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Rethinking urban streetscape: Enhancing urban design qualities for higher walkability at intersection of Itahari, Nepal

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Abstract

The state of Itahari Chowk currently presents the challenges stemming from urban development, prioritizing vehicular traffic. This article aims to assess the qualitative aspects of physical surroundings, aiming to identify how different urban design features affect walkability. By applying evidence-based design principles within a knowledge-driven framework, the research seeks to study the ways to enhance walkability and propose effective design solutions for pedestrian-friendly environments. The methodology included a detailed site inventory, community perception analysis, and the application of the Serial Vision Method, both before and after the proposed design interventions. The proposed design interventions led to notable improvements in walkability across all observation spots. These findings highlight the potential of thoughtful streetscape design to improve pedestrian experiences. The study offers valuable insights for architects, urban planners, and academics aiming to promote walkability in emerging urban streets.

1. Introduction

One proposed definition for walkability is: "The extent to which the built environment is friendly to the presence of people living, shopping, visiting, enjoying or spending time in an area. Southworth [1] 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". "Walkability is a quantitative and qualitative measurement of how inviting or un-inviting an area is to pedestrians. Walking matters more and more to towns and cities as the connection between walking and socially vibrant neighborhoods is becoming clearer.

Built environments that promote and facilitate walking to stores, work, school and amenities are better places to live, have higher real estate values, promote healthier lifestyles and have higher levels of social cohesion" [2].

Since walkability is a multidisciplinary issue, it is a complicated organization in achieving a generic technique that guides walkability in a built environment, evaluates the condition of the environment on the basis of walkability, and clearly informs variables that influence walkability. However, "Walkability studies have provided enough evidence through statistical analysis that walking behavior is related to the condition of the built environment" [3].

Ewing and Handy [4] focus on problem of evaluating urban design feature related to walkability, which they claim are often difficult to measure but are critical for developing livable and sustainable citizen. To address these issues, they suggest a methodology for measuring six urban design qualities related to walkability: Imageability, Enclosure, Human Scale, Transparency and Complexity. Southworth [1], examines pedestrian demands in urban and suburban settings, with an emphasis on the performance factors and criteria for walkable city. This explores the difficulty of developing walkable cities

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in the United States, where more than half of the typical American metropolitan was designed to automobile dominated stands. Therefore, it's clear that the enhancing the urban design qualities, one can achieve higher walkability. This underscores the importance of studying how the built environment influences walkability in a way that's specific to each area.

Many studies show the relation between urban design qualities and walkability but detail study was done by BK and Bajracharya [5], in their article Built Environment and Walkability: Investigating Urban Design Qualities by Serial Vision Method at Itahari Chowk. The research based on four major urban design qualities: Imageability, Enclosure, Transparency and Human Scale; it was found that human scale as a most important urban design quality among all. The paramount importance of "Human Scale" in the participants' rankings can be attributed to its direct relevance to the comfort and experience of pedestrians within the urban environment. As a critical factor in creating vibrant and livable urban spaces, "Human Scale" emphasizes designing streetscapes that cater to pedestrians' needs. It focuses on creating a sense of intimacy and human interaction, offering walkable distances, pedestrian-friendly amenities, and an inviting environment that encourages people to walk, socialize, and explore the area on foot [5]. The paper undertakes an analysis of the current conditions at Itahari Chowk using the serial vision method and a ranking method. It presents the respective findings and conducts a comparative assessment. However, a research gap persists regarding how to enhance the existing walkability coverage through design. This paper endeavors to address this gap by proposing a redesign of Itahari Chowk and applying the serial vision method to evaluate whether the walkability coverage is indeed increased.

2. Objectives

This article aims to analyze the road intersection of Itahari chowk to identify the relationship between specific urban design features and their impact on walkability. By applying evidence-based design principles within a knowledge-driven framework, the study proposes design improvements for the area. It compares the walkability of the redesigned streetscape with the existing conditions and recommends street enhancements measures to make the road intersection more pedestrian-friendly.

3. Methodology

The study identifies specific variables from the existing literature, relating to urban design attributes that includes Imageability, Enclosure, Human Scale and Transparency. To assess people's satisfaction levels, these urban design features are further subdivided into various attributes, and specific statements are generated based for each attribute.

Our previous article BK and Bajracharya [5], utilized the Serial Vision Method and ranking method to assess the walkability of the existing conditions at Itahari Chowk. The serial vision method developed by Gurdon Cullen [6] and this paper uses the same method to assess the walkability of the street design. The research process follows the comprehensive site inventory and development of the design interventions based on people's perceptions, case studies, and design guidelines. Following these interventions, the Serial Vision Method was applied to evaluate the walkability coverage of the proposed design. This new assessment was then compared with the walkability coverage of Itahari Chowk as determined in the previous article BK and Bajracharya [5]), titled "Built Environment and Walkability: Investigating Urban Design Qualities by Serial Vision Method at Itahari Chowk".

Pedestrians at the Itahari Chowk Road intersection were selected for the study through purposive sampling Participants included both male and female respondents, aged between 18 and 45 years. Priority was given to individuals who regularly walk in the area to ensure that responses captured the experiences of daily users of the streetscape. Most respondents were local residents and commuters who rely on walking as their primary mode of mobility, and their feedback provided valuable insights into the perceptions of active pedestrians directly influenced by the quality of the urban environment.

