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Designing Walkable City through Public Perspective and Walkability Assessment: A case of Jhamsikhel Neighborhood

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Abstract
The literature in urban planning shows that walkable cities are healthy, resilient, sustainable, economic, and inclusive. Urban Walkability study has been done a lot in recent years to help planning a city. Walkability is a subjective issue, and objective study only is not sufficient to analyses walkability. However, different literature studies have identified some standard features of walkable cities and have been tested to rate the walkability of any urban space. Walkability has been often neglected in the planning process due to difficulty in quantitative measurement and is taken for granted in many cases. Establishing indicators help to analyze walkability quantitatively and plan a walkable city. The paper reviewed existing literature available in the field of walkability indicators. The framework to measure walkability was then be established, filling the gap in existing assessment methods in terms of urban areas and public perspective. Both subjective and objectiv e aspects of walkability measurement were combined in the research. The study demonstrated uniformity of pavements, cleanliness, plantation, lighting and ease of crossing as important aspects to enhance walkability. The result was then illustrated using GIS and Photoshop for better visualization. The framework established can be helpful in the assessment of walkability in similar urban areas and thus provide guidelines to plan walkable cities.

Keywords
Walkability, Walkable cities, Walkability indicators, Urban Planning

1. Introduction

Walking is one of the most common forms of moderate physical activity. People walk for fun, work, or as exercise. Walkability is understood as a walking experience that is functional, safe, comfortable, and enjoyable. Generally, all of these components must come together for a place to be walkable. [1] Active transport is known as the most common form of physical exercise. Increasing walking and cycling is often the most practical way to improve public fitness and health. Non-motorized modes can solve transport planning problems like traffic and parking congestion, energy consumption, and pollution emissions. They can also help achieve land use planning objectives, such as urban redevelopment and more compact ”smart growth” development. Walkability is the overall support for pedestrian travel in an area. The extent to which the built environment is friendly to people living, shopping, visiting, enjoying, or spending time in an area is considered to determine road walkability. [2] The study consists of several steps. First, the literature review was carried out to understand different units related to walkability and established literature in walkability indicators. Based upon the literature review, main indexes and indicators to measure walkability was established. The indicators were then empirically tested using surveys to establish the validity of indicators in our context. The indicators were then analyzed statistically, and spatial evaluation was done on the case area. The result is then illustrated using GIS to access the representation of the indicators in the study area.

The ontological position of the research is that reality is critical realism. The ontological claim after various studies is that the built-up environment has a certain impact on walkability. However, the reality is not absolute and depends upon subjective experiences. The reality is socially constructed. The main research questions asked in the study are:

- How are different aspects related to walkability perceived by the users?
- What is the walkability score in the study area?
- How can walkability be enhanced in the study area?

2. Literature Review

Walkable cities are the major talk in the recent decade of urban planning. While much focus was given to motor-able and car streets earlier, the shift to active transport is increasing in recent times. While transportation planners mostly focus on abstract "macro" variables like capacity, demand, volume, rate of flow, trip origin/destination analysis, congestion patterns, and regional land use patterns, urban designers and landscape architects have highlighted micro variables like the form and use of local places. [3] Some transportation planners consider microelements such as landscape, path design, or street furniture as important factors affecting pedestrian behaviour. A highly walkable environment encourages walking using a highly connected road network that provides access to the everyday places people want to go. It is safe and comfortable, with streets that are easy to cross for people of varied ages and degrees of mobility.[4] Spaces are attractive and engaging to be in, with street trees or other landscape elements, coherent but varied built form and visual connection with the life of the place. The pedestrian network links seamlessly, without interruptions and hazards, with other transit modes such as bus, tram, or subway, minimizing automobile dependence. Researches have been carried out in walkable cities and walkability to identify what makes cities walkable. While different terms have been used, major themes have been the same. The most commonly used terms in walkable cities are:

- Linkage
- Tidiness
- Safety
- Enclosure
- Image ability
- Human Scale
- Transparency
- Legibility

