Enhancing Accessibility to Objects of Cultural Heritage in Cities of Syran Arab Republic: Challenges and Solutions

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Abstract. Historic city centres are significant cultural and economic hubs. However, they often encounter challenges in preserving their heritage amidst urbanisation and modernisation. This article presents an integrated approach that combines theoretical insights with innovative methodologies to address the urban planning dilemmas facing historic centres. Additionally, the article analyses mobility dynamics within these centres using analytical techniques to accurately decipher pedestrian and vehicular movement patterns. The objective of this article is to optimise street intersections and enable informed decisions in city design and infrastructure development through the use of mathematical analysis. The study analyses various transportation elements to gain a comprehensive understanding of the complex transportation system by linking them to key aspects. This study presents an integrated framework that promotes the development of adaptable transportation systems in urban environments. The aim is to facilitate innovative solutions and the seamless integration of diverse transportation modes into urban planning frameworks. The development of road networks in historic cities aims to balance cultural preservation with modern transportation integration, striving to maintain authenticity while implementing sustainable solutions.

1 Introduction

Enhancing the accessibility of cultural heritage collections in historic cities requires addressing challenges and implementing solutions. This often involves innovative approaches to ensure accessibility for both locals and visitors alike, due to the complex tapestry of history, art, and architecture woven in historic cities around the world [1-2].

In this context, it can be concluded that improving the accessibility of cultural heritage collections in historic cities requires a multifaceted approach. This includes emphasizing universal design principles to ensure that all people have access to heritage sites regardless of their physical abilities [3-4].
Additionally, studies highlight the importance of enhancing accessibility and safety in the vicinity of heritage sites by reducing vehicular traffic and promoting pedestrian-friendly zones that encourage walking and cycling. This helps to mitigate pollution in historic urban environments [5-6]. Additionally, it is important to provide convenient public transportation options, such as buses and trams, to reduce reliance on private vehicles and promote sustainable modes of mobility [7-8].

Maintaining a delicate balance between managing visitor influx, tourism, and minimizing environmental impact is crucial for the long-term sustainability of historic cities [9-10].

Previous studies have not explored the specific challenges faced by historic Syrian cities [11]. Therefore, this study focuses on these centers, aiming to identify their unique issues and devise tailored solutions that respect their historical significance and distinctiveness. Additionally, the study seeks to address the knowledge gap between sustainability and cultural heritage preservation by using a mathematical model to identify vulnerabilities in the development process of Syrian cities.

2 Materials and methods

2.1 Identification of urban planning problems of historic city centers

The historic city center's allure lies in its enchanting blend of centuries-old architecture, meandering streets, and iconic landmarks, drawing countless visitors each year. However, the city grapples with a plethora of urban planning hurdles, imperiling its sustainability and vibrancy.

This study aims to analyze the challenges facing the city, including traffic congestion, pedestrian flow, accessibility to key attractions, and the preservation of its cultural heritage.

1. Automobile movements:

Large number of cars: Historic centers, often designed for the past, struggle to cope with the huge amount of modern automobile traffic. Narrow streets become congested, making accessibility difficult and creating air and noise pollution.

Car Priority: Urban planning that prioritizes automobile travel creates a dominance of roadways over public spaces, sidelining pedestrians and cyclists.

Safety issues: Traffic congestion and poorly designed intersections put both drivers and pedestrians at risk, making getting around the city center stressful and potentially dangerous. presented in (see figure 1) [12-13].
2. **The problem of pedestrian movement:**

   Safety and comfort: Historic centers lack dedicated pedestrian spaces such as sidewalks, crosswalks, and safe zones, making walking uncomfortable and unsafe. In addition, uneven surfaces and obstacles further hinder accessibility.

   Lack of infrastructure: Navigating through the city center can be an unpleasant and disorienting experience due to limited pedestrian infrastructure such as lighting, signage, and benches, shown in (Figure 2) [14-15].

3. **The problem of access to heritage sites:**

   The lack of accessibility schemes: in which makes it difficult for people with disabilities or mobility impairments to move around historic centers, limiting their access to cultural assets and public spaces, and may also hinder tourism and economic development.
Balance of needs: The balance between accessibility and preservation requires creative solutions that preserve the historic property while providing ramps, elevators, and accessible pathways as shown in Figure 3 [16-17].

Fig. 3. The problem of object access

4. Specificity of the historical center:
Historic town centers are valuable cultural heritage sites that require sensitive conservation and management to prevent damage and loss of authenticity.