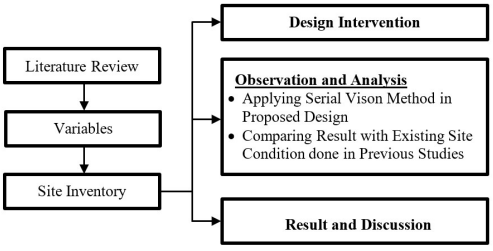


Figure 1: Research Method

4. Study area

Itahari, a key transportation and commercial hub in the Koshi Zone of eastern Nepal, is vital due to its location along the Mahendra Highway, connecting eastern Nepal to the country. Positioned about 400 kilometers east of Kathmandu, Itahari has seen substantial growth

driven by its strategic location and rising demand for goods and services. However, the current state of Itahari Chowk, an intersection of two major highways, reflects challenges in urban development, particularly the prioritization of vehicular traffic. Urbanization efforts and traffic congestion have transformed the intersection, diminishing pedestrian-friendly features. To address these issues and enhance walkability, a comprehensive study is essential, focusing on integrating urban design principles to create a vibrant, pedestrian-friendly urban space at Itahari Chowk.

Figure 2: Map of Nepal

Figure 3: Map of province

Figure 4: Map of Sunsari district

The **??** below illustrate the transformation of Itahari Chowk across different time periods, reflecting the socio-political and urban development dynamics of Nepal. In 1975 AD, the Chowk retained a modest and organic character, with low-rise traditional structures and a simple circulation system that reflected a walkable and human-scaled environment. By 2007 AD, the space had begun to adopt a more structured form, incorporating landscaped features and a clearer organization of traffic, hinting at an emerging sense of enclosure and imageability. The year 2008 AD marked a symbolic transition when the statue of the king was removed following the end of monarchy, embedding national political change directly into the physical and cultural fabric of the public realm. By 2013 AD, Itahari Chowk had emerged as a bustling commercial hub, characterized by mid-rise commercial blocks, prominent signage, and a redesigned roundabout that accommodated increasing vehicular pressure. While this period enhanced commercial visibility and activity, it gradually eroded pedestrian comfort and weakened qualities such as transparency and human scale. The 2020/21 AD phase documents the Chowk in flux once more, as road expansion projects sought to address mobility demands but further compromised spatial cohesion. In 2023 AD form, Itahari Chowk stands as a highly urbanized, automobile-oriented intersection where urban design qualities such as imageability, enclosure, transparency and human scale are subordinated to vehicular dominance, resulting in a space that is efficient for movement but less accommodating for pedestrians and social interaction.

Taken together, this progression reveals how Itahari Chowk has shifted from a modest, people-oriented node to a heavily vehicular space, underscoring the tension between modernization, mobility, and the preservation of pedestrian-friendly urban qualities in contemporary Nepalese cities.

5. Literature review

City of Rome founded as back as 753 BCE. Street infrastructure made up of a system of informal, weathered and meandering roads which is most suitable walkable roads on Earth. Till 1930s, walking was the main way of travel. After 1930's, economic growth led to increased automobile manufacturing. Cars were become more affordable. In 1961, critic Jane Jacobs released widely renown novel "Death and Life of Great American Cities" shows concern in the future development of walkability concepts. In 1990s, first walkability related specific scientific paper appeared which concern the quality of urban environment and suburbs. In 1993, the evolving metropolis: Studies of commonly, neighborhood and street from the urban edge [10] and in 1997, walkable Suburbs: An evolution of neotraditional communities at urban edge [11]. In 2003, environmental correlates of walking and cycling from the transportation urban design and planning literatures examine relationship between environment perception, physical activity and body weight.

Table 1: Transformation of Itahari Chowk

Itahari chowk 1975AD (Source: Chaudhary [7])

Itahari Chowk at 2007 AD (Source: Chaudhary [7])

2008 AD after end of monarchy (Source: Online Khabar [8])

Itahari Chowk after end of monarchy (Source: Chaudhary [9])

Itahari Chowk during road expansion at 2021 AD (Source: Photograph by Author, 2021)

Itahari chowk after road expansion at 2023AD (Source: Photograph by Author, 2023)

In 2010, walkability study in Kathmandu, Bhaktapur and Pokhara by Clean Air Initiative for Asian Cities walkability index of Kathmandu, Bhaktapur and Pokhara were generated. In 2021 designing walkable city through public perspective and walkability assessment: A case of Jhamsikhel neighborhood by Gaurav Nepal was published [12]. The urban design literature points to numerous perceptual qualities that may affect the walking environment [4]. Out of these various perceptual qualities, four major urban design qualities are Imageability, Enclosure, Transparency and Human Scale.

5.1. Imageability

Lynch [13] defines imageability as a quality of a physical environment that evokes a strong image in an observer: "It is that shape, color, or arrangement which facilitates the making of vividly identified, powerfully structured, highly useful mental images of the environment". A city that is highly imageable is well structured, has distinct components, and is easily recognized to anyone who has visited or lived there. It taps on our intrinsic propensity to identify and remember patterns. It has plainly recognized pieces that are organized into an overall pattern. Landmarks are thought to be an important component of imageability.

5.2. Enclosure

Outdoor settings are shaped by vertical elements that can obstruct views, creating a sense of enclosure. This feeling, akin to being in a room, is emphasized by urban design theorists like Gordon [6], who views enclosure as a powerful means to instill a sense of position and connection to surroundings. Alexander [14] adds that a positive outdoor space, similar to a room, has a distinct and important shape. In urban settings, enclosure is established by aligning buildings along streets, forming 'street walls' that define outdoor rooms. Maintaining a comfortable feeling of enclosure involves proportions, with Jacobs [15] suggesting a balance between building heights and street width. However, fractures in the street wall, such as building setbacks and inactive uses, erode enclosure. Dead spaces, like vacant areas and parking lots, diminish the human presence. Alexander [14] criticizes building setbacks, originally meant for light and air, for undermining streets as social spaces.