Past research and established indicators in our context have often addressed the technical sides of walkability, like the width and footpath height. The subjective side of walkability has often been ignored by proposing a framework to evaluate walkability both subjectively and objectively. The case study method will provide a framework to guide future walkable cities. Indicators are universal units to quantify measurements and data.Maslow's hierarchy of needs were traditionally used as a framework used to establish indicators in similar social researches. Alderfer then discarded the idea by stating that human needs cannot be specified in terms of hierarchy [5]). The theory was replaced by existence, relatedness, and growth in no fixed order. Walking behaviour is a complex economic, social, and cultural dynamic that influence different needs hierarchies. Some walk for leisure while some have to do it as a bare minimum. Walking behaviour is also coupled with the quality of the urban environment. Basic requirements like heterogeneity, dimensions of space, walking speed action radius are guiding for walking behaviour [6]). Another established and widely used walking audit tool is Pedestrian Environment Review System (PERS), used extensively in the UK [7]. PERS allowed planners and policymakers to measure pedestrian environment on five convenience, conviviality, coherence conspicuity, and connectivity requirements. PEQI is an observational survey that quantifies street factors that affect people's travel behaviour into five categories. The five categories are further divided into 30 units that reflect the quality of the built environment that influences walking behaviour. Based on the literature review, five different indicators were identified for this research. Five indicators included;

- Practical Aspects
- Safety Aspects
- Accessibility
- Aesthetic and
- Functionality

The research will test these indicators based on public opinion.

3. Scope and Limitation

The study will be focused on a neighbourhood scale in terms of size. Neighbourhood blocks are known to be building blocks in an urban area, which will help scale the findings in larger districts. Due to the Covid Lockdown situation online method of data collection is used in the study. Forms are distributed to people living nearby the study area, people who frequently

use the study area. Subjective data is collected by asking people to rate different aspects. The sampled population is missing representation from disabled people due to the method of data collection. The weightage may have to be recalculated by conducting interviews or surveys with disabled people to establish validity further.

4. Study Area

The study area is limited to Jhamsikhel, Pulchowk neighbourhood. The nearby neighbourhood of Jhamsikhel would also be investigated. The study area is chosen considering the walking activities and mixed land use in the stretch. Jhamsikhel lies in ward no 2 of Lalitpur SMC. The study area features a newly developing trendy neighbourhood on one side and a mixture of different institutional offices. On another side of the institutions, there are dozens of newly opened restaurants and cafes. The area features thus work trips and leisure trips. Mixed land-use makes the area a highly walkable area with no different trips. The mixed land use makes the neighbourhood an interesting mix.

The area also features Pulchowk Road, a 25-meter highway with secondary roads that feed the highway. There are sidewalks on either side of the highway, whereas not all secondary roads feature the requirements. The unique mix of land use, road hierarchy, and neighbourhood area is selected for the study.

Figure 1: Study Area

The study will focus on four main sections of road. 300-meter subsection of roads will be studied in detail to examine walkability measurement. The indicators of walkability obtained from literature and survey will be used to study the road sections. As mentioned earlier, the area is selected because of its mixed land use. Commercial establishments like Big Mart, Sajha Petrol Pump, Labim Mall, and several eateries lie in this section. Institutional buildings like the Pulchowk campus, Norwegian embassy, Head office of Bibeksheel Nepal party lies in the section. There are two hospitals in the selected area as well. The neighbourhood is also a rich residential area with well-designed, beautiful homes, making it a great area of interest.

4.1 Road Hierarchy

The study area has mainly two types of road hierarchy; Arterial road and collector road. The road marked red in Figure 2is an arterial road. The road is of width—25 m with sidewalks on both sides. There is a median in the centre of the road with street lighting fixtures. Crosswalks are used in the form of zebra crossing an overhead bridge. The road section is a pretty busy one with heavy traffic flow. This road is the main arterial road in Lalitpur Municipality. Roads marked in green colour in the above diagram is collector road. Collector roads are of varying widths of 8-11m in different sections. The road sections are pretty busy as it connects arterial road with Ring road at various points. The area experiences moderate traffic flow all day.

