



# Evaluating Livability Through Pedestrian Experience: A Case Study Of Al Jamiya Street, Babylon, Iraq

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## Abstract

Urban livability is a very important aspect of sustainable urban development especially when it comes to historic cities that are being affected by climatic changes and extreme growth of urban areas. The research assesses the livability of Al Jamiya Street, a major commercial-recreational street in Babylon, Iraq, using a mixed-method which incorporates morphological and pedestrian survey (n = 50). Its results demonstrate an inherent contradiction namely the street is a well-developed economic tourism spot, but its livability is grossly limited by the environmental pressures (excess heat with poor shading, surface temperatures above 50 °C), infrastructure shortcomings (pedestrian-vehicle interactions, lack of crossings), and social restraints (lack of diversity among users). The study proves that the existing situations result in seasonally contingent livability, which puts commercial activities ahead of social equality and environmental comfort. Some of the recommendations can be immediate shading interventions, strategic greening, traffic calming, and public policy initiatives that can be implemented to ensure the city is more inclusive and resilient. This research adds to the literature on livability because it offers a contextual framework of evaluating and enhancing urban streets in historic Middle Eastern cities through the requisite balance of economic vitality and holistic quality of existence in hot arid climates.

**Keywords:** Urban Livability; Pedestrian Experience; Public Space Quality; Mixed-Methods Evaluation; Social Vibrancy; Hot-Arid Urban Design.

## 1. Introduction

Urban livability may be adopted as a key paradigm in urban studies and as an interactive nexus of physical infrastructure, environmental sustainability, social equity and economic vitality that come together to define the quality of life in cities [1,2]. Although considered an indispensable element of sustainable development in the world, the realization of livable urban environments is especially troublesome in historic cities of the Global South, where the rapid urbanization, hostile climatic conditions and preservation of the cultural heritage introduce intricate planning challenges [3,4]. These difficulties are nowhere more evident than in cities such as Babylon, Iraq, has to reconcile past and present while dealing with the harsh environmental factors [5,6].

Livability is no longer a functional concept but includes the aspects of encouraging human well-being by enhancing access to open areas, comfortable microclimates, and open-ended social amenities [7,8]. These aspects become crucial in hot-arid zones, where high temperatures and sun exposure may make popular areas unusable over time, which is the eventual defeat of social life and economic activity [9,10]. Although there is an increasing acknowledgement of these issues, much remains still to be known about the way livability is practiced in middle-sized historic cities with multidimensional social and environmental conditions, especially within post-conflict settings like Iraq [11,12].



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This paper may fill these gaps by reviewing the Al Jamiya Street, a busy business street in Babylon, which links the residential quarters to the major leisure spots such as the Babylon Safari Zoo and the Al Karama Park. The street is a small-scale reflection of more general urban issues: it is a critical economic center in addition to being heavily burdened by environmental, infrastructural, and social limitations on what it could be as a living urban environment [5,13].

This study explores three basic questions, which include: (1) How do the environmental conditions and especially thermal comfort influence perceptions of living conditions and usage patterns, as investigated through integrated morphological analysis and full pedestrian surveys. (2) How well does the design of the street accommodate the inclusion of various population groups? (3) How can the corridor be converted into an inclusive living environment, which integrates the three functions of economic, social and environmental purpose?

The paper has been structured in such a way that it first outlines the theoretical basis of the concept of urban livability, especially in Middle East settings, and then describes the mixed-methods approach used. The analysis section presents combined results on environmental performance, functional infrastructure and social dynamics where the discussion section places the results in wider contexts of urban design paradigms [14,15]. The conclusion provides some practical recommendations on how to enhance livability by making specific interventions at various levels, including some that are very immediate and others that are more long-term policy interventions. By examining livability through both physical measurements and human experiences, this study contributes to a more nuanced understanding of how historic commercial corridors in hot-arid climates can evolve to meet contemporary needs while respecting cultural heritage and environmental constraints [16,17]. The findings provide valuable insights for urban planners, policymakers, and researchers working to create more sustainable and livable urban environments in climatic and cultural contexts.

