Future Cities and Environment
ISSN 2363-9075 Volume 11 (2025)

https://doi.org/10.70917/fce-2025-037
Article

Conserving Urban Heritage for Tourism Development: Addressing the Constraints Affecting Urban Heritage Sites Conservation Using FAHP Approach

Umar Lawal Dano

College Architecture and Planning, Imam Abdulrahman Bin Faisal University, Dammam 31451, Saudi Arabia; uldano@iau.edu.sa; ORCID number: 0000-0002-6786-5223

Abstract: This study aims to identify, analyze, and prioritize the key constraints affecting the conservation and management of urban heritage sites in Saudi Arabia while evaluating viable solutions to address these challenges. Although previous research has acknowledged these constraints, comprehensive prioritization of their impact and systematic evaluation of alternative strategies remain limited. To address this gap, the study adopts an expert-driven approach and employs the Fuzzy Analytic Hierarchy Process (FAHP) to assess the relative importance of seven critical constraints and five potential solutions. The findings reveal that lack of awareness and appreciation (LAA) (27%) is the most significant constraint, followed by an inadequate legal framework (ILF) (23%) and a lack of professional expertise (LPE) (20%). Rapid development and urbanization (RDU) (4%) and insufficient funding and resources (IFR) (2%) rank lowest. Among the proposed solutions, improving legislation and enforcement (ILE) (37.7%) emerged as the most effective strategy, followed by raising public awareness (RPA) (24.1%) and fostering partnerships (FP) (19.6%), while allocating adequate resources (AAR) (3.5%) was deemed least influential. Based on these results, the study proposes a final FAHP-based decision-making framework for enhancing heritage conservation in Saudi Arabia. This framework integrates expert judgment with fuzzy logic to systematically prioritize challenges and align them with the most impactful interventions. It provides policymakers, planners, and heritage professionals with a structured tool for developing targeted, data-informed strategies that promote the sustainable preservation and revitalization of urban heritage sites. In doing so, the framework also supports heritage tourism and aligns with national development goals.

Keywords: alternative solutions; conservation; constraints; F-AHP; heritage sites; management; protection; Saudi Arabia

1. Introduction

World heritage sites, recognized for their unique significance, have increasingly become major tourist attractions. Tourism is a key driver of economic growth globally (Girard & Nijkamp, 2009), and its development remains an inevitable trend. Urban heritage serves as a vital testament to human progress, reflecting how communities have harmonized with their environments while embodying cultural, social, and religious values upheld by past generations (Levy et al., 2023; García-Hernández et al., 2017). Over the past fifty years, Saudi Arabia has made significant strides in preserving its historical sites and buildings, marking a shift toward sustainable heritage management in the post-oil era (Mazzetto, 2022). Once neglected in the 1960s, many sites are now recognized on the prestigious UNESCO World Heritage list as illustrated in Figure 1 (UNESCO, n.d.). According to the National Antiquities Register, Saudi Arabia has over 10,000 heritage sites and buildings, with a substantial number located in urban areas. However, conservation efforts remain inadequate due to limited involvement of non-governmental organizations and local communities (Sodangi & Kazmi, 2023; Al-Tokhais & Thapa, 2020).

Additionally, insufficient funding and overlapping responsibilities among multiple government agencies hinder effective heritage management, leaving many sites vulnerable to deterioration and vandalism (Sodangi & Kazmi, 2023).

Khalil & Nasr (2021) emphasize that preserving historical sites is crucial for maintaining cultural heritage and national identity. Recognizing the economic potential of heritage tourism, authorities are working to protect and promote these cultural assets for both local and international visitors (Saleem et al., 2019). If effectively safeguarded and integrated into cultural tourism, heritage sites could drive economic growth for local communities and the nation as a whole (Alqahtany & Aravindakshan, 2022). Saudi Arabia's Vision 2030 prioritizes heritage preservation, underscoring the revival of Saudi, Arab, and Islamic cultural legacies as a source of national pride (Saudi Vision 2030, n.d.). This aligns with the Sustainable Development Goals, particularly Goal 11, Target 11.4, which calls for strengthened efforts in protecting cultural and natural heritage. However, achieving these objectives requires a thorough understanding and assessment of the constraints affecting heritage conservation.

