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Study of Variables of Built Environment That Affect Walkability

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Abstract – Walkability is a significant concept in sustainable urban design. Walking helps to cut ozone depleting layer and various emissions that are harmful for the environment by requiring less driving and improve occupants' wellbeing by giving more freedom to work out; decrease probability of crime by providing opportunities for social connection among people. An extensive study of literature by various scholars has been done on the relationship between natural factors and walking activity. The investigations show that the spaces designed for pedestrians those that are human-scaled, comfortable in all aspects and appropriate for people on foot could motivate people to walk, and accordingly could improve general wellbeing of people. Elements impacting walkability incorporate the presence or absence of physical condition and nature of pathways or walkways, traffic conditions, land use planning nearness of the buildings, and sense of security, among others. In particular, the investigation records various key factors affecting walkability by reviewing and summarizing the studies previously done by various scholars. Furthermore, this paper assesses walkability of two different roads of the same city - Indore; Sarafa Bazaar road and Vasant Vihar road by scrutinizing all the design and planning factors that are human made. Additionally, ideas are given for improving walkability on the roads and encourage people to travel on foot. The outcomes from this exploration give knowledge into how urban designers can comprehend the collaboration between the built environment and walkability.

Key Words – Sustainability, Built Environment, Walkability, Environmental Variables

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INTRODUCTION

Walking has broadly been considered by analysts to be significant for physical wellbeing and a vital aspect for up surging communication between people and develop social connections among them within the community, and also it is one of the most sustainable modes of transportation in such a time of high non-renewable energy source cost. The adverse consequences of low-density, vehicle reliant, isolated use planning of land and transportation systems are drawing in physical wellbeing consideration. Accordingly, more urban designers and city planners are starting to take the idea of "walkable city" into thought in their endeavors. Walkability is a significant idea in sustainable urban design. Walkability is a measure of how cordial a region is for the people who are walking. Walkability has numerous physical wellbeing, ecological, and monetary advantages. Elements impacting walkability incorporate the presence or absence of physical condition and nature of pathways or walkways, traffic conditions, land use planning, nearness of the buildings, and sense of security, among others. Walkability is a significant idea in sustainable urban design. Walking help to cut ozone depleting layer and various emissions that are harmful for the environment as there would not be burning of fuel if people would prefer walking over driving. Walking is associated with physical fitness of the citizens as well since walking is an easy form of exercise; it also decreases probability of crime by providing opportunities for social connection between people. Walking is a significant type of every day physical activity with many realized medical advantages, including upgrades to cardiovascular wellbeing, lung work, bone strength, and psychological wellness, and a diminished danger of diabetes, corpulence, disease, and generally mortality.

Sustainability centers around promoting long term viability by lessening utilization, waste and destructive effects on individuals and places while improving the overall well-being of the both individuals and place. Well-being incorporates the physical, ecological, monetary, social, health and value factors, among others, that involve urban areas and their populaces.

Sustainability is a vital part to proficient practice in urban design. Sustainability centers on decreasing a person's or society's utilization of the Earth's natural resources. Sustainability can be accomplished by decreasing the carbon impression of people by altering strategies for transportation and energy utilization. Compact walkable spaces

are the most sustainable type of living. Designing and Planning and away the requirement for vehicles is the main step in making sustainable places or accomplishing sustainability.

Built environment alludes to the human-made surroundings that give the setting to human movement, going in scale from structures to parks. Models would incorporate urban areas, structures, metropolitan spaces, walkways, streets, parks; and so on. It is the human-made space wherein individuals live, work, and recreate on an everyday premise. Built environment has strong influence walkability. By considering and forming the built environment, "included urban design, land use pattern, and transportation framework and enveloping examples of human action inside the physical environment", walkability can be urged as an approach to promote general physical wellbeing of the people through urban design strategies.

Walkability relies on physical factors of built environment and furthermore on mental components dependent on user insights. This research centers on physical factors of built environment that influence walkability.