## **2. Theoretical framework**

### **2.1. Theoretical foundations of livability**

Urban livability refers to the multidimensional environment in which environmental, social, and physical aspects interact and it defines the quality of life in the city. The pioneering work of Jacobs (1961) [18] highlighted the importance of the diversity of the different neighborhoods, which are people oriented, in creating vibrant neighborhoods, whereas Gehl (2010) [2] advanced this point of view by adding human-scale design as the way of improving social interaction and community health. These principles were further elaborated by Lynch (1960) [8] in his study of the concept of legibility and how it affected the spatial experience and the emotional connection of residents to the surrounding world. Modern research has built on these ideas with multidimensional models estimating the input of pedestrian access, mixed-use development, and the design of the public space in terms of urban vitality [1,19]. Specifically, an important contribution made by Baobeid et al. (2021) [7] is that this study draws obvious connections between walkability and public health outcomes and sustainable development and encourages the adoption of the integrated methods of assessment, covering the environmental, social, and economic aspects of the quality of life in the city.

### **2.2. Social and cultural dimensions of livability**

The social and cultural aspects of the city life are quite evident in various geographical and historical settings. Investigations in Middle Eastern cities show that the national space patterns and modern city issues bring about special living conditions. Al-Haglah (2010) [20] explained the impact of culturally specific patterns of social interaction and gender relationships on the use of the public space, and Salama (2015) [4] and [16] Abdelhamid et al (2021) [16] clarify the complicated development of the balance between cultural heritage preservation and modernization in the historical urban center. Scholarly works by Albabely and Alobaydi (2024) [5] and Nabil et al. (2021) [12] have measured the impact of rapid urban growth in Iraqi cities after the conflict and have identified the negative effects of the growth on social inequality with vulnerable populations being disproportionately affected. The paper by Al-Harithy (2020) [3] demonstrates how institutional fragmentation and urban infrastructure disregard results in the amplification of social inequalities in such cities as Baghdad, and participatory community planning approaches are necessary to manage such multifaceted social and cultural interactions.

### **2.3. Environmental and climatic considerations**

Hot-arid climate also sets some fundamental conditions on urban livability, as environmental factors lead to physiological and behavioral limitations of the people in the city. The studies of Elsheshtawy (2008) [9] and Labdaoui et al. (2021) [10] have proved that the presence of thermal comfort is a precondition of the use of outdoor spaces, and drastic solar exposure significantly reduces the use of outdoor space. Saudi Arabia [21,22] and Iran [13,17] studies indicate the effectiveness of such mitigation strategies as strategic shading, integration of vegetation, and high-reflective surface materials. As opposed to that, Yassin (2021) [6] documents the effects of thermal stress and reduced functionality of the space on the populace in the face of the dominance of asphalt and the scarcity of vegetation in Iraqi cities. More recent research by Li et al. (2024) [23] is able to determine a change in the level of comfort of pedestrians as a result of small-scale design interventions (i.e.,

strategically located canopies and street trees) and Traboulsi et al. (2023) [24] discuss the effect of artificial lighting design on the usability of a nighttime public space and security levels.

## 2.4. Methodological approaches to livability assessment

The determination of livability must be done using both mixed methods, which involve quantitative measures with qualitative input. Participatory approaches and indicators [14,10] are encouraged in both studies, including the Street Walkability and Thermal Comfort Index (SWTCI) that reflects the objective and subjective aspects. The use of sophisticated methods, including the space syntax analysis and the mapping done with the help of GIS, allows the researchers to quantify spatial connectedness and determine the locations, where intervention is needed [25,5]. Nonetheless, Benita et al. (2021) [26] warn that data-based solutions should be placed in the local context of the social and environmental reality to prevent oversimplification. Al-Saffar (2024) [11] suggested a framework that may be used to make social sustainability part of the pedestrian infrastructure planning in the Middle East, especially the post-conflict situation, and Balsas (2024) [27] emphasizes the usefulness of composite indicators in measuring livability performance.

