The Study of Walkability Index: A Case Study at Jalandhar City in India

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Abstract - **Objectives: The primary point of our study is find the walkability index of the Jalandhar city - one of India's biggest and oldest city demonstrating a large number of pedestrians, by using walkability index as the tool, to compare walkability through the various places of the city. It is necessary to find the safety, comfort and convenience level of walking for pedestrians for which we need to calculate the walkability index of Jalandhar city. Methods: The method used to determine walkability index is "Ministry of Urban development (MOUD) Method". This method is most suitable in Indian conditions. Findings: The walkability index is used to compare cities and the helps to identify areas that need improvement and to make them walking-oriented so that pedestrians feel comfortable while walking on that. One of the important finding is that the "walkability index" of Jalandhar city came out to be 0.64, although not the walkers paradise but still better than many other cities in India but needs a lot of improvisation to make it pedestrian friendly city. Since Jalandhar city is the third largest city in India and the most crowded one with its population density of 250 persons/km² and road density 223kms/100 km², it has seen rapid urbanization and developed into a highly industrial centre of commercial activity in recent years. The city has subtropical humid climate with cold winters and hot summers with mercury soaring up to 48ºc in summer. The path walks are narrow, crowded and obstructive and has very unwalkable conditions as far as conditions of sidewalks are concerned. Thus it has become menace for the pedestrians of the city. Improvement: Thus the Walkability index is calculated to improve the various pedestrian related shortcomings, enhance the walking infrastructure and compare it with various cities considering the following basic attributes: the well being, security, economy, and convenience of traveling by foot. In simple term, walkability portrays and measures the availability and nature of pathways and walkways in urban areas.**

Keywords : Walkability Index ,Walkways , pedestrians ,walking, safety

1. INTRODUCTION

Jalandhar city is seeing a lot of urban sprawl and industrial growth over the past decade. The traffic congestion is increasing day by day. It has total area of 3401 km² with the total population of 862196 (2011 census)[1]. Walking is an activity in which most of the people are involved. Most of the people use walking to go from one place to another. Walking reduces the risk of various physical diseases like cardiac diseases, blood pressure, diabetes, cancer risk, osteoporosis and the mental diseases like anxiety, depression and worry[2]. Walking is considered as the most basic form of transport, because of   it is considered to be the universal, it is very affordable, It acts as the bridge to connect various modes of transport, it reduces the risk of various diseases and prevent various pollutions. The four basic distinguishing features of "Walkable environment" that include "foot-friendly" man-made environment ,the beneficial destinations are away at a walking distance ,It provides a natural environment that mediocre the harsh climatic conditions and bonds the people together culturally, religiously and regionally[3]. The prosperous pedestrian network has six criteria for design including, connecting the community with other road network of city, provides linkage with other carriers, for surveying purposes, the area should be zoned very minutely, the crime rate and number of accidents should be minimum, the various characteristics of walkways , and path context, that includes design of streets, aesthetics of built environment, spatial arrangement and overall appearance of the community[4].The undervalue walking in traditional transport planning are issues to measure walking techniques, economically weak, low price, advantages ignored and not taken seriously[5].The walkability of a place is determined by 5c's that include connectivity, conviviality, conspicuity(Crime free), comfortable, convenient[6]. The walkability index of 30 major Indian cities was calculated. The average walkability index of India was reported as 0.52. The best walkability in the country according to this ranking was in Chandigarh (value 0.91)[7]. Walkability index values for the area of the Nakhon Ratchasima Muang Municipality– one of Thailand's biggest city was calculated by using Global walkability index method[8].

2. Methodology

2.1 Ministry of urban development (MOUD) method

This method was developed by Ministry of Urban Road Development (MOUD), Government of India. They especially developed this method based on the Indian conditions. According to this method walkability index is a function of availability of footpath and pedestrian facility rating. This can be calculated using equation given below

$$Walkability\ Index = [(W_1 \times Avalibility\ of\ footpath) + (W_2 \times Pedestrian\ facility\ ratings)]$$

Where, W_1 and W_2 are weights (assumed 50% for both)

Availability of footpath = Footpath length / Length of major roads in the city

Pedestrian Facility Rating = Score estimated based on opinion on available pedestrian facility