AIM

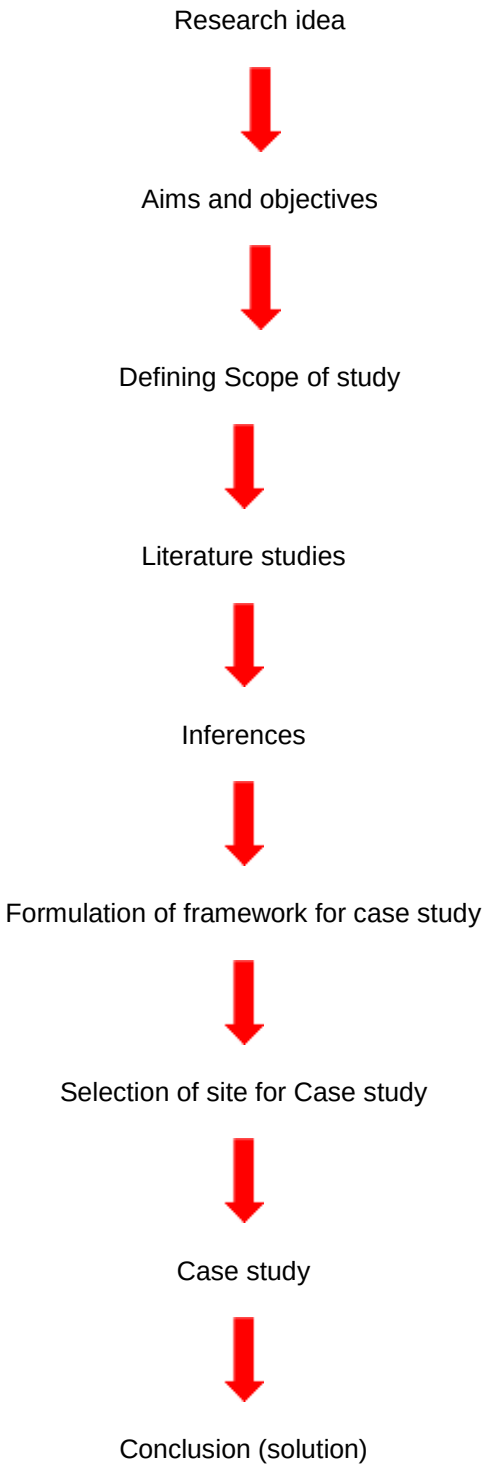
To comprehend the effect of built environment on walkability

OBJECTIVES

- To comprehend the connection between built environment and walkability
- To recognize key physical design variables of built environment that have an impact on walkability
- To study the effect of natural factors on walkability with regards to Sarafa bazaar road, Indore and Vasant Vihar road, Indore.
- To recommend arrangements and approaches to upgrade walkability on the roads

METHODOLOGY

Study writings by different authors and specialists on walkability. From the learning, produce a set of physical design parameters that promote people to walk. Then, based on the formulated design parameters analyse roads of a city and record the observations and components. The observations will be centred specifically on the physical components of built environment and ideas will be given to improve walkability on the roads.



SCOPE OF THE STUDY

The outcomes and conclusions will be an investigation and examination of just physical factors of built environment that impact walkability. It doesn't cover intangible factors of built environment psychology, behavioural pattern of public etc.

LITERATURE REVIEW

To comprehend walkability according to environmental factors, an extensive writing review of various scholars that considers multiple

environmental factors and assessments of walkability should be presented. Environmental factors are viewed by city designers and planners as a portion of the vital components influencing walkability, therefore various environmental factors canvassed in the previous decade in design studies have been evaluated.

Few examples of Environmental factors that impact walking activity in a city are, road trees, walkway width, city block sizes, traffic speed, traffic volumes and mixed land uses etc. The review of literature studies particularly in designing and planning domain delineates that a large number of examinations have effectively explored how built environment impact on walking activity. Along with other sociopsychological factors, physical factors have been recognized that effect walkability. Even though these investigations show that walking activity is impacted by the qualities and characteristics of the area or urban environment, a thorough rundown of physical design factors influencing walking activity actually should be contemplated. It is important because only few built environmental factors have been empirically reviewed for their effect on walking activity. This research fosters an extensive list of such built environment factors.