## 2.5. Local and regional research

Local research can be used to give insights on critical issues and opportunities of improving livability in Middle Eastern cities. Al-Sawi et al. (2019) [28] and uwaer et al. (2025) [17] note that heritage-grounded renewal and climate-friendly design can be used in Iran to promote pedestrian activity. In Saudi Arabia, traffic safety and shading are the priorities, determined by Almahdy (2020) [21] and AlQahtany et al. (2024) [22] as the way to enhance the livability of the streets. Albabely and Alobaydi (2024) [5] in Iraq investigate the influence of the features of street networks on the pedestrian density, and Nabil et al. (2021) [12] demonstrate how the zoning of pedestrians can restore historic cities. Yassin (2021) [6] criticizes the conflict between the short-term livability requirements and the long-term sustainability ambitions in Iraqi urban areas and proposes policy changes that would help balance economic growth and environmental stability.

## 2.6. Research gaps and the contribution of this study

Although the topic of urban livability is becoming increasingly popular, there are still major gaps in the literature on the post-conflict, medium-sized, historic cities within the Global South. Numerous investigations are more focused on big cities, or based on standardized measures which disregard any local social, cultural, and environmental nuances [11,27]. In addition, walkability and thermal comfort have been sufficiently studied, but their integration into a holistic livability approach remains under-researched in such areas as Iraq (Yassin, 2021) [6]. This paper fills in these gaps by offering a multifaceted evaluation of the Al Jamiya Street in Babylon where morphological analysis of the street, environmental measurements and surveys of the pedestrians are used to offer a backdrop of the livability to the street amidst the peculiarities of Babylonian heritage and climate. By so doing, it will help in coming up with flexible approaches towards improving the living conditions in such urban areas.

## 3. Methodology

The research uses a mixed-methods research design to determine the walkability of the Al Jamiya Street, Babylon, Iraq, combining both quantitative and qualitative research methods to address possible limitations of availability of data and guarantee a comprehensive analysis. The methodology is consistent with the existing research methods of livability in complex urban settings [1,14,10] and was modified to fit the Babylonian social and environmental setting.

### 3.1. The study location: al jamiya street, babylon

The paper explores the Al Jamiya Street as shown in Figure 1, a busy business district in central Babylon, Iraq as an important connection between residential areas and other significant recreational zones such as Babylon Safari Zoo as shown in Figure 2, and Al Karama Park as shown in Figure 3. The street is a typical mixed-use urban avenue in Iraqi pre-Islamic cities and is distinguished by a ground-floor commercial level and apartments on the upper floor, a high pedestrian traffic, and severe environmental conditions in terms of thermal comfort and spatial functionality.

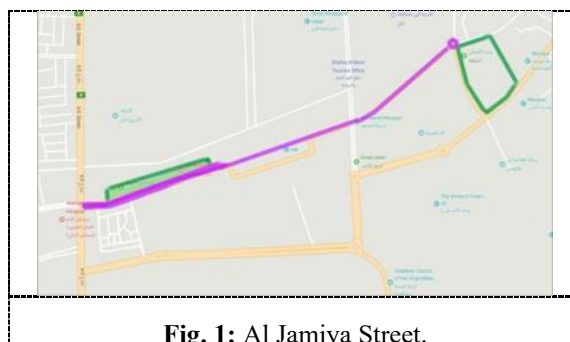


Fig. 1: Al Jamiya Street.



Fig. 2: Babylon Safari Zoo.

Fig. 3: Karama Park.

### 3.2. Data collection methods

To gain both objective physical data and subjective human emotions, a mixed-methodology was used, modifying the developed methodology of Moura et al. (2017) [14] and Labdaoui et al. (2021) [10] to the local environment.

#### 3.2.1. Paper mapping and ground surveys

The physical features of the street were being systematically documented by:

- Morphological analysis: the dimensions of sidewalks, the cross-sections of the streets as shown in Figure 4, building heights as shown in Figure 5, and the distribution of land use.