Unmanaged tourism can lead to strain on infrastructure, gentrification and threaten the cultural fabric of the city center (see figure 4). It is very important to find a balance between tourism and conservation [18-19].

Fig. 4. Specificity of the historical center
2.2 Metodology

To enhance the accessibility of historic city centres for pedestrians, a methodical approach comprising several phases is crucial. The following is a detailed explanation of each step:

1. **Determining the type of street cross-section for the reconstruction of public pedestrian spaces:**

   The first stage involves analysing the types of street cross profiles in the historic city centre. This includes analysing street widths, pavements, parking availability and other factors that affect pedestrian accessibility. Based on this analysis, areas requiring reconstruction or pedestrian infrastructure improvements are identified.

2. **Formation of conditions of pedestrian accessibility to historical city centres with the help of geographical modelling:**

   This stage utilises advanced geographic information modelling techniques to analyse existing infrastructure and evaluate its effectiveness in terms of pedestrian accessibility. The analysis may involve modelling pedestrian routes, estimating distances to key sites, and evaluating public transport accessibility. The modelling results can help identify bottlenecks and problematic areas, and determine the most effective ways to improve pedestrian infrastructure.

3. **Identify the basic requirements for a pedestrian space system:**

   This step outlines the fundamental requirements and principles that should govern the pedestrian space system in the historic city centre. This involves establishing standards for width, connectivity, capacity, functional saturation, comfort, safety, and other relevant aspects (see figure 5).

   Additionally, it considers the needs of diverse pedestrian groups, such as people with disabilities, the elderly, and children.

![Fig. 5. Conditions of accessibility of the historical city center](image-url)
2.3 Analyses the structure of automobiles

The methodology adopted in this study focuses on a detailed analysis of various transportation elements, including private automobiles, public transit, shared transportation, personal vehicles, and pedestrian transportation. The aim is to clarify these elements by linking them to key aspects and to gain a comprehensive understanding of the complex transportation system. The analysis considers the modes of transportation, the scale of transportation, the impact of electric vehicles, and the infrastructure that supports these modes.

To comprehend this analysis, it is essential to consider the features of each mode of transportation. Private cars are usually employed for individual transportation and play a significant role in the overall transportation system. Public transportation, including buses and streetcars, contributes to the broader social fabric. Shared mobility, such as ride-sharing services and public transportation options, adds a dynamic layer to the transportation system. The micro layer of transportation includes individual mobility facilities and walking mobility, which are integral components of the transportation system.

A comprehensive analysis of the transportation system requires an examination of the interrelationships between various transportation elements and related aspects. The diversity of the transportation system is revealed by focusing on different modes of transportation, such as personal automobiles and public transit. To analyse the scale of transportation, it is necessary to examine both geographic and operational boundaries. This examination can provide valuable insights into the scale and impacts of different modes of transportation.

The inclusion of electric vehicles in sustainable transportation takes into account changes in the landscape and their impact on the urban environment. Additionally, the infrastructure highlights the support necessary for efficient transportation, including road networks, charging stations, and other key components. (Figure 6) shows an analytical system that integrates various transportation components and develops a model for predicting potential changes in road conditions.

This approach creates opportunities for innovative solutions and integration of various types of transportation into urban planning. In short, it lays the foundation for designing flexible and durable roads capable of adapting to the changing needs of modern society.
This study uses a methodical approach to analyze the transportation elements, examining each component and establishing links between its key aspects. The main objective is to create a comprehensive view of a complex transportation structure. By examining the key aspects of each element, we can confidently identify the
interdependencies and subtleties that define the overall transportation network. The analytical approach presented here lays a solid foundation for street profile design by synthesizing a comprehensive understanding of the transportation system and presenting potential options.

3 Results

3.1 Determining the total number of sets:

By systematically examining and evaluating the available options for the proposed transportation scheme, an integrated understanding can be achieved. This will allow for the synthesis of various elements into coherent scenarios, creating complex images that visualize the envisioned shared street space as shown in Table 1.

This method promotes a holistic perspective and uncovers links between different components, leading to innovative solutions that improve usability, inclusivity, and environmental impact.