A few studies in the previous decade have shown that both macro-scale and micro-scale built environmental features can influence individuals' desire for proactive tasks.(Alfonzo et al., 2008) However, research on urban design and walkability normally stresses more on macro-scale features rather than micro-scale features of the physical environment. Macro-scale features, for example, block length and number of intersections can be estimated by geographic information system(GIS) and aerial photos, while the micro-scale features, for example, road trees, road amenities, walkways, and physical condition of the structures (Alfonzo et al, 2008) can't be estimated by such technological advancements. As the literature survey outlines, both macro-scale and micro-scale features can be persuasive to the manner in which individuals perceive its environment. (Pleasantness, safety, accessibility, and so on) The factors of built environment exhaustively are disclosed to understand how they affect walkability.

Macro-Scale Environmental Variables

Macro-scale environmental factors are features like block length and number of intersections that can be estimated by geographic information system (GIS) and aerial photos (Alfonzo et al., 2008) summed up much exploration on the connections between built environment features and walking activity, especially centred around the macro scale physical environmental factors study fields like transportation and urban planning. As per these reviews, built environment factors related with walking, non-mechanized transportation and urban planning incorporate closeness, network, block length, access to programs and facilities, population and housing density, land uses, uninterrupted continuous sidewalks. Elements that influence individuals' decision of choosing motorised or non-motorised vehicle depend essentially on two basic ways in which land is utilized: (1) proximity (distance) and (2) connectivity (directness of movement) (Frank, 2000). Different components, for example, travel cost, ecological quality, and aspects of convenience and access (e.g., parking facility available) are additionally likely to be compelling in walking (Saelens et al., 2003). Proximity is the distance between trip beginnings and trip endings. Proximity is controlled by two land use factors: density (compactness of land uses) and mixed land uses (the distance between or intermixing among various types of land uses) (Saelens et al., 2003). Living in a high-density region with mixed land uses is more advantageous for an occupant to walk for doing shopping, feasting in an eatery, and visiting neighbours than in a low density with single land use region. Among all the macro-scale physical factors of built environment which influences walking, the most conceptual one and furthermore the critical segment for good neighbourhood is connectivity between places (Dill, 2004). Length of built Blocks is a significant criterion for measurement of connectivity between two blocks/places. Shorter block length means higher connectivity. Numerous new communities now have maximum block length principles to build good connectivity (Handy et al., 2003). The fundamental theory behind the action is that lesser block length implies more intersections and accordingly more limited travel distances and a more noteworthy number of routes between two areas (Dill, 2004). Block size is comparative with the square length, yet utilizing block size measured by its area or perimeter as a standard might be more adaptable than block length for each side. (Frank et al., 2000) utilized the block density as an intermediary measure for connectivity, which is viewed as a decent intermediary for road connectivity. Intersection density is estimated as "the number of intersections per unit area" (Dill, 2004). A higher number would demonstrate more intersections and, apparently, higher connectivity. Road density is estimated as the number of linear miles of roads per square mile of land. A higher number would show more roads and, apparently, higher connectivity (Dill, 2004).

Micro-Scale Environmental Variables

In expansion to macro-scale factors normally viewed in planning and transportation fields, the literature studies additionally brings up various physical built environmental factors that may influence walking, different fields like urban design, architectural engineering, landscape design, planning of parks, environmental psychology, and literary works from visual inclination and visual appraisal likewise add to it (Ewing, 2000; Ewing et al., 2005). At the micro-scale, the related and associated built environmental factors of walkability are normally about characteristics of route in