 2.2 Study area

Some parts of Jalandhar city (figure 1), were studied which include Urban estate phase 1 and 2, central town, Lal Nagar, Rishi Nagar and Dada Nagar as shown in figure 2. The population of the city is 862196 with density of 250 persons /km^2 and the number of vehicles is 966802.It has the black-topped road 5878 km with road density of 223km/100km^2. The chosen areas are most congested and crowded in the city that are of much concern. Jalandhar is all set to become the Smart city in the upcoming years under the smart cities mission initiated by PM Narendra Modi in 2015.It is the urban renewal and retrofitting program by the govt. of India with the mission to develop 100 cities all over the country making them citizen friendly, more Walkable and sustainable.
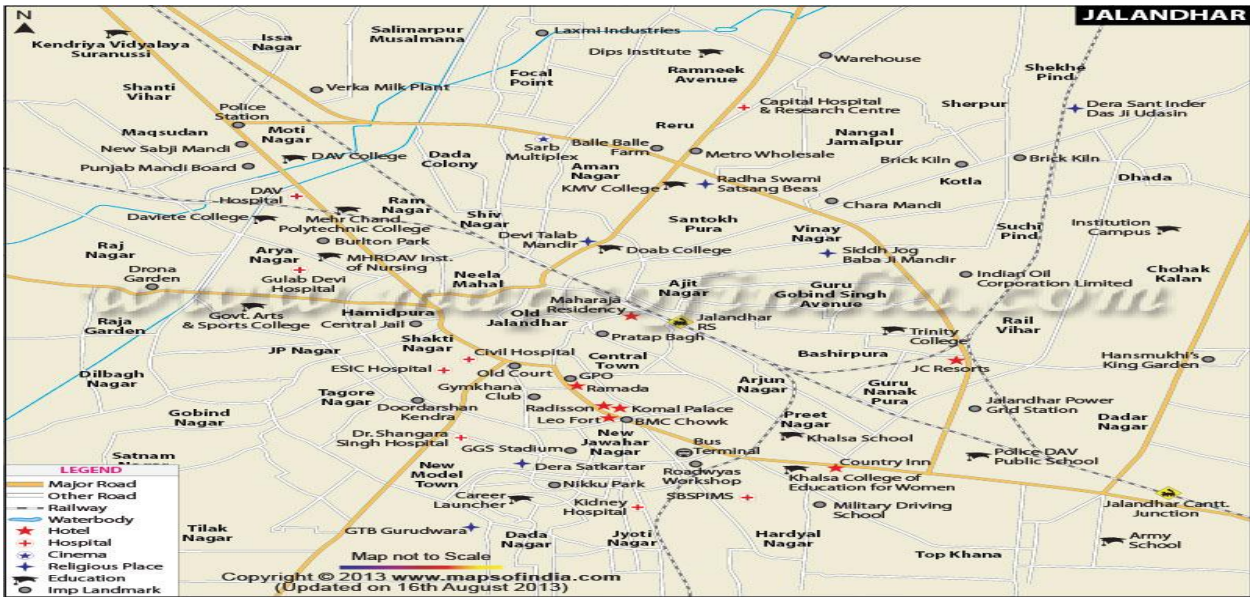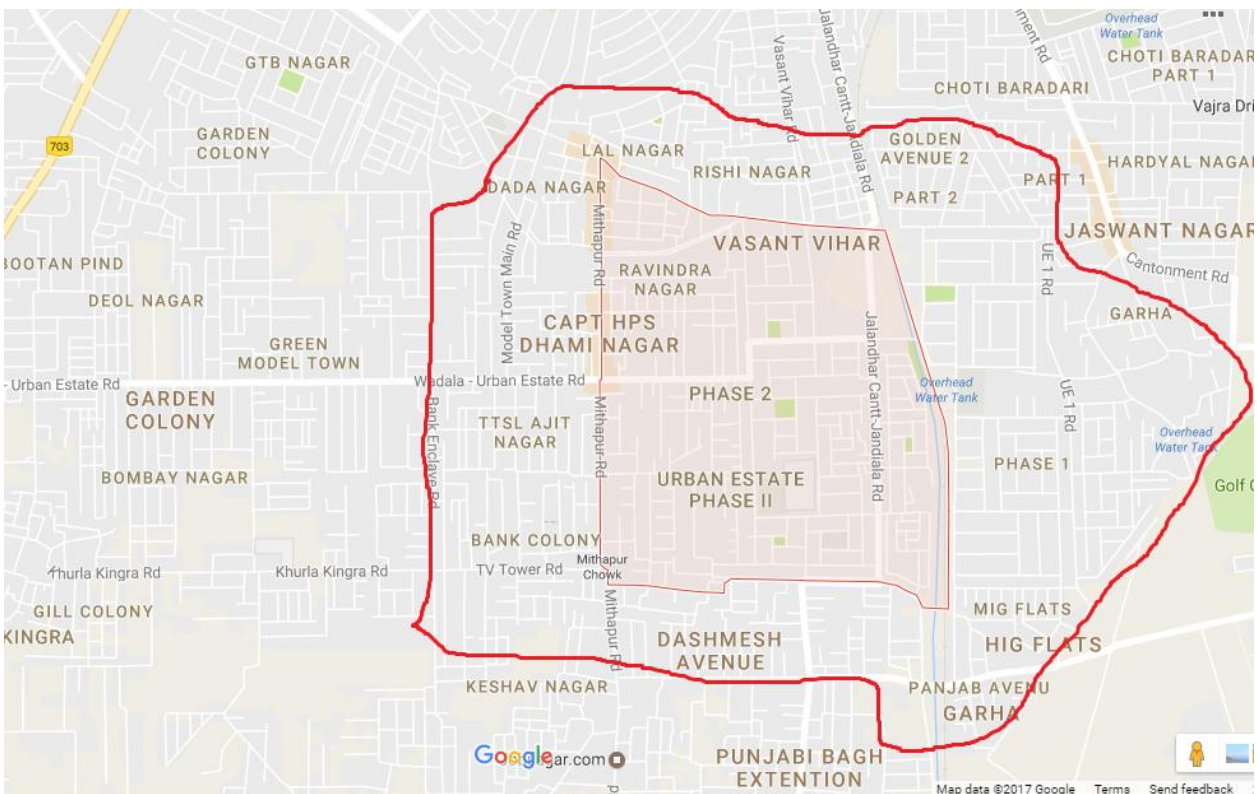
Figure 1: Map of Jalandhar City