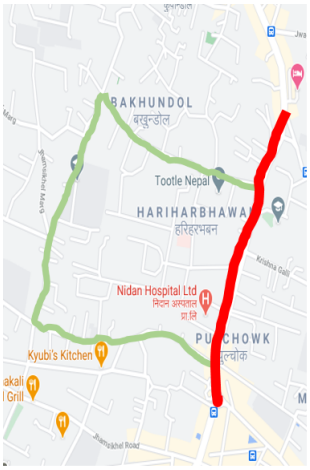

Figure 2: Road Hierarchy

4.2 Road Sections

The study area is divided into four major road sections. One section is of the arterial road, and the other three are of collector road. The road sections of the study area are shown in the figure below:

4.2.1 Section 1

Section 1 of the road marked in red in the diagram above is an arterial road. The section is 658meter long. Land use is of mixed nature with the retail and institutional building. The footpath is present on both sides of the road. The ROW of the road is 25 meters. Lamps provide lighting in the median. Crosswalks and a sky bridge are used as crossing features. The footpath is separated from traffic flow using steel rails except in the crosswalk. Bus stops are present on the road. This section is the only section of the road with public vehicle service in the study area. Plantation can be seen on the sidewalks, but the growth of plants is not enough for shading in the road. Pulchowk engineering campus building, Labim Mall are featured buildings in this section. The road is linked with different other road sections. A cycle lane is present in the section as a shared lane that is encroached by traffic flow in heavy traffic flow. New sidewalks are developed in the road with tactile tiles as paving. There is no street furniture on this road. Pedestrian traffic is high in this road segment. Due to the wide footpath and availability of footpath on both sides, the section satisfies LOS A with a flow rate of 5 p/min/ft.

4.2.2 Section 2

The road section marked by yellow in the diagram is section 2. The road is 669m long. Mixed land use is evident in the section with commercial and institutional establishments. The sidewalk is present on one side of the road and is encroached by shops in some sections. Lighting is done with electric poles on the sidewalk. The section has one crosswalk near the junction of Jhamsikhel chowk. Public transportation does not operate on the road. Ward office of ward no 3 is one of the prominent institutional buildings in this section. The plantation is not done on sidewalks. There is one major feeder road in the section. A cycle lane is not present in the section. Sidewalks use traditional hexagonal block paving. There is no street furniture on this road. Pedestrian traffic is high in this road segment. Due to the lack of uniform footpath and narrow sidewalks, the section satisfies only LOS B with a seven p/min/ft flow rate.

4.2.3 Section 3

The road section marked by blue in the diagram is section 2. The road is 650m long. Mixed land use is evident in the section with commercial, residential and institutional establishments. The sidewalk is present on one side of the road and is encroached by shops in some sections. Lighting is done with electric poles on the sidewalk. The section has one crosswalk near the junction of Jhamsikhel chowk. Public transportation does not operate on the road. Plantation is being done on sidewalks. Hasapota Ganesh, one of the biggest religious temples of the neighbourhood building, lies in the section. Arun Thapa memorial statue is also present on the road. There is one major feeder road in the section. A cycle lane is present as a shared lane in the section, but the narrow road width makes it unsafe for the cyclist in the area. Sidewalks use traditional hexagonal block paving with the raised curb. There is no street furniture on this road. Pedestrian traffic is moderate in this road segment. However, the section satisfies only LOS B with a six p/min/ft flow rate due to the lack of footpath on both sides and narrow footpath.

4.2.4 Section 4

The road section marked by green in the diagram is section 2. The road is 650m. The width of the road is 9m with a sidewalk. Mixed land use is evident in the section with commercial, residential and institutional establishments. The sidewalk is present on one side of the road and is encroached by shops in some sections. Lighting is done with electric poles on the sidewalk. The section has one crosswalk near the junction of Bakhundol chowk. Public transportation does not operate on the road. Plantation is being done on sidewalks. The Norwegian embassy is one of the prominent buildings in this section. There are two major feeder roads in the section. A cycle lane is present as a shared lane in the section, but the narrow road width makes it unsafe for cyclists in the area. Sidewalks use traditional hexagonal block paving with a raised curb. There is no street furniture on this road. Pedestrian traffic is moderate in this road segment. However, the section satisfies only LOS B with a six p/min/ft flow rate due to the lack of footpath on both sides and narrow footpath.