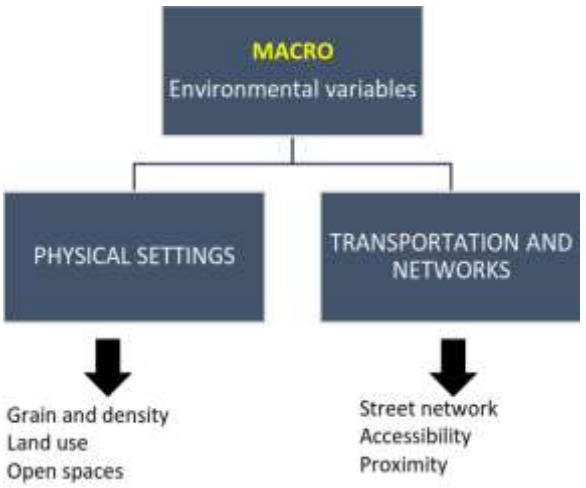
context of quality of the pathway. Southworth (2005) mentions six parameters of walkability: connectivity, linkages to different modes, fine-grained and mixed use land development, safety and security, quality of the walkway, and path context (for example visual interest, landscaping, spatial definition, and so forth) Among these, connectivity, linkages to different modes and land use patterns are essential for macro-scale natural factors which have been talked about previously. At the small-scale, the pertinent physical environmental factors of walkability are route characteristics related to its the quality.

Numerous studies regarding this subject have demonstrated that different components related with streets may impact pedestrians. The fundamental thought of this is that roads with more width draw quicker traffic speed, which decreases the sense of safety in pedestrians. Therefore, narrow road is more walkable and preferable for walking (Southworth, 2003). They recommended 24 feet as the ideal street width. A few researchers say that roadways with less number of lanes are beneficial for people on foot since road crossing distance is reduced. Along with this, different scholars have brought up that traffic calming factors additionally increment the pedestrian's sense of safety, since these variables lessen traffic speed also. Improvement and modifications in the design of pedestrian crossings, like the nature of signage and signs, raised pedestrian crossings, presence of middle islands, and curb extensions can make it more secure and simpler for walkers to go across road. Additionally, specific pavements for crossings and single direction traffic may likewise be useful. Buffer zone typically shows the space between walking zone and traffic zone, is a key factor that influences walking movement, since it shields people on foot from the adverse effect of heavy traffic(Jacobs, 1993).Building's setbacks have also been referenced in walkability writing (Lamont, 2001). However whether a building's setback is positive or negative for people on foot is yet to be resolved with thorough exploration. Exterior façade's transparency has been examined by numerous scholars in reference to walkability (Jacobs, 1999; Lamont, 2001) Fenestration is the plan and position of windows and different openings in a structure. The overall thought is that transparent glass is better than a clear blank wall for people on foot close to the building facade. Additionally, pedestrians prefer a passageway to a building confronting the road as rather than entering from parking areas. Mixed land use was additionally considered to give more joy in walking than vacant land and abandoned buildings. Commercial use is typically viewed as the most preferred land use type for walking.

The significance of road trees in walking activity is referenced in numerous studies. Jacobs et al. (2002) calls attention to two advantages of road trees: providing shade from daylight, and giving a physical and mental buffer from fast moving vehicles on the road. Some exploration additionally shows that road trees can viably reduce wind speeds. Ewing's visual preference review found that "trees along the road" was one of the most important among the five determinants affecting decision of pedestrians to select the route to public transport stations/stops. Road furniture, for example, road lighting, garbage bins, seats, bollards, post boxes, telephone boxes and public art, have additionally been referenced in numerous explores. Road lighting, particularly pedestrian level lighting, makes a brilliant and sufficiently bright road climate and can build feeling of safety among the people on foot. But, there are no or few conversations about how other road facilities impact walkers. Road Scale and Enclosure Design writing also refers to "intimate human scale," which is normally assessed by road width (Jacobs, 1993). The "human scale" definition depends on whether a passer-by on one side of the walkway can perceive the facial expressions of person on foot on the opposite side. As a component of this study building height is additionally considered as a significant factor in road scale. Jacobs likewise proposes that the proportion between building height and road width is an important factor. He claims that 1:2 (or less) gives a strong sense of enclosure in area, and 1:5 (or more) shows a weak sense of enclosure (Jacobs, 1993).