Extensive research has examined the significance of heritage conservation and the challenges it faces worldwide (Alhefnawi et al. 2023; El-belkasy & Wahieb, 2022; Ali et al., 2018; Guzman et al., 2018; Alzahrani, 2016; Alnaim, 2022a; Alnaim, 2022b; Sodangi & Kazmi, 2023; Moscatelli, 2022; Dwidar, 2019; Badawy & Shehata, 2018). The evolving approaches to managing cultural heritage sites demand strategic decision-making, as conservation becomes increasingly complex (Piaia et al., 2020). In Saudi Arabia, heritage site management is hindered by insufficient investment in essential infrastructure (Al-Tokhais & Thapa, 2020), due to budget constraints. This financial shortfall often results in poor maintenance and inappropriate adaptive reuse, accelerating structural decay (Alrawaibah, 2016; Al-Tokhais & Thapa, 2020). Additionally, Bagader (2018) highlights inconsistent management policies and a lack of prioritization in funding as major obstacles to preservation. Baik (2017) further underscores the challenge of unclear responsibilities among multiple government agencies, complicating effective oversight.

Bagader (2018) also points to the exclusion of local communities from conservation efforts, leading to a shortage of skilled labor for restoration. Moreover, limited public awareness of heritage management and the absence of strategic visitor management contribute to inappropriate visitor behaviors at these sites. Furthermore, Sodangi & Kazmi (2023) identify the lack of conservation management plans as another significant constraint in heritage preservation. Despite extensive research, existing studies remain fragmented, making it difficult to understand the interconnections between constraints and potential solutions. Many studies fail to establish a hierarchy of challenges or assess their relative impact. This study seeks to bridge the research gap by applying FAHP, aiming to provide policymakers and researchers with a comprehensive resource for developing effective heritage management strategies in Saudi Arabia. Through fostering sustainable and proactive conservation approaches, this initiative could enhance the preservation of cultural heritage sites and attract tourism activities both nationally and beyond. Therefore, the aim of this study is to develop a comprehensive FAHP framework to enhance heritage conservation efforts in Saudi Arabia.

The present study identifies seven key constraints based on recurring themes in the literature and their contextual relevance to Saudi Arabia. Rapid development and urbanization (RDU) threaten heritage sites in fast-growing Gulf cities, where modern expansion often displaces or overshadows historic assets (Sodangi & Kazmi, 2023; Udeaja et al., 2020). Lack of awareness and appreciation (LAA) persists as community disengagement continues to undermine conservation efforts (Bagader, 2018). Insufficient funding and resources (IFR) remains a major obstacle, particularly in the Middle East, where heritage projects are frequently underfunded (Alrawaibah, 2014; Al-Tokhais & Thapa, 2020; Mazzetto, 2021; Sodangi & Kazmi, 2023). An inadequate legal framework (ILF) further limits conservation, with heritage protections poorly integrated into urban planning (Zia-ud-Din, 2024; UNESCO, 2021). Natural and environmental factors (NEF) such as desertification, extreme heat, and climate-induced flooding pose increasing risks, especially in coastal areas (Porębska et al., 2019). A lack of professional expertise (LPE) also hampers progress, as many regions still lack trained conservation personnel (OECD, 2022). Lastly, rapid social change (RSC) driven by modernization and evolving cultural values has weakened public support for preservation (Quiñones & Fouseki, 2022).

To address these challenges, five strategic alternatives were selected. Raising public awareness (RPA) is vital for community engagement and long-term heritage stewardship, as recommended by ICOMOS and supported by Lou et al. (2021) and Bagader (2018). Improving legislation and enforcement (ILE) aligns with national priorities such as the Saudi Ministry of Culture's 2030 strategy (Ministry of Culture, Saudi Arabia, 2023). Allocating adequate resources (AAR), financial and institutional, is widely regarded as a prerequisite for sustainable heritage management (Mazzetto, 2021; Sodangi & Kazmi, 2023). Promoting research and education (PRE) helps bridge knowledge gaps and cultivate skilled professionals (OECD, 2022). Finally, fostering partnerships (FP) among government, academia, and the

private sector has shown global success and is increasingly implemented in the region (UNESCO, 2021).

Figure1.Selected heritage sites registered by UNESCO in Saudi Arabia showing: (**A**) At-Turaif Neighborhood, (**B**) Al-Hijr Archaeological Site, (**C**) Al-Ahsa Oasis, and (**D**) Rock Art of the Hail Region (Source: UNESCO, n.d.).

