner actions to transport from a place to another. But better term that the Green transportation that has been used widely is Sustainable Transportation. The European Council describes it as a transportation which first: meets the need of community safety and takes in consideration the health of human and ecosystem, second: is affordable, efficient, and supports economy with a balanced development, and last: it is a transportation that reduces emission within the earth’s ability to absorb, uses renewable and non-renewable resources at conditioned rates, while decreases the land use and noise production [6].

The three pillars of sustainable transportation are also emphasized by the OECD [7] and the Canadian Center for Sustainable Transportation which defines it as the one that "Responds the want of accessibility and mobility in individuals and society level with esteem on human and environment, is sufficient and effective gives alternative options of modes of transport, reduce the emission uses, alternative power resources and minimizes the used space".
In order to reach sustainability in transportation all choices of sufficient transport modes especially walking must be encouraged.

III. VALUE OF WALKABILITY

Walkability is a term that has been used frequently in the planners and landscape designers research. Studies in these fields focused on the importance of walkability to define a better pedestrian walking environment[8,9,10]. The specialists are involved in the degree of safety and comfort-ability of the walking community by using environmental adjustment to benefit the pedestrian exposed to the environment [11,12,13] They agreed that specific aspects of the built environment are strongly related to the weakness or strength of walking habit.

Walkability is defined as a measure that determines the perceived friendliness, safety, and aesthetics of a space [14]. It can be regarded as a measure of how friendly an area is for walking [15]. Kumar identifies the walkability as a quantitative measure of the pedestrian friendliness of the environment [16]. Others relate walkability with conditions in the built environment that encourages walking [17,18,19,20,21]. Brown [22] and Leslie [23] argue that one of the main problems to persuade people to walk is deficit with the environment.

For Southworth [21] the walkability is the extent to which the built environment supports and encourages walking. Its meaning is associated with safety, comfort, visual interest, and a reasonable amount of time and effort. According to Fontino, walkability is the level in which the street and built environment influence sense of pedestrian for comfort and safety, moreover the degree of streets appealing plays a key role in the level of walkability [24]. Hence, walkability can be considered as a mirror image of the walking friendly built environment.

IV. FACTORS AFFECTING THE PEDESTRIAN WALKABILITY

Many urban designers and scholars in the field of landscape architecture gave studied the factors related to walkability. They connect the influence of the built environment with walkable pedestrians. The physical characteristics of the built environment have a great impact on walking environment both directly and indirectly [25]. US Green Building Rating System, Leader in Energy and Environment Design (LEED) refers to the characteristic of walkable streets as function of safety, appeal, comfort, and health [26]. Other studies reveal the connection between the level of walking by pedestrians and factors as individuals security, safety in the street, unavailability of obstacles, and directness of the street [27]. According to Frank the most essential indicators of walkability are safety, destination, functional, and aesthetics [28]. Based on Miyakoda [29] factors affecting on the status of walkability are directness, security, street crossing, continuity, aesthetics and amenities.

A study research on pedestrian walking environment in the city of Sydney categorizes the crucial determinants as safety, comfort, visual variety & aesthetics, stimulating pedestrian interaction, accessibility, and obligatoriness & maintenance [30], Littman [31], explains the characteristics of walkable communities as path condition, land use pattern, path surroundings, comfort, safety, convenience, and connectivity. For Kumar [16] the design of the pathway should respond to many criteria such as connectivity, proximity, safety, and appearance.

V. RESEARCH METHODOLOGY

A quantitative research method- multi-dimensional model is designed to assess the pathway fundamental factors. These factors are organized in a set of variables in the theoretical model. The theoretical model includes five main variables which are Safety, Security, Proximity, Connectivity and satisfaction & comfort. These variables are derived from the architectural literature and reinforced by visual analysis. The proposed model will analyze the most significant variables that influence the pathway walkability in terms of green transportation (Table III).

For the purpose of the study the complex distributed into four zone based on the pedestrian accessibility, academic activities, and pathway location. Samples of forty pathways were selected in four different zones (twelve samples were selected in the two main zones (A&B), with eight samples in zones (C&D) “Fig. 1” and “Fig. 9”.

Figure 1. Distribution of Engineering complex zones

Therefore, the process of data collection includes the following procedures:

a) Identify cases of the study in each zone within college complex and check the capability of data collection.

b) Record the necessary data for each case using the pathway checklist factors survey form and arrange these records in a specified database to systematize relevant data efficiently.

c) Make photographic documentation for each case and...
tabulate these documents into organized lists for each zone.

d) Conduct direct interviews with campus students and staff to enhance the documentation process and to insure the consistency of data.

VI. RESULTS:

A. Safety of Pedestrian flow is discussed in two main aspects:

1) Safety of Pedestrian flow related to traffic:
   - The observation and pathway checklist factors survey form results show that the pathways adjusted to main roads in the college complex have high levels of conflict between traffic and pedestrian flow especially in the entrance pathways meanwhile no conflict have been recorded in separated pathways “Fig. 2”.
   - Results indicate that 24% of college complex pathways have been blocked completely by illegal parking, 30% were blocked partially and 46% of cases are not affected by illegal parking.