INFERENCES

The findings from various studies are sorted and segregated under macro-scale and micro- scale factors. At the micro-scale, the variables of walkability are commonly about route attributes in context of its quality and way setting. Macro-scale variables are features, for example, block length and number of convergences can be estimated by geographic information system (GIS) and aerial photos.



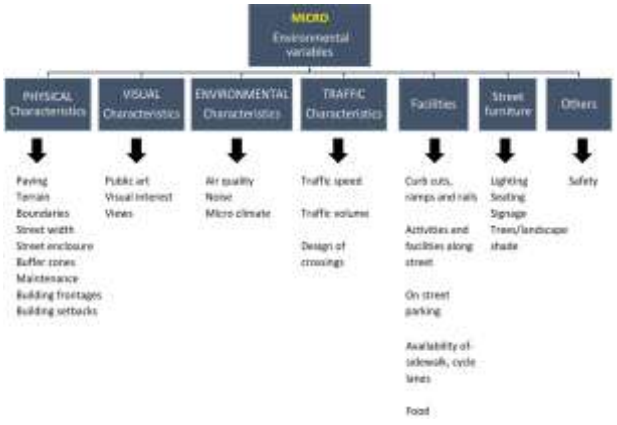


Figure 1 Flow chart showing various macro and micro variables

Table 1 Most common variable that affect walk ability

MACRO VARIABLES	MICRO VARIABLES	
land use	Street trees	Sidewalk condition
density	Lighting	Dimension of sidewalk
Connectivity	Seating	Pavement -Material
Accessibility	Signage	Safety
Crime	Building front porches	Windows facing street
Street pattern	Art work	Overhead structure
Vehicle volume and speed	Micro climate	Food
Public open spaces	Street furniture	Street scale and enclosure
Proximity	Terrain and slope	Curb cuts, ramps, rails
Block size	On street parking	Presence of people
Presence of sidewalk	Visual complexity	Historical characteristics
No. of blocks	Buffers	standards
No. Of intersections	Noise	

CASE STUDIES

1. Sarafa Bazaar Street, Indore

Figure 2 Plan (not to the scale) of Sarafa food street, Indore

Sarafa Bazaar is located in the central Indore; the core area of the city. Sarafa bazaar in Indore is traditionally famous for its Gold & Silver jewellery, gems, etc. like any other city's jewellery market, but unique to Indore's Sarafa Bazaar is the interesting fact that it turns into a food street every single night (after 8 pm till 2am).

Figure 3 People of all age groups on street

The street observed to be very safe for the public for entire day and night. The street is well lit with proper and sufficient street lights but there is no provision for seating for the pedestrians.

Figure 4 Sarafa food street at night

The parking is done on streets in front of closed shops or in a multi-level parking planned in the middle of the market surrounded by mixed use buildings. The parking areas are visible to the public.

Street width is 6 m. And has no designated sidewalk. The street is open for pedestrians and two wheelers in the day time and only pedestrians after 8pm. The entry is controlled through barricades. There is no provision for handicapped public.

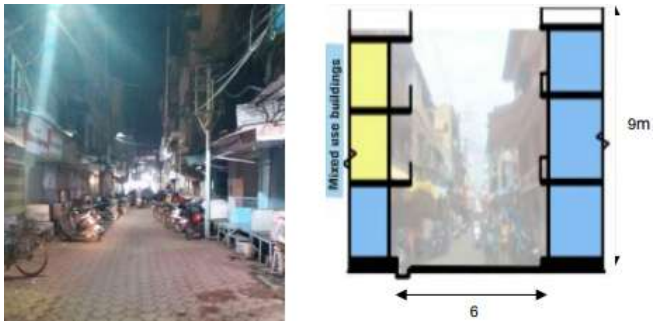


Figure 5 Parking in front of closed shops and street enclosure

The buildings along the street are 9-10 m in height (g+2) and width of street is 6m. Street enclosure is 3:2. There is clear sense of enclosure. The street has no trees but buildings provide mutual shading.