2. Methodology

2.1. Study Area

Saudi Arabia, the largest and a high-income country in the Middle East, spans approximately 2,149,690 square kilometers, occupying most of the Arabian Peninsula (CIA, 2023). Strategically positioned at the intersection of Asia, Africa, and Europe, it shares borders with Jordan, Iraq, Kuwait, Qatar, the UAE, Oman, and Yemen and features coastlines along the Red Sea and the Arabian Gulf (Figure 2). The country comprises 13 provinces, with Riyadh as its capital. Its diverse geography ranges from the vast Rub' al Khali desert to the Asir Mountains and coastal plains, while its climate is predominantly arid, with minimal rainfall and extreme seasonal temperatures. More than half of Saudi Arabia's land consists of deserts and mountain ranges. However, approximately 2.7 million hectares are covered by sparse forests, 3,500 hectares by mangroves, and around 2% is arable land, primarily supporting the cultivation of dates, vegetables, and fruits (AlQahtany et al., 2022).

Rich in cultural heritage, Saudi Arabia is home to six UNESCO World Heritage Sites, reflecting its historical role as a trade hub and a center of Islamic civilization (UNESCO, 2023). These sites are integral to the country's Vision 2030, which aims to preserve and promote cultural heritage while advancing economic diversification and sustainable development (Saudi Vision 2030, n.d.). The nation's blend of historic sites, palm oases, coastal cities, and vast desert landscapes positions it as a key recreation and tourism destination. With a population of approximately 36 million and an urbanization rate of 85%, concentrated mainly in Riyadh, the Eastern Province, and Jeddah, Saudi Arabia is undergoing rapid transformation. Large-scale infrastructure projects such as NEOM and the Mukaab, along with initiatives to enhance cultural tourism and heritage conservation, are shaping its future while preserving its past (Reuters, 2024). According to CIA (2022), with a projected GDP of $1,543 billion in 2020, Saudi Arabia holds the largest economy in the Middle East and North Africa region and ranks among the top 20 economies globally.

Figure 2. Map of Saudi Arabia showing bordering countries (Source: Author).

2.2. Data Collection and Analysis

Decision-making involving multiple criteria and diverse stakeholders is inherently complex (Ding et al. 2020). The differing perspectives of stakeholders often complicate consensus-building, making it crucial to identify solutions that accommodate the majority (Bekkers & Lazaj, 2024). This study aims to identify key constraints affecting cultural heritage site conservation and explore alternative solutions. Given that these constraints vary by location, they must be assessed on a case-by-case basis. To achieve this, a comprehensive literature review was conducted using multiple academic databases and scholarly platforms. Keywords such as historic buildings, urban areas, management, protection, and constraints were utilized to retrieve relevant studies. Common challenges in cultural heritage conservation include inadequate funding, lack of stakeholder interest, insufficient expertise, and weak legal frameworks (Sodangi & Kazmi, 2023). Prioritizing constraints is essential for effective heritage site management.

A structured expert-based approach was adopted, involving experts selected through purposive sampling. These experts were chosen based on their extensive experience and recognized contributions to the fields of heritage conservation, urban planning, architecture, and construction management in Saudi Arabia. The selection ensured representation from both academic and professional sectors. While an assessment of a well-versed expert can be sufficient in expert-based surveys (Saaty & Sagir, 2009), involving multiple experts minimizes bias and enhances reliability (Ishizaka & Labib, 2011). A number of related studies have employed relatively small expert panels, such as 8 experts in the study by Dahri and Abida (2017), 9 experts in those by Danumah et al. (2016) and Papaioannou et al. (2015), 10 experts in the research conducted by Abbas and Routray (2014) and Gigović et al. (2017), and 16 experts in the work of Dano (2020) and Ouma and Tateishi (2014). Therefore, in the present study, Table 1 below summarizes the profiles of the 8 participating experts, including their domain of expertise and years of experience.

Table 1. Expert Panel Profile.

Expert ID	Field of Expertise	Current Role	Years of Experience
E1	Architecture	University Professor	12
E2	Urban planning	Senior Urban Planner	18
E3	Heritage management	Museum Curator	15
E4	Construction management	Project Manager	14
E5	Heritage conservation law	Associate Professor	20
E6	Urban planning	Municipal Planner	10
E7	Architecture	Assistant Professor	11
E8	Cultural heritage	Government Official	17

The data collection instrument was a structured questionnaire developed in alignment with AHP methodology. The questionnaire consisted of pairwise comparison matrices where respondents evaluated the relative importance of seven constraints and five alternative solutions using a nine-point scale derived from Saaty's fundamental scale (Table 2), a method consistent with prior research (Aminu et al., 2014; Dano et al., 2019). Prior to distribution, the questionnaire was validated through a two-step process: (1) expert review by two senior faculty members with backgrounds in decision-making methodologies and (2) a pilot test involving three non-sample experts to assess clarity and usability. Feedback from these validation steps informed refinements in wording, structure, and the inclusion of explanatory notes to aid interpretation.