Figure 2: The parts of city where study was done

2.3 Experimental design study

For calculating Walkability index we need of footpath and pedestrian facility ratings. Pedestrian facility survey for taking pedestrian ratings is prepared which includes the design and usability factors of pedestrian facilities that are provided in the area. The length of the major roads and pathways in the city is calculated using the city plan or a tape or Google maps. For finding the pedestrian facility rating, a pedestrian survey is to be done The factors that were considered in the pedestrian survey form are: Walkway height, Walkway width, Walkway Surface (smooth and regular),Walkway continuity, Provision of ramps connecting to carriageway, Illumination at night time, Traffic separator like pipe railing and hand rails, Obstructions, Maintenance and cleanliness, Raised continuous crossing facility, Walkway available on appropriate side of carriageway.

MOUD method considered only 9 attributes. This pedestrian survey form includes walkway height and availability of walkway on appropriate side of the carriageway, because they also play a critical role in the use of pedestrian facilities. The pedestrian have to rate the above mentioned attributes on 5 point usability scale where '1' defines 'not at all usable' and '5' define 'highly usable'. Same attributes need also be evaluated on an importance scale of 0 to 100, which will highlight their role in facility

provision and its use. In addition to above data, the details like gender, age, occupation and annual household income of the pedestrian will help in the subjective and qualitative perceptions of the user. A manual survey is conducted for 750 persons, comprising of students-400 (male-250, female-150), employee-200 and non-employee-150.The average value of pedestrian facility rating is obtained from these pedestrian survey responses. Now by using the above equation, the walkability index of the area is calculated.

3. RESULTS AND DISCUSSIONS

In accordance to the procedure used by MOUD, the length of roads in some parts of Jalandhar city was estimated from the map of city, which was drawn on a scale of 1:2500. It came out to be 6249m. The length of walkway was measured using a 30 m tape. It came out to be 4560 m. Pedestrians perceptions were collected on 11 decision attributes. Their scores were taken on a scale of 1 to 5. The average values for these are given in Table 1. These were further categorized based on pedestrian characteristics. The average value of the pedestrian facility rating came out to be 2.87 (on a 5 point scale). This average value must be divided by 5 to convert into a 1 point scale. Walkability index is calculated using the formula as below:

$$Walkability\ Index = [(W_1 \times Avalibility\ of\ footpath) + (W_2 \times Pedestrian\ facility\ ratings)]$$

Where, W_1 and W_2 are weights (assumed 50% for both)

Availability of footpath : Footpath length / Length of major roads in the city

Pedestrian Facility Rating : Score estimated based on opinion on available pedestrian facility

$$WI = \left[0.5 \times \left(\frac{4560}{6294}\right) + \left(0.5 \times \left(\frac{2.87}{5}\right)\right)\right] = 0.64$$

Therefore, the WI for Jalandhar city by MOUD method comes out to be 0.64.