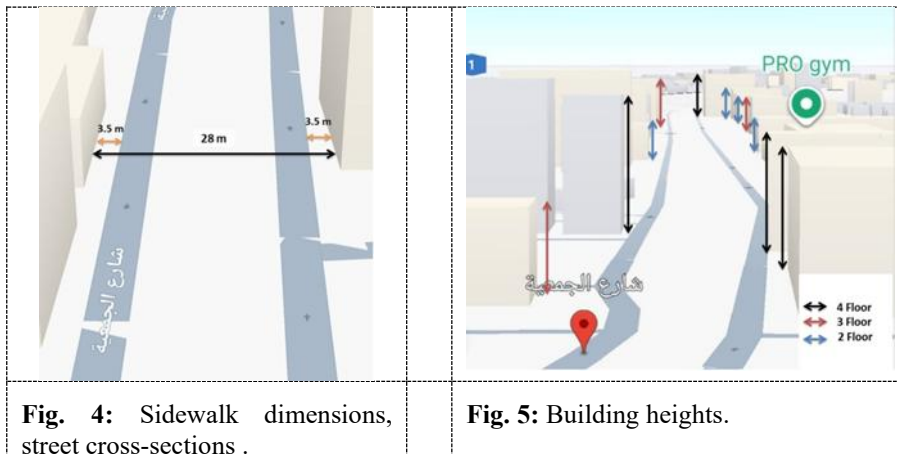


Fig. 4: Sidewalk dimensions, street cross-sections .

Fig. 5: Building heights.

- Pedestrian infrastructure analysis: checking the condition of the sidewalks, crossings, and barriers.
- Environmental mapping: recording shade patterns, surface materials, and vegetation at the various times of the day.
- Intended to be captured by recording: Behavioral mapping: capture of pedestrian flows and patterns of activities during peak hours as shown in Figure 6 and off-peak hours as shown in Figure 7.



Fig. 6: Pedestrian flows and activity patterns during peak hours.

Fig. 7: Pedestrian flows and activity patterns off-peak hours.

The observations were held within the period of seven days to observe the changes in usage patterns and environmental conditions.

### 3.2.2. Pedestrian surveys

A total of 50 pedestrians were surveyed using structured surveys to provide perceptual information on the dimensions of livability. The survey was conducted during summer. The tool was created based on the existing frameworks provided by Baobeid et al. (2021) [7] and it consisted of the sections, which covered:

- Patterns and frequency of use, walking.
- Sense of security, comfort and ease of access.
- Identification of major obstacles to enjoyment.
- Aspects of shading and thermal comfort
- The environmental impact on street activities.
- Preference of improvements and interventions.

The demographic profile of participants was characterized as follows as shown in Table 1:

**Table 1: Demographic features, No. of participants, %age**

Gender		Age Group		Purpose of Visit	
Male	40- 80%	20 years and below	1-2%	Shopping	38 -76%
		21-40 years	22 -44%	Family visit	4- 8%
				Work	4 -8%
Female	10 -20%	41-60 years	25 -50%	Residence	2 -4%
		Above 60 years	2 -4%	Zoo visitation	1- 2%
				Other	1- 2%

Note: Five participants from the shopping group reported later deciding to visit the zoo during their trip.

The gender distribution indicates the larger social trends of using the public space within the regional setting whereas the age distribution shows the presence of the economically active adults. The fact that the biggest part of the activities in the street is shopping shows the central commercial role of the street in the urban ecosystem.

### 3.2.3. Additional qualitative evaluation

Short, semi-structured discussions with street vendors and shop owners also provided additional information on how different aspects i.e. physical, social, economic and environmental aspects livability of public space. It has highlighted the following:

- Shopping is the major motive for their being in the street
- Side walks are sufficient in terms of width though they suffer from lack of maintenance and disrepair
- Traffic congestion and insufficient pedestrian cross ways causes feelings of discomfort and insecurity, otherwise the overall feels generally secure
- Winter, Spring and Autumn are the favorite seasons for pedestrian in the street
- Lack of shadows and glare reflected from glass facades are main reasons for thermal discomfort in the street

### 3.3. Data analysis

The method of analysis that was used was a mix of quantitative and qualitative:

- Spatial analysis: physical features and behavioural patterns compose mapping.
- Descriptive statistics: quantitative analysis of survey data by frequency distributions and cross- tabulations.
- Qualitative analysis: determining the presence of common themes and patterns through open coding methods.