Table 2. Saaty's 9-Point Scale of Relative Importance (Lawal, 2025).

Intensity of Importance	Definition	Explanation
1	Equal Importance	Two elements contribute equally to the objective.
2	Weak or Slight	A preference is very slightly in favor of one over the other.
3	Moderate Importance	Judgment slightly favors one element over the other.
4	Moderate Plus	Intermediate value between 3 and 5.
5	Strong Importance	One element is strongly favored over the other.
6	Strong Plus	Intermediate value between 5 and 7.
7	Very Strong or Demonstrated Importance	An element is strongly dominant and its dominance is demonstrated in practice.
8	Very Strong Plus	Intermediate value between 7 and 9.
9	Extreme Importance	Evidence favoring one element over another is of the highest possible order
Reciprocals (e.g., 1/3)	If activity i is preferred over j, then j is 1/x of i	For example, if i is rated 5 times more important than j, then j is 1/5 of i.

The study's AHP model structured constraints and alternatives hierarchically. The primary constraints examined include rapid development and urbanization (RDU), lack of awareness and appreciation (LAA), insufficient funding and resources (IFR), inadequate legal framework (ILF), natural and environmental factors (NEF), lack of professional expertise (LPE), and rapid social change (RSC). The alternatives considered include raising public awareness (RPA), improving legislation and enforcement (ILE), allocating adequate resources (AAR), promoting research and education (PRE), and fostering partnerships (FP). The hierarchy was analyzed using a pairwise comparison matrix, and the completed questionnaires were processed to calculate constraint and alternative priorities. FAHP was employed to integrate AHP with fuzzy set theory, enhancing analytical precision. This study employs an Approximate Reasoning (AR) algorithm, a fuzzy logic-based approach that addresses imprecise or ambiguous feedback from decision-makers (Bailey, 2005). AR enhances human interaction with analytical models, effectively managing uncertainty stemming from diverse semantic interpretations, imprecision, and vagueness (Balogun et al., 2015).

FAHP was selected over conventional AHP because it provides a more realistic representation of expert judgments under uncertainty. Traditional AHP assumes decision-makers can make precise

judgments, which is rarely the case in complex, subjective domains like cultural heritage conservation. Through incorporating fuzzy set theory, FAHP accommodates linguistic assessments (e.g., 'moderately important' or 'extremely high'), allowing for a richer, more nuanced evaluation of criteria. This makes FAHP particularly well-suited for studies where expert opinions may vary or where decisions are based on qualitative perceptions. FAHP, an extension of the traditional AHP, integrates fuzzy logic with an analytical hierarchy process to handle complex decision-making under uncertainty (Bozbura et al., 2007). Through incorporating fuzzy logic, FAHP refines decision-making, addressing ambiguity and vagueness more effectively (Verma & Koul, 2012). It employs a fuzzy matrix to determine the priority levels of competing criteria and has been successfully applied in various domains (Balogun et al., 2015). In this study, FAHP is adapted to assess cultural heritage conservation challenges.

Following the procedures outlined by Torfi et al. (2010) and Balogun et al. (2017), the FAHP methodology converted the normalized AHP matrix into fuzzy numbers, represented using triangular fuzzy numbers (TFNs) due to their computational efficiency in uncertain environments. A TFN is defined as (a, b, c), where 'a' represents the lower bound, 'b' the median, and 'c' the upper bound. TFNs are crucial as they define the range of the membership function, allowing for effective representation of uncertainty. Their linear representation enables the membership function (μ) to be expressed as follows (Khan et al., 2019):

$$\mu\left(\frac{x}{M}\right) = \begin{cases} 0, & x < a \text{ or } x > c \\ \dfrac{x-a}{b-a} & a \le x \le c \\ \dfrac{c-x}{c-b} & b \le x \le c \end{cases} \quad (1)$$

The fuzzy transformation table (Table 3) presents triangular fuzzy numbers and their corresponding linguistic variables, which experts use to evaluate the significance of constraints and alternatives (Balogun et al., 2015). For example, "Extremely Low" corresponds to the TFN (0.00, 0.10, 0.25), representing the minimum, median, and maximum values. The fuzzy weights were derived using Equation (1) and then defuzzified into crisp values to determine final priority rankings (Kordi & Brandt, 2012). Defuzzification is the process of converting fuzzy numerical values, expressed as triangular fuzzy numbers into crisp scores that can be used for ranking and decision-making.

Table 3. Linguistic Terms and Corresponding Triangular Fuzzy Numbers (TFNs) (Balogun et al., 2015).