5.3. Transparency

Transparency, in a literal sense, refers to materials allowing light and air, like glass walls. An example is a shopping strip with inviting display windows. Design elements limiting transparency include blank walls and reflective glass. Beyond a street's edge, perception of human activity depends on entryways or blank walls; even blank walls with trees suggest habitation ([15][16]). Trees with high canopies create 'partially transparent tents,' offering awareness of space beyond while maintaining enclosure. In urban settings, small trees work against transparency. Street-level transparency is crucial for indoor-outdoor interaction [17]. Calculating a blank wall index shows their dominance in cityscapes. Transparency peaks when internal processes extend onto the sidewalk, as seen in outdoor dining and retailing [18].

5.4. Human scale

Urban designers have varied views on human scale. Alexander [14] considers buildings over four storeys as beyond human scale, while Lennard, et al. [19] sets the limit at six storeys, and Blumenfeld [20] at three. For taller buildings, Trancik [21] suggests lower floors spreading out and upper floors stepping back for a human-scale feel. Hedman and Jaszewski [22] stress articulated architecture and features like belt courses and cornices for scale moderation. Gehl [23] categorizes distances from intimate to public. Human scale is also linked to paving patterns, street furniture, setbacks on tall structures, parked cars, building ornamentation, and window/door spacing. Interestingly, offsetting components at street level make both Rockefeller Centre and Times Square appear human-scaled.

5.5. Design development

In this phase of the study, translating theoretical concepts into tangible design implementations becomes crucial, as it is through specific design interventions that the intended vision of the designers truly takes form. The design approach for Itahari Chowk draws heavily upon insights garnered from interviews, research, and the findings discussed in the preceding chapter of this report. Valuable lessons from relevant literature and case studies have been extracted to inform the design proposal.

Commencing with a comprehensive site inventory and an assessment of its surroundings, a master plan and road section have been crafted based on the conscious data measurements previously undertaken. Existing conditions have been faithfully captured to provide a foundation for the ensuing design interventions. Central to the design concept are four paramount urban design qualities: Imageability, Enclosure, Transparency, and Human Scale. These qualities, both quantitatively and qualitatively explored in the previous chapter, now serve as guiding principles for the design interventions aimed at enhancing walkability.

The overarching goal is to enhance the coverage of these four urban design qualities in order to promote a pedestrian-friendly environment. The ensuing design interventions are as such linked to the primary priorities expressed by respondents with regard to these urban design qualities. The individual responses have been precisely translated into architectural design concepts, forming the basis for the subsequent design interventions.

By following this approach, the visualized improvements seek to not only address the specific needs and preferences of the community but also to harmonize with the unique context of Itahari Chowk. This complex harmony between research, theoretical underpinnings, and design applications underscores the holistic nature of the endeavor, ensuring that the proposed interventions align with the area's distinctive character and aspirations for heightened walkability.

5.6. Site inventory

The site inventory compiled data from road division records, Google Earth, site visits, and measurements to assess road conditions and inform future design. The area includes a key intersection of Mahendra and Koshi Highways (Figure 5). Right-of-way (ROW) and sectional details were documented in visual drafts.

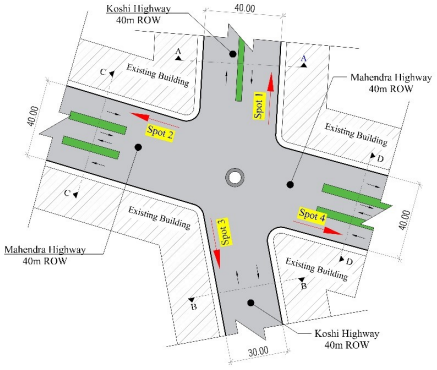


Figure 5: Master plan of Itahari Chowk

Section A-A: Although the planned ROW is 50 meters, it was reduced to 40 meters due to existing structures. The road includes six 3.5-meter lanes, a 5.5-meter service lane, a 2.5-meter green median, and a 2.25-meter elevated sidewalk over a drain (Figure 6).

Section B-B: Under construction, this section's ROW is reduced from 50 to 30 meters due to setback limitations (Figure 7). This narrower layout requires creative design solutions.

Sections C-C & D-D: These follow a similar layout, with a reduced ROW of 40 meters. Each has four traffic lanes, 7-meter service lanes on both sides, dual 3.5-meter green medians, and 2.5-meter elevated sidewalks over drains, maintaining design continuity (Figure 8).

5.7. Concept development

The design concept was shaped by participant input, aiming to enhance four key urban design elements imageability, enclosure, transparency, and human scale to improve walkability. Insights from respondents were translated into architectural strategies, supported by contextual analysis, literature, and case studies to ensure community alignment and design coherence.