### 3.4. Methodological limitations

Though the study offers valuable insights, it has several limitations:

- Sample size: Although large enough to determine current trends, it does not allow the deep analysis of subgroups. The cross-sectional design represents the conditions at a particular time period rather than capturing seasonal differences.
- Manual mapping has a chance of creating some variation of measurements in contrast to geospatial methods.
- Even with such constraints, there will be methodological triangulation using multiple sources of data that will allow robust findings that can be applicable to the study context.

### 3.5. Ethical considerations

Verbal consent was informed and all participants gave consent following an explanation of the research purposes. No names or other personal information was used, and all data was anonymized when analysing the data to ensure the confidentiality of participants. The data collection processes were made in such a way that they would have minimal effects on the vendors and pedestrians.

## 4. Analysis

### 4.1. Thermal comfort and environmental performance

The livability in the Al Jamiya Street is greatly limited by the environmental conditions especially in summer. The fact that strategic shading and vegetation are virtually absent, makes the climate thermally hostile, which in turn directly restricts human movement. Asphalt paving materials frequently reached surface temperatures above 50 °C during peak daylight periods forming quantifiable heat islands along the route. This is an environmental stressor that affects the vulnerable population disproportionately among elderly persons and young children who said that they avoided the street during the peak heat hours as shown in **Figure 8**.



**Fig. 8:** Absence of strategic shading and vegetation in summer.

A lack of natural shading features especially trees compels pedestrians to use building shadows solely to control heat which offers unequal protection as building shadow remains in a single position and varies according to the seasons. This shortage is directly proportional to the results of the surveys, with 88 % of the participants in the survey citing extreme heat as the biggest factor in limiting their use of the streets. The overwhelming support of the preference towards the use of tree planting (64% participants) in comparison to artificial shading solutions indicates the general awareness of the great effectiveness of natural solutions to reduce the city climate in addition to the improvement of the aesthetics as shown in Figure 9.



**Fig. 9:** Relying pedestrians exclusively on building shadows.

## 4.2. Functional performance and pedestrian infrastructure

The commercial life of the street showed the conflict between the business life and the accessibility of pedestrians. Although the physical infrastructure has broad sidewalks (2-4.5 meters wide), the capacity of the sidewalks is highly compromised by encroachment that is continuously taking place. Vendor occupation leads to less than one meter in width of effective walking at bottlenecks which reduces the flow of pedestrians and forces them to walk on vehicle paths as shown in Figure 10.



**Fig. 10:** Street vendor.

Poor crossing opportunities worsen this weakness in infrastructure. The pedestrians also have a major obstacle to movement across the street as there are only three formal crossing points across the entire corridor as shown in Figure 11. The ensuing haphazard crossing pattern poses serious conflicts with traffic especially to the elderly who testified that they avoided crossing efforts altogether. These conflicts are further increased due to the lack of bicycle infrastructure that makes bicycles and motorcycles to use sidewalks, posing more dangers to pedestrians as shown in Figure 12.



**Fig. 11:** Formal crossing point.



**Fig. 12:** Bicycles and motorcycles on sidewalks.

## 4.3. Social dynamics and economic function

The Al Jamiya Street has a lively business nature, which is both an asset and a challenge to living in. This boosts the concentration of pedestrians as there are numerous shops, which give natural surveillance and the feeling of safety during working hours. Nevertheless, such density of commerce also produces congestion areas and noise disturbances which have adverse impacts on the residential appropriateness of the street.