Linguistic Term	**Triangular Fuzzy Number (TFN)**
Extremely Low (EL)	(0.00, 0.10, 0.25)
Below Average (BA)	(0.15, 0.30, 0.45)
Average (A)	(0.35, 0.50, 0.65)
Above Average (AA)	(0.55, 0.70, 0.85)
Extremely High (EH)	(0.75, 0.90, 1.00)

Figure 3 illustrates the methodological framework, which offers a structured approach for prioritizing constraints and alternatives in Saudi Arabia's cultural heritage conservation efforts, providing valuable insights for policymakers and researchers.

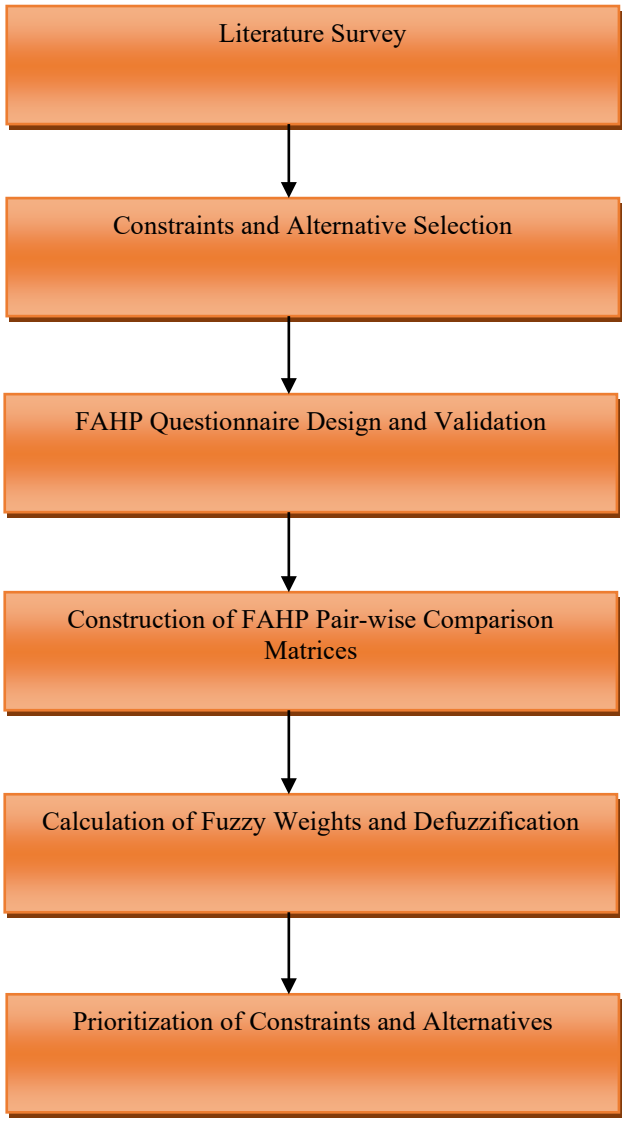

Figure 3. Conceptual and methodological framework for prioritizing constraints and evaluating solutions in cultural heritage conservation in Saudi Arabia using the FAHP approach.

2.3. Conceptual Framework for Sustainable Heritage Conservation Decision-Making

This study is anchored in a conceptual framework that combines principles of sustainable heritage conservation with participatory decision-making and multi-criteria evaluation. It acknowledges that effective heritage conservation requires not only the identification of physical and administrative constraints but also a structured approach to evaluating and prioritizing responses. The framework emphasizes the integration of cultural sustainability, expert engagement, and adaptive planning strategies. In this context, the FAHP is not only adopted as a methodological tool but also serves as a conceptual model that captures the complexity of heritage management decisions. FAHP supports the prioritization of constraints and the evaluation of solutions under uncertainty, reflecting the real-world ambiguity often encountered in heritage planning. Through linking expert judgment to systematic analysis, the framework bridges theoretical insights from heritage studies such as the need for inclusivity, resilience, and contextual sensitivity with practical tools for evidence-based decision-making. This conceptual orientation ensures that the study contributes meaningfully to the broader discourse on heritage conservation, offering both a robust analytical approach and a replicable model for use in similar contexts.