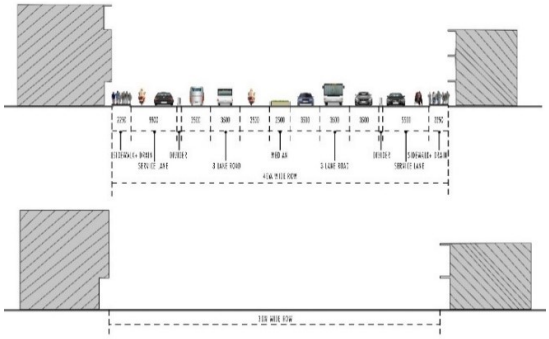


Figure 6: Section at A-A

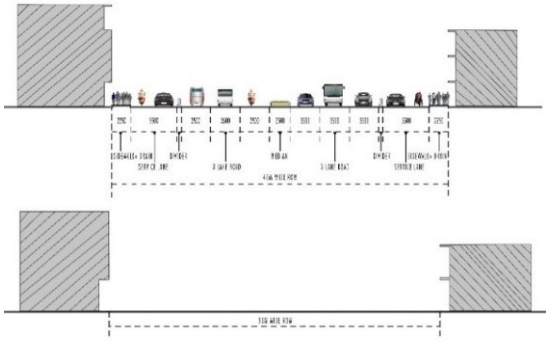


Figure 7: Section at B-B

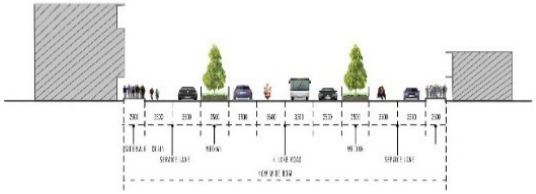


Figure 8: Section at C-C/ D-D

Imageability: Imageability emerged as the top priority, with an emphasis on views and visual appeal. Two strategies were proposed: facade treatments using varied materials and colors to enrich streetscapes, and the creation of memorial spaces that offer meaningful visual anchors and new sightlines for pedestrians (Table 2)

Enclosure: Enclosure focused on providing shelter from sun and rain. This was addressed through the strategic planting of trees for natural canopies and the inclusion of built shading structures like pergolas along walkways, combining function with aesthetic value (Table 2).

Transparency: Transparency centered on making storefronts more visible and inviting. The use of transparent materials and large openings in facades was proposed to blur the line between interior and exterior spaces, enhancing visual access and promoting engagement with commercial areas (Table 2).

Human Scale: Human Scale emphasized comfort and accessibility through greenery, seating, and lighting. Design solutions include planting trees and small plants, installing street furniture, and incorporating adequate lighting to create a safe, welcoming environment conducive to pedestrian use. Together, these interventions form a comprehensive, community-informed design strategy rooted in both practical needs and urban design theory (Table 2).

5.8. Design with emphasizing four urban design qualities

The design is grounded in research findings and user feedback, with a focus on four key urban design qualities: imageability, enclosure, transparency, and human scale. Informed by case studies from Stroget, Copenhagen [24] and Hunan Street, Nanjing [25] alongside relevant design guidelines including Nepal Road Standards [26] and UTTIPEC's street design guide [27] the design aims to translate local needs into responsive urban interventions (Figure 9).

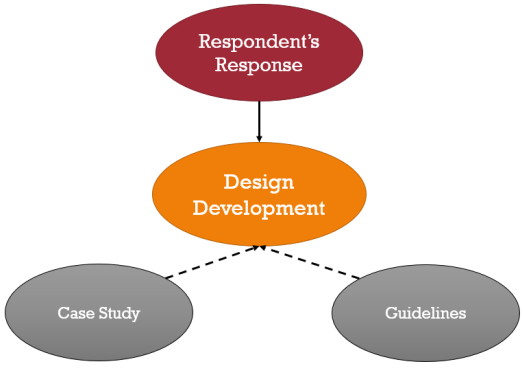


Figure 9: Conceptual development for design interventions

To enhance imageability, improvements were made selectively, including upgrading building facades, refining pavement design, and adding visual cues like tactile paving. Walkways were structured into three distinct zones frontage, pedestrian, and planting each with

Table 2: Concept development from People's Perception

Respondent's view	Basic interpretation	Design intervention
Imageability: • It looks really nice from while watching. • It looks good. It becomes even better when has great seen. • It has a good memory. • Because it looks good. • From a distance, it looks attractive, and you can easily recognize this place. • It leaves a lasting impression when you see it quickly. • It's hard to realize how time flies by. If it's a good thing. • No matter what people are looking for, if they see an appealing image, they enjoy exploring and it benefits businesses. • Its feels good for watching.	Views/ Vista	Facade treatment
Creating memorial spaces / Enclosure • It saves from sun and rain. • If something happen then one can get shelter. • Shopkeeper stay inside shops during extreme heat, but customers cannot stay there. • In hot and intense sunlight, it's nice to stay in the shade, and it offers a pleasant respite. • No need to wait in sun and rain. • It's enjoyable to stay in shade. • It offers relief from the heat and ensures safety as well. • You can walk even when it's raining or when there's sunlight.	Shade from rain and sun	Trees plantation
Pathway / Transparency • When you observe everything, you come up with ideas and also find beauty. You can discover new things as you keep looking. • Everything inside is visible. It's interesting. • If you want to buy something, you remember where to find it. It saves time. • It's easy to see the items inside the shop, and it's also enjoyable to browse. • Itahari is a commercial hub. So, if you can't see the products or services properly, it's not ideal. It shouldn't take much time to find the product. • If there's transparency, visibility increases. Window shopping is enjoyable. Exploring the surrounding area is interesting. If you can't see inside, it's not favorable.	Visibility of shops interior	Use of transparent material at front shop
Creating opening / Human Scale • The fragrance of flowers makes it feel pleasant. It also feels good to the eyes.es a lasting impression when you see it quickly. • It's a good place to sit. • It's about seating in a place. It's visible at night, and during the day, it's easily accessible. • Suitable for taking walks and enjoying the view. • If one has to wait for longer time for bus then they can sit. • During hot weather, it's refreshing to stay in the shade and find relief. • It's cool there, and you can enjoy the view. • If people from outside come and stop here, it's convenient. If it is green, it becomes more delightful. • If you're tired and need to rest, you can sit inside the shop. If there's a place outside for rest then there is no need to sit inside the shop. • People always wait for someone, so having a place to wait is necessary. • Pedestrians have rest space while raining. • The scale should be human-oriented because it's the central area and requires space for resting and security. Adequate lighting and resting spaces are provided, along with small plants. • If it doesn't match the human scale, even if it's aesthetically pleasing, it won't be comfortable. Without comfort, it won't be as effective as others. • Small trees bring in fresh air and cool down the area. They also provide oxygen. It's possible to find places to sit as well. • It's good to sit and rest. • It's comfortable and also ensures safety.	Greenery, Shade and seating, Lighting	Tree plantation, Street furniture, Street lighting

unique paving styles for visual clarity and accessibility (Figure 10).