Table 1. Numbering of sustainability indices and subindices of urban and rural settlements

<table>
<thead>
<tr>
<th>Set</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>V</td>
<td>Element related to cars is labeled (X) and their expected path probabilities within the street space are given by the following symbols ((X_1, X_2, X_3, X_4)).</td>
</tr>
<tr>
<td>W</td>
<td>The element related to public transportation is denoted by ((Y)) and the expected probabilities of their movement paths within the street space are given by the following symbols ((Y_1, Y_2, Y_3, Y_4, Y_5, Y_6, Y_7, Y_8, Y_9)).</td>
</tr>
<tr>
<td>X</td>
<td>As for shared mobility, it is denoted by the symbol ((W)) and the expected probabilities of their movement paths are coded by the following symbols ((W_1, W_2, W_3, W_4)).</td>
</tr>
<tr>
<td>Y</td>
<td>The element associated with individual mobility means is denoted by the symbol ((V)) and the expected probabilities of their paths within the street space are given by the following symbols ((V_1, V_2, V_3, V_4)).</td>
</tr>
<tr>
<td>Z</td>
<td>As for pedestrian mobility, it is denoted by the symbol ((Z)) and the expected path probabilities are coded by the following symbol ((Z_1, Z_2, Z_3, Z_4)).</td>
</tr>
</tbody>
</table>

The various combinations of elements that can be made from the set \{V, W, X, Y, Z\} without repetition can be determined by the following (formula 1):

\[
C_{(n,k)} = \frac{n!}{k!(n-k)!} \quad (1)
\]

where; \(n\) : Total number of elements, 
\(K\) : Number of elements in each combination 
\(!\) : Stands for factorial

Set Z is crucial for the successful implementation of pedestrianisation in the historic city. It defines the shape of a street that is suitable for pedestrian-only use and can accommodate people with limited mobility as shown in Table 2. This value was fixed.
during calculations to limit the number of scenarios available when designing the street profile.

Table 2. Numbering of sustainability indices and subindices of urban and rural settlements

<table>
<thead>
<tr>
<th>A set consisting of only ( k ) elements from ( n )</th>
<th>Formula</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>A set consisting of only one element out of four given that set ( z ) is fixed</td>
<td>( C(4, 1) = \frac{4!}{1!(4-1)!} )</td>
<td>4</td>
</tr>
<tr>
<td>A set consisting of only two elements out of four given that set ( z ) is fixed</td>
<td>( C(4, 2) = \frac{4!}{2!(4-2)!} )</td>
<td>6</td>
</tr>
<tr>
<td>A set consisting of only three elements out of four given that the set ( z ) is fixed</td>
<td>( C(4, 3) = \frac{4!}{3!(4-3)!} )</td>
<td>4</td>
</tr>
<tr>
<td>A set consisting of only four elements out of four given that the set ( z ) is fixed</td>
<td>( C(4, 4) = \frac{4!}{4!(4-4)!} )</td>
<td>1</td>
</tr>
</tbody>
</table>

The final result characterizes the total number of street profile probabilities given that the set \( z \) is fixed. Which means only the total number of profiles that the set \( Z \) contains 15.

3.2 Evaluation of Aleppo’s historic streets:

The city of Aleppo is located in northern Syria, opposite Turkish lands. Between the plains of the Euphrates Valley to the east and the Ghor al-Haddam plains to the west. It occupies an area of 190 km\(^2\). The urban structure of the historic city consists of several categories, namely: the area around the castle, which includes historic and traditional listed buildings from ancient times to the Ottoman era, the urban market which dates back to the Hellenistic Roman era, two types of residential neighborhoods were found; the first is highly organized buildings, the second also includes open spaces, which in turn are divided into squares and walkways [20-23].

Figure 7 displays the distribution of significant public buildings in the historic central part of Aleppo city. These buildings represent valuable architectural and urban planning features of the historic city center, such as traditional courts, mosques, schools, hamams, hotels, and markets. They are an important attraction for the entire population of Aleppo city.
Based on our analysis of the transport elements used in the network, it was found that the city of Aleppo primarily relies on public transport powered by oil derivatives. Additionally, there is a lack of shared and electric transport services, as well as inadequate infrastructure for people with limited transport capabilities and bicycle paths. Furthermore, public transport parking is insufficient.

The analysis presented in Figure 8 assists in identifying transport and infrastructure issues during the upcoming reconstruction period and subsequent phases.

Fig. 8. Identification of urban mobility patterns in the historic city centre of the Aleppo
The classification scheme of streets in Aleppo city centre based on the percentage of pedestrians present in the streets of the historic centre. This scheme aids in comprehending the structure, dimensions, and historical significance of the streets. Despite the age of the historic centre, most of the streets are narrow and congested due to cars (see figure 9). This requires reconsideration and solutions that are suitable for the nature of the archaeological city.