3. Results and Discussion

The results of the FAHP analysis of the seven constraints, based on expert inputs, are presented in Table 4. This analysis highlights the factors affecting the maintenance of urban heritage sites, evaluating

their relative significance. The findings offer insights into prioritizing efforts to address these challenges effectively. The most critical constraint identified is LAA, ranking first with a defuzzified weight of 0.270, contributing 27% to the overall significance. This suggests that public indifference and insufficient understanding of the value of urban heritage sites significantly hinder their maintenance. Addressing this constraint requires targeted awareness campaigns, community engagement, and educational initiatives to foster appreciation and support for preservation efforts. While previous research has often emphasized financial constraints as primary challenges, Sodangi & Kazmi (2023) identified "lack of clearly defined roles for multiple government agencies" as the most influential constraint in managing historic sites in remote areas of Saudi Arabia. The difference in findings is expected, as remote sites receive less attention compared to urban heritage sites.

The second-most significant constraint is ILF, with a defuzzified weight of 0.229, accounting for 23% of the total weight. Weak or poorly enforced legal regulations pose substantial barriers to effective maintenance. This finding aligns with prior research emphasizing the necessity of strong legal frameworks in heritage conservation. Yung & Chan (2012) discuss the critical role of comprehensive legal regulations in safeguarding heritage sites. Strengthening policies, enhancing enforcement mechanisms, and adopting comprehensive legal measures are essential for ensuring the long-term preservation of heritage sites. Ranking third, LPE contributes 20% to the overall significance, with a defuzzified weight of 0.204. This highlights the shortage of skilled professionals specializing in heritage conservation. Investments in capacity-building programs, technical training, and collaboration with international experts are essential to overcoming this limitation. Høllеland & Skrede (2019) also emphasize the importance of skilled professionals in heritage conservation.

RSC ranks fourth, with a defuzzified weight of 0.182 (18%). This reflects the impact of demographic shifts, cultural changes, and evolving societal norms on heritage site maintenance. Holtorf (2018) discusses how changes in heritage over time can inspire communities to embrace uncertainty and adapt, increasing cultural resilience. This finding suggests that developing adaptive strategies that acknowledge and incorporate social change is crucial for effective and inclusive conservation efforts. NEF rank fifth, contributing 5% to the overall significance, with a defuzzified weight of 0.047. Although less influential than other factors, environmental challenges such as climate change and natural deterioration still pose obstacles to heritage site maintenance This contrasts with Sodangi & Kazmi (2023), who identified environmental factors as among the most critical constraints to heritage conservation. Implementing mitigation measures, such as regular monitoring and the use of resilient materials, can help address these challenges effectively.

RDU ranks sixth, with a defuzzified weight of 0.044 (4%). While rated among the least significant constraints, other studies emphasize its critical impact on heritage conservation. Research on urbanization in Jordan found that urban expansion leads to moderate physical changes in heritage buildings, influenced by increased occupancy and rental revenue (Alnsour et al., 2023). Proper urban policies that account for the socioeconomic benefits of heritage buildings can mitigate these impacts. Similarly, the study by Udeaja et al. (2020) highlight that heritage sites in India are vanishing due to rising housing demands and socio-cultural changes. Despite local government initiatives, numerous historical edifices are being replaced by contemporary concrete structures. This underscores the necessity for sustainable urban planning that integrates heritage preservation.

Finally, IFR ranks as the least significant constraint, with a defuzzified weight of 0.024 (2%). This finding contrasts with Sodangi & Kazmi (2023), who identified financial limitations as a major challenge in managing historic sites in remote Saudi Arabia. While funding constraints remain important, the analysis suggests that addressing awareness, legal frameworks, and expertise gaps would have a greater overall impact on improving urban heritage site maintenance.

Table 4. Fuzzy geometric mean, weights, and rankings of the constraints to urban heritage site conservation.

Constraints	**Fuzzy geometric mean**	**Fuzzy weights**	**Defuzzified weights**	**%**	**Ranking**
RDU: Rapid development and urbanization	0.034, 0.044, 0.058	0.045	0.044	4	6
LAA: Lack of awareness and appreciation	0.210, 0.273, 0.351	0.278	0.270	27	1
IFR: Insufficient funding and resources	0.018, 0.023, 0.033	0.025	0.024	2	7
ILF: Inadequate legal	0.169, 0.231, 0.305	0.235	0.229	2	2

framework				3	
NEF: Natural and environmental factors	0.034, 0.047, 0.064	0.048	0.047	5	5
LPE: Lack of professional expertise	0.141, 0.200, 0.289	0.210	0.204	20	3
RSC: Rapid social change	0.139, 0.182, 0.240	0.187	0.182	18	4

Table 5 presents the ranking of alternative strategies for mitigating constraints in urban heritage site preservation, utilizing fuzzy geometric mean, weights, and defuzzified values. The highest-ranked solution is ILE, with a defuzzified weight of 0.377, underscoring the necessity of strong legal frameworks and strict enforcement for sustainable conservation. Udeaja et al. (2020) highlight how the absence of robust legislative measures in rapidly urbanizing cities, such as Surat, India, has led to unchecked development and the deterioration of heritage sites. The prominence of ILE aligns with global best practices that advocate for regulatory frameworks as a primary mechanism for heritage protection.