The character street is 9m of the mixed-use with 6 commercial at ground floors and residential on upper floors. The upper floors have habitable rooms like drawing/living rooms in the front facing the street that creates surveillance and ensure safety.

The ground floor has porches and verandas and is designed in such a way that it maximizes opportunity of active frontages and allows clear observation of streets.

The upper floors either have balconies or windows oriented towards the street to overlook public spaces and street.

Figure 6 Windows and balconies oriented towards street

Density of pedestrians is very high on the street during day and night. The street is crowded both day and night. Lack of trees and green cover, pollution from two wheelers during day and fumes from the food stalls in a narrow street contributes to air pollution. Speed of vehicles is very less in the street since it has to make its way through the high-density pedestrian population. The street does not have mix of activities but it is active throughout the day and night. Hence, Markets and food attract high no. of pedestrians and safety is crucial for encouraging walkability. Presence of people of all age groups brings sense of security and shaded pathways also improve walkability.

Figure 7 Veranda's of shops used as seating spaces

2. Vasant Vihar Road, Indore

Figure 8: Plan (not to the scale of Vasant Vihar Road, Indore)

Vasant Vihar road at night

Vasant Vihar road, Indore connects Agra Bombay road and eastern ring road.

People are observed to feel safe on the street during daytime but degree of safety decreases after 10pm. The character of the street is mixed use. That ensures natural surveillance during day time till 9 pm until the shops are open. After 9pm few food joints operate till 11pm on the stretch. After 11pm the street is found to be unsafe. The street has Mix of activities. It has general stores, medical shops, clothing shops, offices, café, salons, boutiques, laundry, Gym,

Café, Bank, tea stall etc. And buildings have residential on the upper floors. Some are independent bungalows as well. Majority of the buildings along the street are 9-12m in height Street enclosure is 1:2.

Figure 9 Street enclosure

The windows are overlooking the street. Building passages are confronting the road and entrances are easily visible and accessible from the road facade and building exits are lit and have direct connect to car parks. Shops on ground floor have see-through barriers like glass windows and walls.

Figure 10 Windows/ glass facades oriented towards road

There is dense vegetation and shrubs along some parts of street and Sightlines from the balconies, windows of buildings are unclear and opportunities for surveillance are disabled due to dense vegetation in front of some buildings.

Figure 11 Dense vegetation in front of buildings

There is insufficient street lighting which makes this area unsafe during night.

Figure 12 Vasant Vihar road at night; dark due to insufficient street lights

There is no designated on-street parking and vehicles are parked on the vehicular route. And there is absence of sidewalk which reduces walkability on the road. There is buffer zone between building frontages and road but there is no continuity.

Figure 13 Dense vegetation; hiding places, obstructing views

There is dense vegetation at some parts of the road which can be hiding places for the offenders. There are very few trees along the road and therefore the roadside side shaded at intervals.

Figure 14 Cars parked on road, & no side walk

Very few pedestrians were found on the road. Vasant Vihar road is a low traffic road and speed of vehicles is less. The air quality in the area is fair and noise pollution isn't there. The area is quiet.

Figure 15 Pedestrians on the road

Absence of sidewalk and trees that could provide shading, lack of eateries, insufficient street lights are some of the reasons for the road being not preferable for walking by the public. Safety and presence of well-maintained obstacle free sidewalk

is crucial for walkability which needs to be planned on this road for improving walkability on the road.

CONCLUSION

Built environment affects walkability. Both macro and micro-scale features of built environment influences the way people perceive their environment. Places designed for walkability – those that are well lit, human-scaled, comfortable and convenient for pedestrians, mixed use in character and has natural surveillance to the extent that the pedestrian would feel safe and secured and many more such factors – could encourage people to walk, and therefore could promote greater overall health. Walkability is a significant concept in sustainable urban design.

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