   Figure 2. Conflicts in Pathways adjusted to main roads

2) Safety of Pedestrian flow related to sidewalks:
   - Results illustrate that only few cases (as an average of 5%) are covered by slippery materials. the rest in a proper condition that providing adequate and safe paths for student movements inside the complex.
   - In general the number of steps within pathways are rare due to plain surfaces in erbil city (counter lines). It is interesting to note that most of pathways ramps are suitable in term of slope design.
   - Results show that most of cases of pathway surfaces are considered as safe walking surfaces.
   - A limited number of pathways (an average of 8%) are in a bad condition due to water collecting problems “Fig. 3”.

   Figure 3. Water collecting problem in pathway

B. Security variable is discussed in four main aspects namely: existence of people in pathways, visibility of path from surroundings, degree of illumination during dark hours ,and existence of people in nearby buildings during working hours.

   - The results based on pathway checklist factors survey form show that most of pathway are occupied by students or complex staff during working hours as a ratio of 45% crowded paths, 35% moderate occupation and 20% with few occupation or a few number of people gathered together.
   - Results indicate that most of pathways within complex are visible from surroundings as a rate of 65%, meanwhile 35% are Partially visible from surrounding “Fig. 4”.
   - Regarding the effect of lighting on pedestrian security during dark hours, previous studies clarified that lighting is one of the most effective factors in determining the security of pedestrian. in this respect results indicate that two third of pathways were fully illuminated during dark hours to fulfill student requirements. It is interesting to note that paths without lighting are rarely used during the dark hours.
   - Results show that 90% of buildings that surrounding the complex pathways are fully occupied These results is a good indicator to enhance the sense of security of complex users.
2) Enjoyable Scenery Results (Table II), indicate that 30% of cases have enjoyable scenery in term of attractive Softscape (12 samples), 25% have attractive sitting area, and 20% with attractive architectural features respectively. It is interesting to note that only 10% of pathways are classified as non enjoyable scenery within the complex boundary “Fig.6”.

TABLE II. POSSIBLE VALUES FOR ENJOYABLE SCENERY IN COMPLEX PATHWAYS

<table>
<thead>
<tr>
<th>Academic zones in Engineering College</th>
<th>Sample size</th>
<th>Attractive architectural features</th>
<th>Availability of embellishments</th>
<th>Availability of interesting activities</th>
<th>Availability of multi destination</th>
<th>Enjoyable scenery</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zone A</td>
<td>12</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>5</td>
</tr>
<tr>
<td>Zone B</td>
<td>12</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Zone C</td>
<td>8</td>
<td>0</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Zone D</td>
<td>8</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>Total</td>
<td>40</td>
<td>8</td>
<td>5</td>
<td>3</td>
<td>10</td>
<td>12</td>
</tr>
</tbody>
</table>

D. Proximity variable is studied in respect to two sub variables which are :

- Distance to trip (origin & destination)): - the observation and pathway checklist factors survey form results show that most of cases have walkability paths that a pedestrian can reach the farthest destination within 8 minute of walking.
- Pedestrians Exhaustibility: results specify that direct travel is the prominent character in this factor as a rate of 62.5% while the availability of interesting activities is the second possible value as a rate of 25% and multi destination to origin value record only 12.5% of overall cases.
E. Satisfaction and comfort variable is studied in terms of five sub variables which are:

- **Width of pathway:** results show that most (80%) of the cases in the complex zones are pathways with width equal & between 1.5 meters to 3 meters, while 15% of pathways have width larger than 3 meters. 5% recorded for narrow pathway (less than 1.5 meters). These results is an obvious indication that complex pathways are easy to walk through.

- **Shading of the pathway:** the observation and pathway checklist factors survey form results show that only one case is fully shaded by trees; meanwhile two third (67.5%) of pathways are shaded partially “Fig.7”. these results point toward the lack of satisfactory shading pathways.

- **Availability of Amenities:** results show that one third of pathways is provided by amenities that includes benches, landscape elements that used as sitting area and trashcans. It is noted that lack of pathway amenities will affect negatively on sense of place and complex's general identity.

- **Existence of buffer zones to separate the pathways:** based on design standards, this factor is considered to be one of the crucial factors in determining the satisfaction and comfort of users. Design criteria's specify three types of buffer zone to separate the pathways from streets: but, unfortunately the results give a negative statistics about the availability of this factor. In spite of importance of this factors ,nothing recorded as buffer zones to separate the pathways.

- **Relation of street with pathways:** results show that only two third of pathways are adjacent to streets, in these cases semi smooth separations is the common feature of pathways. Site visits, observations, and photographic documentation indicate that the separation is negatively used by car parking “Fig.8”.

Figure 8. Semi smooth relation of street with pathway encouraging illegal car parking

VII. CONCLUSIONS

1) Using cars by complex staff during working hours creates critical conflict between traffic and pedestrian flow especially at the entrance gates. This conflict will extend to affect the social and environmental aspects of complex sustainability, it prevent the campus to get a high quality of urban environment and destroys the enjoyable pedestrian experience. These negative influences will bring to an end the efforts to develop an environmentally friendly complex.