Ranked second (24.1%), RPA reinforces the notion that community engagement is integral to effective conservation. Naheed & Shooshtarian (2022) argue that public awareness plays a crucial role in promoting sustainable urban heritage practices, particularly in developing nations where cultural heritage is often undervalued. Success stories from cities like Amsterdam and Kyoto attribute their conservation achievements to extensive public engagement initiatives. However, RPA's ranking below ILE suggests that awareness campaigns alone may not suffice without legal backing.

FP ranks third (19.6%), highlighting the value of collaborative approaches involving government agencies, private investors, and NGOs. Hassan et al. (2022) emphasize that public-private partnerships enhance conservation outcomes by leveraging financial and technical resources. Examples from Spain and France demonstrate how such collaborations have led to the successful restoration of multiple heritage sites. These findings suggest that partnerships are most effective when integrated with legal and community-driven initiatives.

PRE is ranked fourth (15.2%), indicating a moderate but essential role in conservation efforts. highlight that research and educational programs address long-term heritage conservation challenges by fostering knowledge production and training skilled professionals. While research-driven strategies have been successful in countries such as Germany, the lower ranking of PRE in this study suggests that immediate conservation priorities focus on enforcement and awareness rather than academic inquiry. argue that urbanization's impact on heritage sites cannot be mitigated through funding alone; rather, resources must be strategically allocated within a broader framework that includes legislation, education, and partnerships. This finding diverges from studies that emphasize financial investment as a primary determinant of conservation success but supports the notion that funding must be efficiently managed and integrated with other strategies to achieve meaningful outcomes.

Table 5. Fuzzy geometric mean, weights, and rankings of the alternatives to urban heritage site conservation constraints.

Alternatives	**Fuzzy geometric mean**	**Fuzzy weights**	**Defuzzified weights**	**%**	**Ranking**
RPA: Raising public awareness	0.203, 0.233, 0.325	0.254	0.241	24.1	2
ILE: Improving legislation and enforcement	0.268, 0.361, 0.565	0.398	0.377	37.7	1
AAR: Allocating adequate resources	0.027, 0.033, 0.051	0.037	0.035	3.5	5
PRE: Promoting research and education	0.011, 0.186, 0.283	0.160	0.152	15.2	4
FP: Fostering partnerships	0.153, 0.186, 0.283	0.207	0.196	19.6	3

Figure 4 illustrates the sustainable FAHP-based decision-making framework developed in this study, which hierarchically organizes the most critical constraints and their corresponding strategic solutions for improving heritage site management in Saudi Arabia. The framework reflects the expert-driven prioritization process, highlighting four dominant constraints: LAA, ILF, LPE, and RSC. These were

identified as having the greatest impact on heritage conservation efforts. In response, the top-ranked strategic alternatives: ILE, RPA, and FP are positioned as key interventions. This structured representation not only visualizes the relationship between challenges and solutions but also offers a practical roadmap for policymakers and practitioners aiming to enhance heritage preservation outcomes.