Table 1: Average pedestrian ratings based on survey for various categories

| Attribute | Average score on 1 to 5 scale | | | | | | | | |
| | Overal 1 | Gender | | Occupation | | Annual Household income | | Age | |
		Female	Male	Others	Student	Upto 7 lakhs	Above 7 lakhs	Above 25 years	Below 25 years
Walkway height is reasonable	2.66	3.3	2.33	2.8	3.0	3.0	2.66	3.0	2.8
Walkway width is adequate	3.22	3.67	3.0	3.4	3.0	3.0	3.67	3.5	3.0
Surface is smooth and regular	2.44	3.66	2.0	3.0	1.75	2.0	3.34	3.5	1.4
Walkway is continuous	3.78	3.67	3.84	4.0	3.5	3.83	3.64	3.75	3.8
Provision of ramps connecting to carriageway	2.22	2.0	2.33	2.4	2.0	2.16	2.3	2.0	2.4
Illumination at night time is sufficient	2.10	2.3	2.16	2.2	2.0	1.83	2.6	2.0	2.2
Traffic separator like pipe railing is provided	2.66	3.66	2.16	2.4	3.0	2.67	2.66	3.0	2.4
Complete width is available (free from obstructions)	3.44	3.0	3.66	4.0	2.75	3.16	4.0	3.75	4.0
Walkways are maintained and cleaned	3.77	4.3	3.5	3.2	4.5	3.67	4.0	3.5	4.0
Raised continuous crossing facility is provided	1.77	2.33	1.5	1.6	2.0	1.66	2.0	2.0	1.6
Walkway is available on appropriate side of carriageway	3.56	3.66	3.5	3.6	3.5	3.34	4.0	4.0	3.4
Average	2.87	3.23	2.72	2.87	2.81	2.75	3.17	3.09	2.81

4. CONCLUSIONS

On the whole, Walkability Index of Jalandhar city in India was found to be 0.64,that is satisfactory to some extent, but needs a lot of improvement. The Walkability Index calculated indicates that only a few efforts are needed to improve the walk able conditions of the city. If the walk able conditions improve, it will help in reducing the various menaces including accidents, air and noise pollution congestion and diseases because most of the people will prefer walking as the mode of transport. Walkability graph variability graph as shown in figure 3, indicates that students find it almost same convenient as others, pedestrians having income above 7 lakh find it more convenient as compared to people having income up to 7 lakhs, the people of age above 25 Years they find it more convenient than people of age up to 25 years and females find it almost same convenient as males. Major areas of concern are no provision of traffic separators, absence of pedestrian friendly crossing facility, maintenance, smoothness and ramps connecting to the carriage way .

Figure 3: Graph showing the variation in Walkability Index for various categories
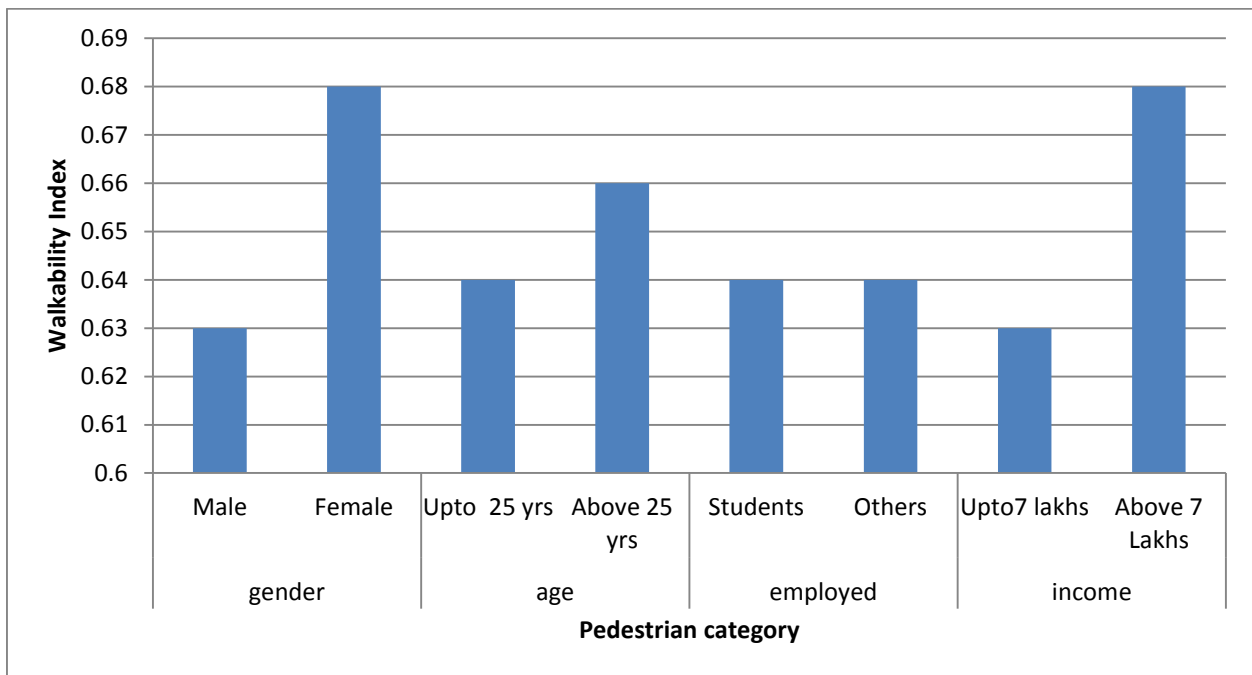
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