Figure 3: Road Sections

4.3 Case Study Method

The case study research method develops the framework to analyze walkability's subjective and objective aspects. The case study will help in an in-depth investigation of different aspects related to walkability. The case study method involves identifying a case; usually, a neighbourhood, collecting and analyzing data and visual representation, and explaining results obtained. The research can open up new dimensions in future research as it is tested in a natural setting. The selection of a case is thus an essential part of the research to establish validity. Different parameters were set to identify the suitable case. Firstly a developing urban area is considered appropriate for the study. The scale of the study is set up at the neighbourhood level, which can be scalable to larger areas by studying similar neighbourhoods combined. The area also has to have a significant number of pedestrians. The pedestrians in the area will help in collecting subjective data. In this view, the area of Jhamsikhel Neighborhood is a new growing area, with public buildings and mixed-use development, the hierarchy of roads is selected. After selecting the appropriate case study, several requirements were set to achieve the desired framework for access walkability. The framework should be:

- Able to incorporate both subjective and objective aspects of walkability.
- Able to quantify the measurement
- Mathematical and visually representable
- Adaptable to large scales
- Able to help in the urban planning design process for walkable cities.

The phases in the study are described with activities and outputs as shown in Table 1:

Phases	Steps	Activities	Results
Choice	Literature Review	Definition of keyword	Selection of papers
		Definition of time span	Assessment method identification
		Database search	Identification of indicators
Analysis	Empirical investigation	Validation of results in choice phase	Elaboration of survey test
		Selection of preiminary sample	Questionaire preparation
		Pilot survey	Questionaire Edit
		Final Survey	Data obtained
Evaluation	Data evaluation	Statistical Analysis	Weight given to indicators
	Spatial Evaluation	Use of Different tools to evaluate street	Road walkability score
		Identification of critical areas	Suggestions to improve

Table 1: Research Method for the framework to access walkability

Choice Phase: Indicators and Indexes were chosen based upon an in-depth literature review. Literature was searched based on three keywords, walkability, and walkability measure and walkability indicators. From literature, mostly common qualitative methods are empirical investigation, assessment survey and visualization. Analysis Phase: The analysis phase consisted of empirical investigation in the case study area. To edit the questionnaire, a pilot survey was done with people working in the Urban planning and transportation planning sector. The survey was administered online with the main categories identified. The survey data were subsequently analyzed using statistical analysis. Indicators established in the choice phase were tested and weighed after the analysis. Evaluation Phase: Current status of the Jhamsikhel Neighborhood was assessed. This phase employed GIS, AutoCAD and Photoshop tools to visualize the data.

5. Results

5.1 Choice Phase

Different literature was analysed from past to present to identify the main walkability indexes and indicators used in the framework. The analysis yielded five different indicators.

Indicators Adopted in the Research			
Practicality	Footpath in Both Sides	Accessibility	Tactile tiles
	Foothpath continued to other roads		Access to bus stops
	Cleanliness of Path		Mix Land use
	Uniformity of pavements		Less crowded streets
	Ramps in Sidewalks		Acess to shops in 5 min walk
Safety	Separation of Road and Footpath	Functionality	Clear Road markings
	Railings in Footpath		Road Side Furniture
	Crosswalk symbols		Street Vendors
	Lighting		Ease of Zebra Crossing
	Low Crime Rate		
	Absence of electric poles	Aesthetics	Plantation in Footpath
	slow speed of traffic		Transparent Boundary Wall
	security personel		Public Art
	low level of air pollution		Attractive Homes
			Religious Buildings in route
			Parks and Greenaries

Table 2: Indicators identified for the study

As shown in the table 2, most commonly used indexes are practicality, accessibility, safety, functionality and aesthetics.