Figure 10: Different pavement for different zone (provided tactile for visually impaired pedestrians)

Enclosure was addressed through the strategic use of dense and columnar trees, offering both shade and spatial definition (Figure 11). Existing building canopies and shaded seating areas further contributed to a cozy, protective streetscape (Figure 12).

Figure 11: Trees providing shade enhancing enclosure (enhancing environmental sustainability)

Figure 12: Existing building cantilever providing shading

For transparency, shopfronts were redesigned with transparent materials to promote visual interaction and activity along the street (Figure 13). While not a top priority for users, these interventions subtly improved the vibrancy and openness of the space.

Figure 13: Use of glass at frontage of shop (Enhancing human transparency)

Lastly, human scale, ranked highest by respondents, was emphasized through street lighting, greenery, and regular seating areas (Figure 14). Lighting was carefully positioned to balance vehicular and pedestrian needs, while the placement of trees, potted plants, and seating every 50 meters created a welcoming, people-centric environment that encourages comfort and social interaction.

Figure 14: Columnar trees and seating area (Enhancing human scale)

6. Observation and analysis

The physical characteristics associated with urban design qualities after design interventions are represented through colour mapping. (Table 5) presents a side-by-side comparison of the existing (before) and proposed (after) conditions at Itahari Chowk. Following colour mapping, many physical characteristics associated with urban design qualities (Imageability, Enclosure, Transparency and Human Scale) were determined in percentage form using a 10x10 grid (Table 6). On Table 7 & Table 8, this calculated percentage is shown. This reveals the coverage of each of urban design attribute in each spot after the design intervention.

Table 3 demonstrates that Spot 2 has the highest coverage at 53.5%, indicating a relatively more walkable area. In comparison, Spot 1 records the lowest coverage

Table 3: Summary of mapping without applying weightage in existing Source: BK and Bajracharya [5]

Urban Design Qualities	Spot 1	Spot 2	Spot 3	Spot 4
Imageability	24.5%	16%	24%	4.5%
Enclosure	12%	25%	16.5%	25.5%
Transparency	2.5%	5%	2%	9%
Human Scale	5%	7.5%	7.5%	10%
Total Coverage	44%	53.5%	50%	49%

Table 4: Summary of mapping with applying weightage in existing Source: BK and Bajracharya [5]

Urban Design Qualities	Weightage	Spot 1	Spot 2	Spot 3	Spot 4
Imageability	23.3%	23.3	15.2	22.8	4.3
Enclosure	24.7%	11.6	24.2	16	24.7
Transparency	23.8%	6.6	13.3	5.3	23.9
Human Scale	28.2%	14.1	21.1	21.1	28.2
Total Coverage		55.6%	73.8%	65.2%	81.1%

at 44%, reflecting a less walkable condition. These values represent the existing condition of Itahari Chowk, and the data has been presented without applying any weightage [5].

The analysis of the existing condition (with weightage applied) shows that Spot 4 has the highest coverage of urban qualities at 81.1% (Table 4), indicating a wide range of features and amenities that enhance walkability and pedestrian comfort. In contrast, Spot 1 has the lowest coverage at 55.6%, reflecting fewer supportive features and a less desirable walking environment [5].

The weightage value of Imageability, Enclosure, Transparency and Human Scale are 23.3%, 24.7%, 23.8% and 28.2% respectively as per the perception of the people, adopted from BK and Bajracharya [5].

For Spot 1, the coverage value of Imageability was initially recorded at 14%. Notably, all four urban design qualities were evaluated using different scales: Imageability received a high coverage rating due to its consideration of large buildings, while Human Scale received a low coverage rating because it focused on smaller elements such as seating and flower beds. To ensure comparability, normalization was applied by dividing the value by the maximum observed Imageability value (33%), resulting in a normalized score of 0.424. This normalized value was then multiplied by the assigned weightage of 23.3%, producing a final weighted coverage of 9.9%. A similar procedure was applied to evaluate the coverage for the other observation spots and the remaining urban design qualities, ensuring a consistent and comparable assessment across all parameters (Table 8).

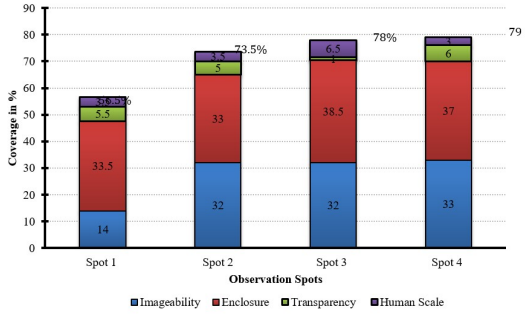


Figure 15: Coverage without applying weightage in design

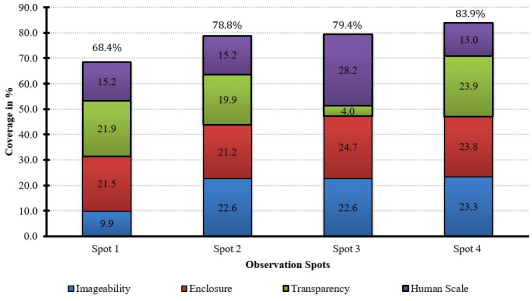


Figure 16: Coverage after applying weightage in design

6.1. Comparison of existing state with proposed design

The comparison between the existing conditions and the proposed design at Itahari Chowk was carried out in two stages: without applying weightage and with applying weightage to the urban design qualities.