2) Based on research findings, our College of engineering complex in Salahaddin University have several positive points to make a significant contribution towards sustainable developments, therefore a healthy campus environment can be achieved through minimizing the negative impact of automobile transportation within the complex boundaries.

3) Despite the availability of the efficient car parking at complex gates and the distance to the farthest activity within the complex is less than 8 minute walking, still there is a need to make a strategic plan in order to achieve effective green transport and sustainability.
VIII. REFERENCES


# TABLE III. MULTI-DIMENSIONAL MODEL TO ASSESS THE PATHWAY FUNDAMENTAL FACTORS

<table>
<thead>
<tr>
<th>Variables</th>
<th>Sub-Variables</th>
<th>Possible values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Related to Traffic</td>
<td>Conflict between Traffic and pedestrian flow</td>
<td>High levels of conflict, Medium levels of conflict, Low levels of conflict, No conflict</td>
</tr>
<tr>
<td></td>
<td>Blocking pathway by illegal parking</td>
<td>Completely blocked pathway, Partially blocked pathway, No blocking</td>
</tr>
<tr>
<td></td>
<td>The effect of street parking on the pedestrian flow</td>
<td>Interfering the pedestrian flow, Partially Interfering the pedestrian flow, Not Interfering the pedestrian flow</td>
</tr>
<tr>
<td></td>
<td>Type of surface material in terms of slipperyness</td>
<td>Slippery materials, Mixed (Semi-Slippery materials), Non-Slippery materials</td>
</tr>
<tr>
<td>Safety of Pedestrian flow</td>
<td>The condition of pathway stair edges</td>
<td>Marked by grooved edges, Marked by rubber edges, Marked by colour Paints, Marked by different materials, No marked</td>
</tr>
<tr>
<td></td>
<td>Suitability of ramp slopes within the pathway</td>
<td>Comfortable slopes less than 1:16, Standard slopes =1:16, Steep slopes more than 1:16, No ramps within the pathway</td>
</tr>
<tr>
<td></td>
<td>The safety condition of pathway surfaces</td>
<td>Unsafe walking surfaces, small holes, cracks, Broken edges, Safe walking surfaces</td>
</tr>
<tr>
<td></td>
<td>The condition of pathway surfaces in term of trapping water</td>
<td>Collecting trapping water, huge trapped water, Small puddle, Wet pathway, Surfaces without trapping water</td>
</tr>
<tr>
<td>Security</td>
<td>Existence of people in pathways</td>
<td>Crowded pathways, Moderate pathways, Few occupation</td>
</tr>
<tr>
<td></td>
<td>Visibility of path from surroundings</td>
<td>Fully seen (visible) from surroundings, Partially visible from surroundings, Not visible from surroundings</td>
</tr>
<tr>
<td></td>
<td>Degree of illumination during dark hours</td>
<td>Fully illuminated, Partially illuminated, No lighting, Fully occupied, partially occupied</td>
</tr>
<tr>
<td></td>
<td>Existence of people in nearby buildings during working hours</td>
<td>Not occupied, cleanliness</td>
</tr>
<tr>
<td>Connectivity</td>
<td>Continuity of path (hindrances)</td>
<td>Utility services, Street furniture, Softscape, Car parking plots, others</td>
</tr>
<tr>
<td></td>
<td>Enjoyable scenery</td>
<td>Attractive architectural features, Availability of embellishments/fountain, Availability of embellishments/statues, Availability of sitting areas, Attractive Softscape, None enjoyable scenery</td>
</tr>
<tr>
<td>Proximity</td>
<td>Distance to trip (origin &amp; destination)</td>
<td>Within 8 minute of walking, Short trip less than 4 minutes, Long trip more than 8 minutes, Multi destination to origin, Availability of interesting activities, Direct travel</td>
</tr>
<tr>
<td></td>
<td>pedestrians Exhaustibility</td>
<td>W &lt; 1.5, 1.5 ≤ W ≤ 3, W &gt; 3</td>
</tr>
<tr>
<td></td>
<td>Shading of the pathway</td>
<td>By trees, By surrounding buildings, By artificial shed, No shadings</td>
</tr>
<tr>
<td>Satisfaction &amp; Comfort</td>
<td>Availability of Amenities</td>
<td>Benches, Landscape elements used for sitting, Trash cans, Not available</td>
</tr>
<tr>
<td></td>
<td>Existence of buffer zones to separate the pathways</td>
<td>Buffer zone type A (1.5m)width, Buffer zone type B (4.5m)width, Buffer zone type C (6 m)width, None</td>
</tr>
<tr>
<td></td>
<td>Relation of street with pathways</td>
<td>Rigid separation, Semi-smooth separation, Smooth separation</td>
</tr>
</tbody>
</table>
Appendix:

Figure 9. Map of Engineering Complex Zonss