5.2 Analysis

The first step of the analysis was to determine which of the indicators were appropriate for the framework. The indicators picked from literature as listed in Table 2 showed almost 90% confidence. Some indicators were added and removed after the pilot survey. The lack of air pollution was listed later after consultation with other experts. Similarly, the absence of an

Table 3: Weight of Indicator

Practical Aspects	
Footpath in Both Sides	0.76
Foothpath continued to other roads	0.74
Cleanliness of Path	0.81
Uniformity of pavements	0.69
Ramps in Sidewalks	0.63
Safety Aspects	
Separation of Road and Footpath	0.78
Railings in Footpath	0.62
Crosswalk symbols	0.77
Lighting	0.84
Low Crime Rate	0.79
Absence of electric poles	0.63
slow speed of traffic	0.60
security personel	0.57
low levelof air pollution	0.74
Accessibility	
Tactile tiles	0.64
Access to bus stops	0.71
Mix Land use	0.71
Less crowded streets	0.54
Acess to shops in 5 min walk	0.73
Aesthetic Aspects	
Plantation in Footpath	0.76
Transparent Boundary Wall	0.60
Public Art	0.61
Attractive Homes	0.62
Religious Buildings in route	0.64
Parks and Greenaries	0.77
Functionality	
Clear Road markings	0.70
Road Side Furniture	0.60
Street Vendors	0.51
Ease of Zebra Crossing	0.74

abandoned building was used as one of the indicators in the questionnaire survey, and it was discarded looking at urban context and consultation. The selected indicators were then surveyed in the larger context. Respondents were asked to rate the influence of different aspects from 1 (No Influence) to 5 (Very High Influence). The survey questionnaire was sent to 400 people living or using the study area. Judgmental Sampling was used to determine the sample size to which the choice is entrusted to a researcher with criteria of representativeness. After analyzing more than 150 data, the weight value started to look constant, and the survey was stopped after 216 responses. Based on the study, statistical analysis was performed to assign weights for different indicators. The weighted average is set to reflect the priorities better. According to the definition of the weighted average, the values in the analysis are added, each multiplied by a coefficient or weight that defines their "importance," and the result is divided by the sum of the weights.

According to Table 3

- Cleanliness and footpaths on both sides are deemed as important aspects in terms of practicality.
- Lighting, separation of road and sidewalk, and low crime rate found important safety-wise
- Access to public transport and mixed land use found more important accessibility wise
- Plantation and greeneries found to be more important aesthetics wise
- Clear road signs and ease of crossing important functionality wise

Practicality= 0.76* footpath+.74* continuity+.81* cleanliness+0.69*uniformity +0.63* ramps +Safety= 0.78*separation+ 0.62*railing+0.77*crosswalk +0.84*lighting+0.79 crime+.63*poles+.60*speed+.57*security+0.74*air purity + Accessibility= 0.64*tactile+0.71* bus stop+ 0.71*landuse+0.54*crowded +0.73 * retail + Aesthetics= 0.76* Plantation+0.6*transparency+0.61*art+0.62*façade+ 0.64*religious + 0.64*parks + Functionality= 0.7*clear marking+0.6*furniture+0.51*vending+0.74*ease of crossing

The road sections are assessed based upon the given formula and observational value.

5.3 Evaluation Phase

The evaluation Phase involved visual representation of objective and subjective elements of walkability. This phase employed GIS, Open Street Maps, AutoCAD, and Photoshop to paint the walkability situation in the neighbourhood. Indicators identified from the literature were georeferenced based on Google Maps, Observation. Factors like lighting were carefully studied by observing streets at night time. Sidewalk and Crossing features were georeferenced in maps. Access to shops and land use were both measured and asked people living in the area. Different parameters were set based upon literature, standards, codes, and data to rate streets. The streets were then ranked based on the parameters. The current state of walkability was then tabulated and visualized on Photoshop.