Figure 17 presents the comparison without applying

Table 5: Side-by-side comparison of existing (before) and proposed (after) conditions at Itahari Chowk, illustrating design interventions

Spot no.	Existing	After design intervention	Spot no.	Existing	After design intervention
1			3		
2			4		

weightage. The results clearly indicate that walkability coverage improved significantly across all four observation spots after the proposed interventions. Among them, Spot 4 shows the highest improvement, with coverage increasing from 49.0% to 79.0%, reflecting a gain of 30%. Close behind, Spot 3 also records a substantial rise, improving from 50.0% to 78.0%, which accounts for a 28% increase. Spot 2 shows a moderate increment from 53.5% to 73.5%, while Spot 1 demonstrates the lowest growth, improving from 44.0% to 56.5%, or 12.5%. These findings reveal that in absolute terms, the design interventions were most effective at Spot 4, while Spot 1 benefitted the least.

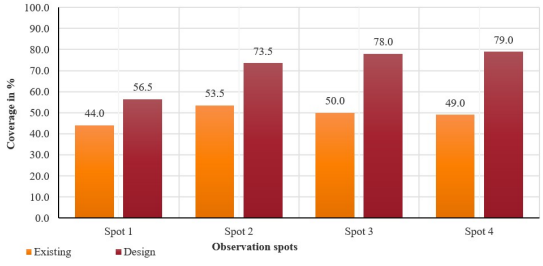


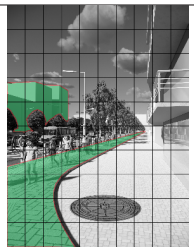
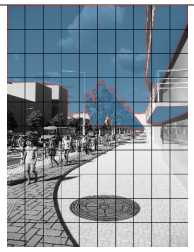
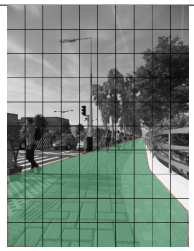
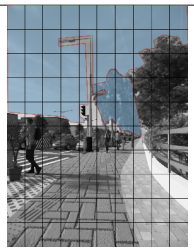
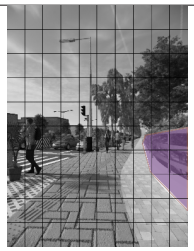
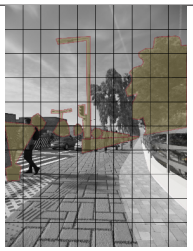
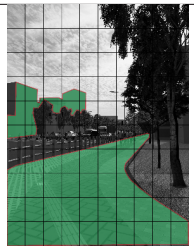
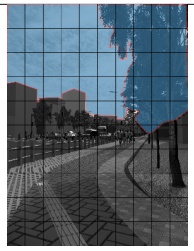
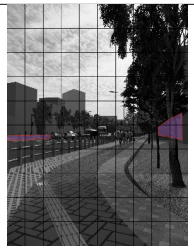
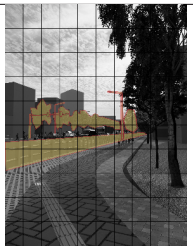
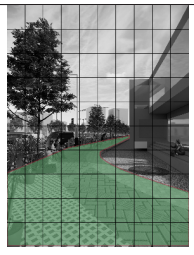
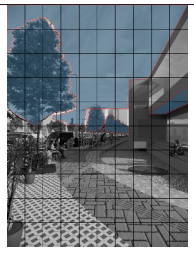
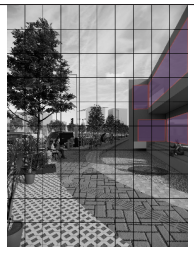
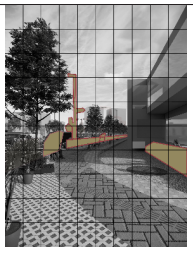
Figure 17: Comparison of existing and design without applying weightage

Figure 18 illustrates the comparison when weightage was applied, based on people's perceptions of the relative importance of the four urban design qualities. In this weighted analysis, the increments appear more moderate because some spots, particularly Spot 4, already had high baseline values in the existing state. Here, Spot 3 shows the highest improvement, increasing from 65.2% to 79.4%, a gain of 14.2%. Spot 1 also improved noticeably, from 55.6% to 68.4%, a rise of 12.8%. Spot 2 records only a slight increment from 73.8% to 78.8%, while Spot 4 has the lowest improvement, rising just 2.8% from 81.1% to 83.9%, suggesting that this location was already close to saturation in terms of walkability coverage.

Overall, the comparison highlights a clear difference between the two modes of evaluation. These results confirm that the design interventions enhanced the existing walkability conditions at Itahari Chowk. While the magnitude of improvement varies by spot and evaluation method, the overall trend demonstrates that carefully planned design measures can effectively transform an automobile-dominated intersection into a more pedestrian-friendly environment, supporting the study's objective of promoting walkability through urban design qualities.

The reason for giving more preferences to the weighted case is that it is based on people's perceptions, which were considered a valuable priority. The lower increment in urban design quality coverage in the weighted case may be due to the fact that the existing scenario itself had a high coverage, as seen in spot 4, with 81.1% coverage, which is close to saturation.