<table>
<thead>
<tr>
<th>Classification of streets</th>
<th>Streets name</th>
<th>Street width</th>
<th>Width of sidewalks</th>
<th>Number of lanes</th>
<th>Street length m</th>
<th>Streets sections</th>
<th>Streets planes</th>
<th>Photo</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pedestrian (20-40)%</td>
<td>St. Mohammad Fares</td>
<td>20-30</td>
<td>2-3.5</td>
<td>4 - two-way</td>
<td>1040</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>St. Mohammad Beck</td>
<td>20-30</td>
<td>3.5</td>
<td>4 - two-way</td>
<td>823</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pedestrian (40-60)%</td>
<td>St. Al-Khansbi</td>
<td>8-10</td>
<td>3</td>
<td>2 - two-way</td>
<td>1200</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>St. Bab El Hadid St.</td>
<td>12-15</td>
<td>3</td>
<td>2 - two-way</td>
<td>450</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>St. Prison</td>
<td>15-17</td>
<td>3.5</td>
<td>2 - two-way</td>
<td>375</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>St. Bab Azadaki</td>
<td>18</td>
<td>2.5</td>
<td>2 - two-way</td>
<td>824</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>St. Marunabi</td>
<td>17</td>
<td>3</td>
<td>3 - one-way</td>
<td>1229</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>St. Anub</td>
<td>10-12</td>
<td>3</td>
<td>3 - one-way</td>
<td>640</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>St. Jawalib</td>
<td>15</td>
<td>3.5</td>
<td>2 - one-way</td>
<td>148</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>St. Snad Bin Al Ans</td>
<td>15-17</td>
<td>3</td>
<td>2 - one-way</td>
<td>819</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>St. Al-Abbassyin</td>
<td>17</td>
<td>3.5</td>
<td>2 - two-way</td>
<td>627</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>St. Al Mshara</td>
<td>8</td>
<td>3</td>
<td>2 - one-way</td>
<td>843</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>St. Qadi Askara</td>
<td>7</td>
<td>3</td>
<td>2 - one-way</td>
<td>460</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pedestrian (60-80)%</td>
<td>Castle Street</td>
<td>8-10</td>
<td>3</td>
<td>2 - one-way</td>
<td>690</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Khan Al Weir</td>
<td>8-12</td>
<td>3</td>
<td>2 - one-way</td>
<td>220</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Seven Haaret</td>
<td>8-10</td>
<td>3</td>
<td>2 - one-way</td>
<td>360</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>Khan al Hani</td>
<td>6-8</td>
<td>3</td>
<td>2 - one-way</td>
<td>420</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Baal Murat Akaba</td>
<td>6</td>
<td>3</td>
<td>2 - one-way</td>
<td>640</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pedestrian (100%)</td>
<td>Al-zohovik market</td>
<td>8</td>
<td>-</td>
<td>-</td>
<td>90</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>El Zeb Merkat</td>
<td>3.5</td>
<td>-</td>
<td>-</td>
<td>130</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Soap Market</td>
<td>3</td>
<td>-</td>
<td>-</td>
<td>155</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Al Farm Market</td>
<td>3</td>
<td>-</td>
<td>-</td>
<td>150</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Baal Azadaki Market</td>
<td>3.5</td>
<td>-</td>
<td>-</td>
<td>250</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Al Sakhi Market</td>
<td>3</td>
<td>-</td>
<td>-</td>
<td>330</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Al Jib market</td>
<td>3</td>
<td>-</td>
<td>-</td>
<td>180</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Fig. 9. Streets description in the historical centre of the Aleppo

4 Discussion and conclusions

In conclusion, the development of road networks in historic cities represents a complex interaction between the preservation of cultural heritage and the introduction of modern transportation systems. Effective urban planning should aim at ensuring ease of movement while preserving the unique historic character of these places. The success of these strategies depends on adaptable approaches, active community participation and innovative solutions to harmonize the past with the challenges of the future.

The planning and management of street widening becomes a key factor in shaping future urban landscapes as historic cities continue their gradual development. This requires
not only technical improvements in infrastructure, but also the active participation of local communities in the decision-making process. It is essential to seek innovative and sustainable methods that balance the preservation of historic heritage with the modern requirements and needs of future generations. Thus, the development of sustainable and adaptable urban spaces is crucial for the preservation of historic cities in the face of a changing world and technological progress.

References