Streets were rated from bad to excellent in terms of the average of different indicators. Street 1, which is the main road, is good in terms of walkability compared to other collector streets. Aesthetics and Functional aspect were found to be lacking in all streets. Street 1 was found to be highly accessible,

	Street 1	Street 2	Street 3	Street 4
Practical Aspects	81.16	70.65	70.65	50.00
Safety Aspects	72.44	57.82	50.06	45.14
Accessibility	90.35	59.38	51.26	51.26
Aesthetics	51.57	23.68	41.90	23.89
Functionality	43.56	57.70	28.29	28.29
	69	54	50	41

Table 4: Final Walkability Evaluation

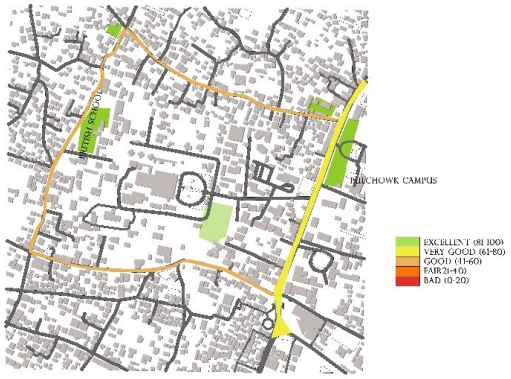

Figure 4: Walkability Index

with ramps on the sidewalk to access public transport. The fact that pedestrian features were recently renovated in the street is no coincidence as the walkability index results are seen.

6. Discussion

Through applying the framework to access walkability, the walkability is measured and visualized in terms of maps. The framework helps in highlighting how some elements can be increased to increase walkability. The study shows the case for maximizing plantation and creation of pocket parks to create more aesthetic routes. Lighting should be carefully installed and maintained in all ways to make streets safer to walk. The research also identified some critical points in the streets based on indicators. Crossroad safety is one of the crucial aspects often ignored in terms of pedestrian safety. Since the streets are at 90-degree angles visibility of adjacent streets is compromised highly. As a result, two crossings in streets 2 to 3 and 3-4 were critical in safety. Footpath continuity is another crucial aspect that contributes to the practical and safety of pedestrians. 2 of the studied streets do not even have footpaths on both sides and are narrower than the other two streets. Lack of sidewalks has created overcrowding, and pedestrians are often forced to enter the carriageway by compromising their safety. The speed of vehicles was found higher than comfortable in streets with narrow sidewalks. Speed limits are also one way to create walkable cities. Among identified indicators, only two indexes got thoroughly ranked in the case area; mix land use and crime rate. Lowered crime rate and land use show that the neighbourhood has high livability. The state of cleanliness and lighting was also found in good condition in all streets aesthetic aspects like plantations and parks were missing. The study has highlighted critical indicators that can be considered while designing walkable infrastructures in other urban areas.

7. Conclusion and Future Recommendation

This paper analyzed one case study dealing with walkable city planning, aiming to understand the contribution of walkability measurement. The case study dealt with Jhamsikhel, a new and upcoming neighbourhood often referred to as a VIP area by people. Concerning research questions following conclusions are made:

- Cleanliness, footpath, lighting, perceived crime rate, mix land use, plantation, and ease of crossing are critical indices for developing walkable cities.
- The neighbourhood has an appropriate walkability state in one street, Main Street, and the condition is okay on collector roads. The investment of walkable infrastructures has often been limited to main roads only. With the establishment of the Nepal Urban Road Standard, the scenario needs to change and prioritize pedestrian needs on all streets.
- The critical points found in the study need to be addressed as the priority to enhance the current state of walkability. The plantation must be done on all roads to provide constant shade. Sidewalks should be uniform, well maintained, and clean to use and continued in all road sections to enhance uniform mobilization of pedestrians.

Walkability measurement can provide guidelines to plan a walkable city. Urban planning and walkability are intertwined as both involve adding psychological wellbeing, comfort, promoting social exchange, and the safety of users. Correct Walkability planning is an essential part of planning walkable cities that are sustainable, resilient, and inclusive. Walkability

assessment should use both subjective and objective data to identify pedestrians' needs correctly. The study can help to create guidelines for planning walkable cities and developing urban areas of the future. The established indicators can also be used to assess the walkability of similar urban regions of the cities. The indicators can be a baseline to scale walkability assessment in a larger context. Change in indicators can also be studied in the future from this baseline to understand the dynamics of human needs and how indicators change in time. Lastly, the proposed multi- framework will be tested to determine whether it can be applied to assess an area's current walkability status and compare different project scenarios.

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