The social usage patterns among the street user population can be noted through the demographic structure of the population. The presence of male users (80 % of the exhibited pedestrians) points to the cultural or social obstacles to female involvement in the use of the public space. Likewise, the under-representation of old age people (4%) and children shows that the environment and accessibility hinder the inclusiveness of the street. The commercial nature of the street seems to be more economically oriented than social; there was little to offer as regards to seating, gathering and informal socializing in the street other than commercial activities.

## 4.4. Perceptual dimensions, user experience

The pedestrian experience showed that there was a complicated view between the lived experience and physical reality of the street. Although 64 % of the respondents indicated that the width of the sidewalks was enough or good, this attitude only indicates the broadness of the sidewalks and not the satisfaction. Through the particular questions of satisfaction with

the environment, safety, and accessibility, the level of satisfaction decreased significantly, especially when it comes to thermal comfort (12% satisfaction) and crossing safety (23% satisfaction).

The difference between the basic walkability and the livability as perceived shows how users change their expectations in accordance with the prevailing conditions. Several of the respondents showed outstanding strengths in pulling through the challenges of the street by having devised ways to overcome it like going in the cooler mornings, taking certain paths to avoid the crowd and adjusting on their walking rate to overcome the challenges. Nevertheless, this adaptation is not the same as satisfaction and this fact is confirmed by the high level of agreement (82% of participants) to the significant interventions aimed at enhancing the environmental situation and safety.

#### **4.5. Summary: the livability paradox**

Al Jamiya Street is a paradox of livability: it is a well functioning commercial street and at the same time fails to offer the main livable elements in a livable urban setting. The same commercial density creates accessibility barriers and environmental degradation but creates pedestrian traffic and natural surveillance due to its economic accessibility. The street is serving its main purpose of shopping mission but has not been effectively fulfilling other secondary purposes of socializing, recreation and casual fun.

This discussion shows that the livability of the street is essentially dependent on the season and conditional. It can be used comfortably in the mild weather but not in the summer seasons. It is a good example of a population that may be used effectively among healthy adult males as well as act as a substantial obstacle to other groups. It is very efficient in supporting destination-focused activities with lesser backup on spontaneous or extended use. Such conditional livability is a lost chance to make an urban space really inclusive and sustainable that can be used not only as a place of commerce but also cater to community needs in a wider sense.

### **5. Discussion**

Even though the population structure of our research sample represents the natural usage trends, it has significant implications for the concept of the livability of the street. The fact that it has a majority of male users (80 %) and shoppers (76 %) predetermines conclusions in the direction of the impressions and interests of the two groups. This narrow range of views could result in the analysis failing to capture all the elements of livability of the street especially those valued by other groups, such as women, the elderly, children and those who use the space without commercial interests.

The fact that women are under-represented in this public space, as it is the case in most of the Middle Eastern urban settings, hints at the possibility of the given circumstances failing to address their unique needs or levels of comfort in the areas of safety, privacy, or social facilities. In the same way, this small involvement of the elderly populations is probably an indication of untapped issues in accessibility that would be more evident with more representatives of this group. The almost complete lack of zoo visitors as a specific group restricts our idea on the impact of recreational uses on livability perceptions in contrast to commercial ones.

These demographic constraints underscore the very fact that it is inherently difficult to assess livability using a sample that reflects existing exclusion rather than the inclusive ideal. It is likely that a street that is a real place to live in would appeal more to a variety of population in terms of gender, age, and purpose of visit. Thus, the results included here are to be viewed as indicative of the suitability of Al Jamiya Street to the existing dominant user group but not the suitability regarding the wider community. The reasons why greater variety of uses of this collective space is not utilized ought to be specifically studied in the future.

### **6. Conclusion and recommendations**

To turn Al-Jamajyah Street into a commercial street and make it a livable place, a comprehensive strategy should be implemented to consider the environmental, functional, and social aspects. Through these suggestions, policymakers and urban planners can design a street that is not only able to accommodate economic activity, but also positively contribute to social well-being, environmental sustainability as well as cultural life, and eventually become an example of similar urban corridors in other historic cities in the Middle East.