Table 6: Color mapping representing urban design qualities

Spot 1			
			
Imageability coverage: 14%	Enclosure coverage: 33.5%	Transparency coverage: 5.5%	Human Scale coverage: 3.5%
Spot 2			
			
Imageability coverage: 32%	Enclosure coverage: 33%	Transparency coverage: 5%	Human Scale coverage: 3.5%
Spot 3			
			
Imageability coverage: 32%	Enclosure coverage: 38.5%	Transparency coverage: 1%	Human Scale coverage: 6.5%
Spot 4			
			
Imageability coverage: 33%	Enclosure coverage: 37%	Transparency coverage: 6%	Human Scale coverage: 3%

The findings suggest that there is room for further intervention to enhance walkability since it has not yet reached a saturation point. It's important to note that achieving 100% coverage in all cases is unrealistic since the research focuses on only four fundamental urban design qualities. To further improve walkability, other

Table 7: Summary of mapping without applying weightage in design

Urban Design Qualities	Spot 1	Spot 2	Spot 3	Spot 4
Imageability	14%	32%	32%	33%
Enclosure	33.5%	33%	38.5%	37%
Transparency	5.5%	5%	1%	6%
Human Scale	3.5%	3.5%	6.5%	3%
Total Coverage	56.5%	73.5%	78%	79%

Table 8: Summary of mapping with applying weightage in design

Urban Design Qualities	Weightage	Spot 1	Spot 2	Spot 3	Spot 4
Imageability	23.3%	9.9%	22.6%	22.6%	23.3%
Enclosure	24.7%	21.5%	21.2%	24.7%	23.8%
Transparency	23.8%	21.9%	19.9%	4.0%	23.9%
Human Scale	28.2%	15.2%	15.2%	28.2%	13.0%
Total Coverage		68.4%	78.8%	79.4%	83.9%

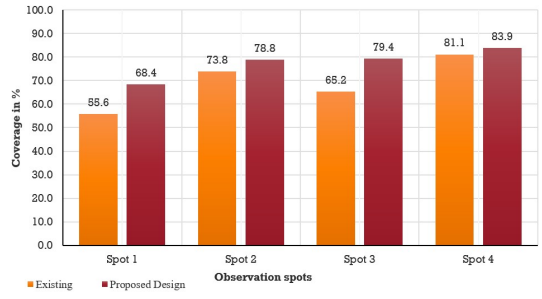


Figure 18: Comparison of existing and design with applying weightage

aspects like the physical characteristics of the street and subjective qualities related to user's perceptions, such as the sense of safety and place, can be studied. It's worth mentioning that these findings are specific to the particular spot and frame where the photos were taken. Changing the frame could lead to different results.

7. Details on proposed design

The proposed design interventions for Itahari Chowk translate theoretical concepts and people's perceptions into practical urban solutions. As highlighted in Table 2, the four urban design qualities: Imageability, Enclosure, Transparency, and Human Scale are applied through targeted strategies. The following figures (25–38) illustrate these interventions and demonstrate how the redesigned streetscape fosters higher walkability.

7.1. Recommended street section

The design interventions along the Koshi Highway focus on developing inclusive, safe, and efficient street sections that accommodate diverse modes of transportation. For the road, 30m ROW (Figure 20 & Figure 21), located south of the Itahari-Biratnagar intersection, the layout includes a 4.3m pedestrian walkway, a 2.6m non-motorized vehicle lane, four 3.75m motorized lanes, and a 1.2m median ensuring balanced use by all road users. The 40m ROW (Figure 22 & Figure 23), on the northern side toward Dharan, features a 3.8m walkway, a 4.2m service lane, six motorized lanes (two 10.75m carriageways), and a 2.5m median, requiring minimal intervention due to recent development. The 50m ROW (Figure 24, Figure 25 & Figure 26), connecting to Kathmandu and Kakarbhitta, includes a 4.6m walkway, 2.75m parking space, 3.5m drop-off zone, 2.4m cycle lane, six motorized lanes (two 10.75m carriageways), and a 2m median. Collectively, these designs reflect a comprehensive approach to street planning, emphasizing safety, functionality, and multimodal accessibility.

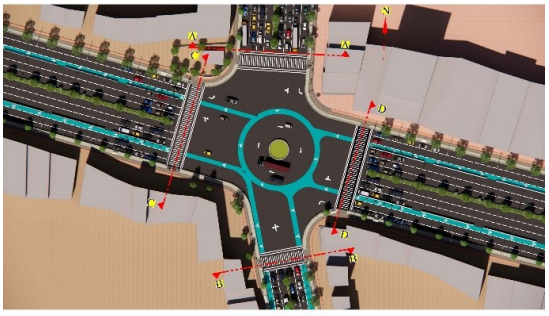


Figure 19: Master plan of Proposed Design

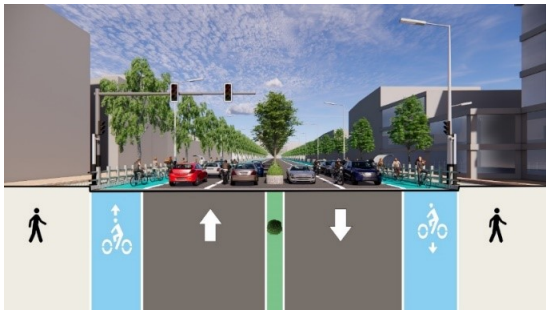


Figure 20: Perspective sectional view of 30m wide road (South side, Section at BB)