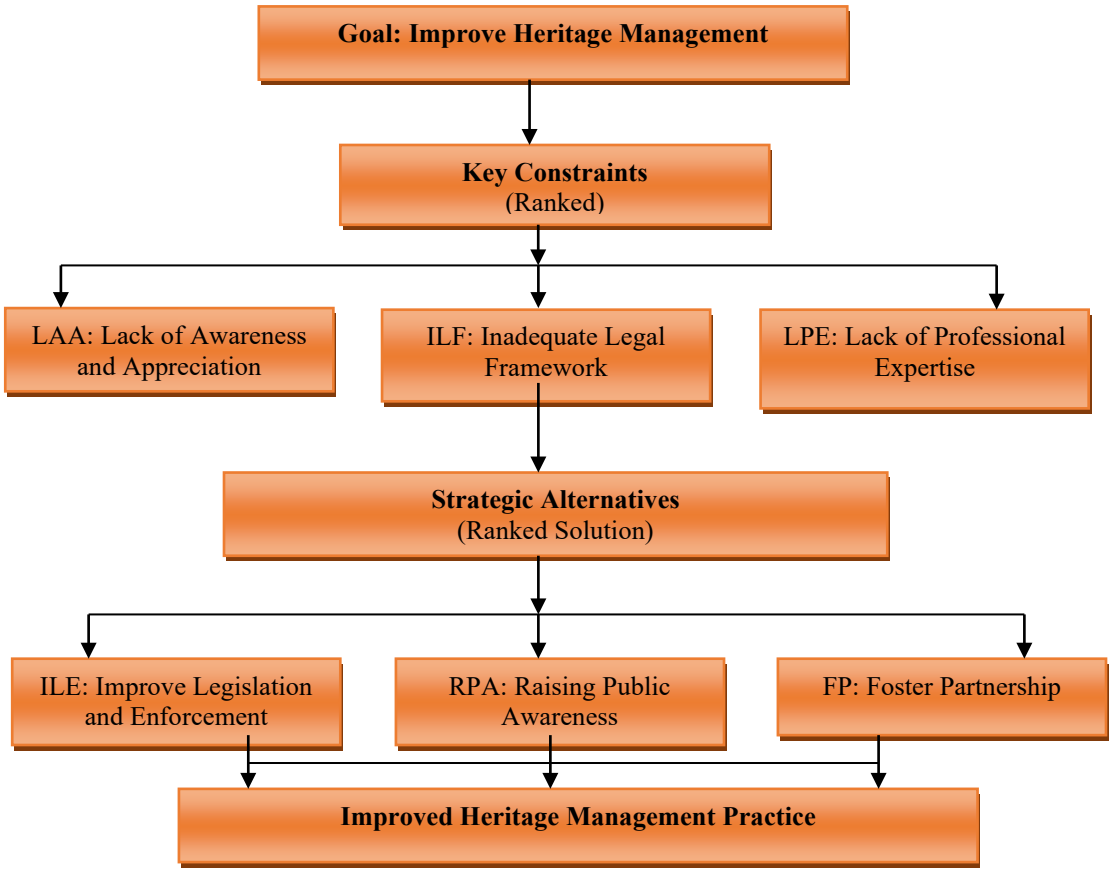

Figure 4. FAHP framework for sustainable heritage conservation decision-making.

4. Conclusion

With over ten thousand heritage sites and buildings listed in the National Antiquities Register, Saudi Arabia faces significant challenges in their management. While prior research has addressed these issues, it often lacks a comprehensive evaluation of both constraints and potential solutions. This study addresses that gap by systematically identifying, analyzing, and prioritizing the key challenges to heritage site management in Saudi Arabia and proposing strategic responses. Using an expert-driven survey and the Fuzzy Analytic Hierarchy Process (FAHP), the study assessed the interrelationships between constraints and solutions, establishing a structured hierarchy of priorities. The findings highlight lack of awareness and appreciation (LAA), inadequate legal frameworks (ILF), lack of professional expertise (LPE), and rapid social change (RSC) as the most pressing constraints. In response, improving legislation and enforcement (ILE), raising public awareness (RPA), and fostering partnerships (FP) emerged as the most effective strategies.

This study makes three core contributions. First, it applies FAHP to heritage conservation, accommodating expert uncertainty in a context-sensitive manner. Second, it offers a validated, replicable decision-support framework tailored to urban heritage management in Saudi Arabia. Third, it advances the strategic planning of heritage conservation through expert-informed prioritization of actionable solutions. From an implementation standpoint, the results can support decision-makers in designing targeted policies such as legal reforms, awareness programs, professional training, and collaborative initiatives. Urban planners, conservation bodies, and cultural agencies can use these findings to guide preservation efforts, improve governance, and engage communities more effectively. Despite its contributions, the study has limitations. It relies on expert judgments, which, while informed, may not capture all regional or stakeholder perspectives. Additionally, the FAHP method emphasizes relative importance rather than causal relationships. Future research could expand the expert pool, include

stakeholder interviews, or apply hybrid decision-making models to enhance the robustness and generalizability of the results. Therefore, this study lays a foundation for more effective heritage site management in Saudi Arabia. Through addressing key constraints and implementing strategic solutions, it supports not only preservation efforts but also the promotion of cultural tourism, contributing to economic development and broader public appreciation of the nation's historical assets.

Competing Interests
The author has no competing interests to declare.

Ethical Approval
This study received ethical approval from the Institutional Review Board at the Scientific Research and Innovation Center, Imam Abdulrahman Bin Faisal University, Dammam, Saudi Arabia, under NCBE registration number HAP-05-D-003. The approval confirms that the research complies with established ethical guidelines for studies involving human participants.

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