#### **6.1. Conclusion**

This paper has given a comprehensive evaluation of the livability of Al Jamiya Street in Babylon, Iraq that indicates that there are challenges and opportunities to enhance it. The study has conducted both morphological assessment and pedestrian surveys in showing that as much as the street is a good commercial street, it is not a habitable urban street that satisfies the varied demands of the people. The performance of the street is defined by an inherent paradox, in which its

economic energy creates movement of people on the street and at the same time, poses a physical obstacle to its operations through environmental and accessibility restrictions.

The analysis revealed three important dimensions that limit the livability of the street, which are environmental stresses as expressed by the respondents especially extreme heat above 40 °C and the lack of adequate shading along with glare by glass facades, deficiency of infrastructures (such as the presence of pedestrian-vehicle conflicts and the lack of crossing points), and social constraints (lack of diversification in users and non-commercial support). The imposed restrictions lead to the creation of a street that is more of a transit medium than a dynamic community space that fosters social interaction, recreational activity, and easy accessibility of the street to people of all demographic strata.

The temporality of the livability of the street, which is viable during mild conditions but not livable during the summer period, accessible to healthy adults and difficult to the vulnerable groups, is an opportunity lost to develop a resilient urban environment which can be used to benefit the community at large. This study is relevant to the knowledge of the urban street livability in historic cities in the Middle East because it presents the interaction between environmental, functional, and social factors to produce the quality of the urban experience under hot-arid climatic conditions.

## **6.2. Recommendations**

To turn the Al Jamiya street into a living environment rather than a commercial street, it is necessary to consider a holistic solution to the problem that would not only cover the environmental and functional aspects but also social ones. With these pieces of advice, the urban designers and policymakers would be able to develop a street that would not only be conducive to economic life but also promote social wellbeing, environmental sustainability, and cultural vibrancy, making it a template of other cities, which have historic urban corridors.

### **6.2.1. Short-term (0-2 years) immediate interventions**

- Environmental Mitigation: Install low weight shading facilities on key pedestrian roads especially around the zoo entrance and market places to offer instant thermal relief during the hottest seasons.
- Pedestrian Infrastructure Enhancement: Introduce proper zoning of vendors to avoid encroachment to the sidewalk without making them economically irrelevant. Introduce special pedestrian priority areas having enhanced signage and road markings.
- Traffic Calming Measures: Install speed bumps and priority pedestrian crossing at major points, especially recreational spots and market access points, to minimize vehicle-pedestrian conflicts.

### **6.2.2. Strategic improvements (medium-term: 2-5 years)**

- Overall Greening Strategy: Design and adopt a master tree planting strategy that targets native, drought resistant plants which can give maximum shade with minimal cost. Make use of wide median strips and available spacing to design green corridors.
- Public Space Enhancement: Install strategic street equipment, drinking water stations, and general toilets to accommodate longer stay and variety of other activities other than shopping.
- Lighting Improvements: Improve street illumination to increase the safety and accessibility of the night with specific respect to the location next to the zoo and residential access points.

### **6.2.3. Policy and planning initiatives**

- Zoning of the Streets: Institute a system of coordinated management between the municipal authorities, merchant associations and community representatives to resolve some of the current maintenance and usage disputes.
- Guidelines of Inclusive Design: Design and adopt design standards that respond specifically to the needs of marginalized groups of people, such as women, the elderly, and children.
- Sensitive Urban Design: Develop design principles that would see any interventions to the historic Babylon upholding the historic nature and upgrading the present functionality.

### **6.2.4. Research and monitoring**

- Longitudinal Studies: Carry out studies on a seasonal basis to learn more about the changes in the livability across the year and determine the effectiveness of the intervention.

- Studies devoted to Marginalized Populations: Specifically research the desires and interests of women, older age population and children to make the public spaces more inclusive.
- Microclimate Monitoring: Installation of environmental sensors to be used to measure quantitatively the thermal conditions in the environment before and after shading and greening of the environment.

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