Figure 21: 30m wide road after design intervention

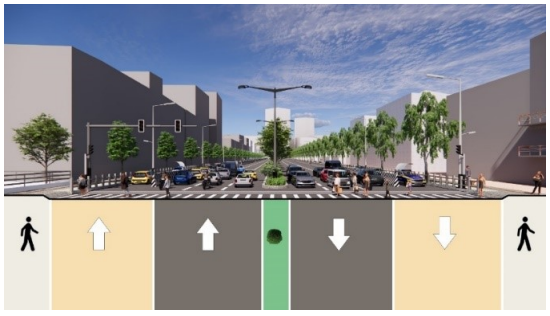


Figure 22: Perspective sectional view of 40m wide road (North side, Section at AA)

Figure 23: 40m wide road after design intervention

Figure 24: Perspective sectional view of 50m wide road (West side, Section at CC)

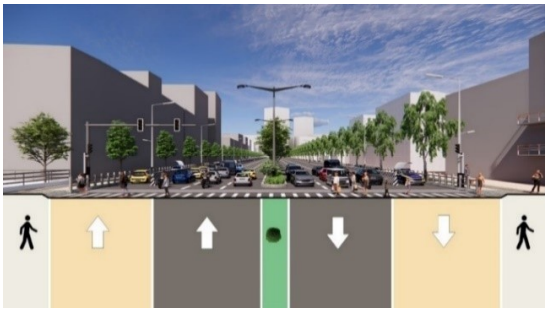


Figure 25: Perspective sectional view of 50m wide road (East side, Section at DD)

7.2. Bird's Eye view of intersection

Figure 27 and Figure 28 present aerial perspectives of the redesigned intersection. These views emphasize imageability by introducing strong visual elements such as tree-lined medians, green buffers, and organized circulation zones. The clarity of spatial structure makes the intersection a memorable urban landmark. Simultaneously, the prioritization of pedestrian and cycle routes reinforces human scale, aligning with people's preference for accessible and visually attractive spaces (Table 2).

7.3. Pedestrian infrastructure

Figure 29 illustrates the redesigned sidewalk. Wide pavements, tactile paving, and shaded seating areas respond directly to community perceptions of comfort and safety (Table 2). These interventions enhance human scale by providing resting greenery, while distinct paving materials improve imageability, giving pedestrians a visually engaging and user-friendly walking environment.

7.4. Traffic management systems

Figure 30 highlights the inclusion of traffic lights to regulate vehicular and pedestrian movement. This intervention ensures safe crossings and reduces vehicular

Figure 26: 50m wide road after design intervention

Figure 27: Bird's eye view of intersection

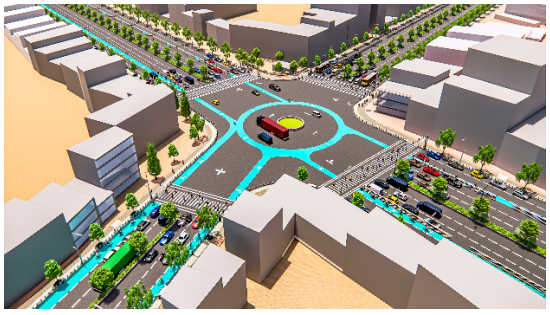


Figure 28: Bird's eye view of intersection 1

Figure 29: Side walk

Figure 30: Traffic light

Figure 31: Cycle Lane and service lane

dominance at the junction. By improving predictability and order in circulation, traffic signaling strengthens the sense of enclosure, resonating with respondents' call for protective and secure urban spaces (Table 2).

7.5. Non-Motorized transport integration

Figure 31 depicts the cycle lane and service lane. This addition promotes sustainable mobility and decreases reliance on automobiles, supporting the principles of human scale. At the same time, the visibility of cyclists and pedestrians contributes to transparency, fostering active and engaging street edges. These interventions reflect community perceptions linking transparency to visibility and accessibility (Table 2).

7.6. Lighting strategy for pedestrian safety

Figure 32 presents the combined lighting system for both vehicles and pedestrians. Human-scaled lighting improves visibility and safety, addressing people's concerns about comfort and night-time accessibility (Table 2). This strategy enhances human scale by prioritizing pedestrian needs and reinforces enclosure by creating a secure and cohesive nighttime environment.

8. Conclusion

This study highlights the potential of thoughtful urban design to transform automobile-dominated intersections into pedestrian-friendly spaces. By applying the serial vision method and incorporating community per-

Figure 32: Combine light for vehicle and pedestrian

ceptions, four key urban design qualities: Imageability, Enclosure, Transparency, and Human Scale were identified as central to enhancing walkability at Itahari Chowk. Among these, Human Scale emerged as the most influential, underscoring its role in providing comfort, safety, and a sense of intimacy in public spaces. The proposed design interventions, supported by case studies [24][25] and guidelines [24][25], demonstrated measurable improvements in walkability, both with and without weighting, thereby validating the effectiveness of evidence-based design strategies. It's important to note that the assessment's outcome is based on the chosen photo frame of analysis. If the photo frame were changed, there might be fluctuations in walkability scores. Therefore, a lower growth in one frame doesn't necessarily mean low overall walkability.

The findings emphasize that creating walkable environments is not only a design challenge but also a social, cultural, and environmental imperative, offering benefits for health, sustainability, economic vitality, and social cohesion. While this study focused on four primary urban design qualities, future research could extend the framework by incorporating additional variables such as green infrastructure, lighting, accessibility, and perceptions of safety. Furthermore, exploring behavioral dimensions such as pedestrian flow, crossing patterns, and dwell time would provide richer insights into user experience. Emerging tools like artificial intelligence also hold promise for more efficient and accurate assessment of urban design qualities.

The study offers a practical framework and design recommendations for reimagining intersections in Nepal and similar contexts. By prioritizing human-centered design considerations, policymakers and planners can ensure that streets not only facilitate movement but also foster livability, inclusivity, and long-term urban sustainability.

Conflict of interest

The authors declare no conflict of interest.

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