

# Revitalizing Historic Urban Centers: The Case of Lahore's Walled City

Ghammaz Husnain<sup>1</sup>

<https://doi.org/10.62345/jads.2024.13.2.94>

## Abstract

*Since the establishment of Walled cities, populations and built environments have outgrown their fortifications. Consequently, the Walled cities have become distinctly identifiable as historic centers within such cityscapes due to their unique urban form. These cities define local collective identities and provide meaning to memories associated with art and architecture. The exchange of such memories exuberates pride in communities and enables cross-cultural dialogue, which is vital for learning from the past and creating a better society. This research critically reviews the Master Conservation & Redevelopment Plan (MCRP) developed for the Walled city of Lahore, Pakistan. By examining the development strategies, policies, planning tools, and the political context of the MCRP, the study aims to provide a comprehensive understanding of the project's impact. The findings will highlight the successes and challenges of the MCRP, offering valuable lessons for future urban conservation and redevelopment projects. This research underscores the importance of preserving cultural heritage while promoting sustainable urban development, aiming to inform global policy and planning frameworks for historic urban centers. Ultimately, this study aspires to enhance community pride, identity, and cross-cultural dialogue, creating a more inclusive and culturally enriched urban environment.*

**Keywords:** Walled City of Lahore, Cultural Heritage, Sustainable Urban Development, Cross-Cultural Dialogue, MCRP, Urban Conservation.

## Introduction

Lahore, Pakistan's second most populated city, is in the Punjab province and is considered the country's economic and cultural hub. Lahore is called the “City of Gardens” because of its landscape and architecture heritage, as it was culturally quite significant for the Mughal Empire (1524 - 1752) and the British Empire (1849 - 1947) (Malik 2018). Even with a turbulent history spanning several centuries, this once-fortified city has retained its urban form and still reflects cultural diversity.

The Walled city prompted a concern for itself as Lahore had substantially outgrown the fortified walls. It is evident that compared to the contemporary architecture and urban fabric of Lahore, the Walled city became the historic center and required special status for its management and attention to its conservation. Today, Lahore is home to 12 million people (UNESCO 2006), and the Walled city is the urban core of it. It is essential to underscore that Lahore is considered a multi-centered city, and it is now among the world's most bustling megacities that offer immense commercial

---

<sup>1</sup>Assistant Professor, RHSA-Beaconhouse National University, Lahore, Pakistan.

Email: [ghammaz.husnain@bnu.edu.pk](mailto:ghammaz.husnain@bnu.edu.pk)



opportunities (Rana, 2018). Nevertheless, the Walled city remains the marker of Lahore's identity and culture.

The Walled city of Lahore is significant for the historic landscape shared by both Pakistan and India. The composition of Walled city is an arrangement of *Bazaars* (Markets), *Mahalle* (Neighborhoods), *Chowks* (Squares), religious buildings, cultural centers, and several historical monuments. The most significant monuments are the *Badshahi* mosque, *Wazir Khan* mosque, and the Lahore fort, which is a World Heritage Site, along with around 2,000 other buildings (Ali, 2020) within the walled city that display an array of architectural features from different periods. Nonetheless, the most significant aspect of the Walled city is the fortification, marking it as an urban center, a city within a city.

This peculiar arrangement is a common feature of such historic cities and can be understood as 'regular irregularity' (Bonfantini, 2012). Hence, the approach to such urban districts requires a strategic and institutional framework for its preservation and management with an overarching vision to preserve the identity and character, improve the life of inhabitants, and cherish the cultural asset (Caccarelli, 2017).

## Literature Review

The following research consulted a broad range of material on urban conservation, redevelopment planning, and the historical significance of walled cities. Critical sources include scholarly articles, policy reports, and case studies that explore the complexities of preserving cultural heritage within rapidly urbanizing contexts, especially in mega-cities such as Lahore. Significant contributions from the Aga Khan Development Network (AKDN) and Aga Khan Cultural Service Project (AKCSP) report emphasized integrating cultural heritage with sustainable development. Previous studies on the Walled City of Lahore and other similar historic urban centers globally provide valuable insights into the challenges and successes of conservation efforts. Theoretical frameworks on inclusive and sustainable development and cultural identity are examined to understand their relevance to the MCRP.

Coupled with anecdotal evidence collected through site visits and interviews, this comprehensive literature review formed the foundation for critically analyzing the MCRP, offering an informed backdrop for understanding its implementation and impact.

## Methodology/ Approach

The research follows a qualitative design to provide a holistic understanding of the MCRP for the Walled city of Lahore. It includes conducting detailed site visits to observe the physical condition of historic buildings, infrastructure, and public spaces within the Walled city. During these visits, extensive field notes and photographic documentation were taken to record the changes and improvements brought about by the MCRP.

Additionally, semi-structured interviews were conducted with residents, business owners, and community leaders to gather their insights and experiences. These conversations provided valuable firsthand accounts of the socio-cultural and economic impact of the redevelopment efforts. By focusing on the voices of the local community, this study aims to highlight the successes and challenges of the MCRP, offering a comprehensive understanding of its implications for future urban conservation and redevelopment projects.

## Findings and Implications

The research reveals that the MCRP has significantly impacted the Walled city of Lahore, revitalized its cultural heritage, and improved urban infrastructure. Residents reported enhanced community pride and a strengthened sense of identity due to the preservation of historic architecture and cultural essence.

However, challenges such as the area's touristification, inadequate stakeholder engagement, and socio-economic disparities were also identified. This study highlights the importance of inclusive planning and community involvement in urban redevelopment projects. The findings provide valuable insights for policymakers and urban planners, contributing to developing more effective and sustainable conservation strategies for historic urban centers in Pakistan and globally.

## The Institutional Background

Since the late 1980s, The Aga Khan Trust for Culture (AKTC) has been actively involved in Heritage and Monument conservation in Pakistan. AKTC initiated the service from the Northern side of Pakistan, particularly from 'Hunza Valley' in the 'Gilgit-Baltistan' district, and gained prominence in the cultural landscape of the entire region (Akbar, 2022). The global recognition of the artistic contributions made by AKTC prompted the government of Pakistan in 2005 to request the Aga Khan Historic Cities Programme (HCP) to provide financial and technical assistance to initiate heritage conservation in the walled city of Lahore.

Following the Pakistan government's request in 2007, the HCP has been concerned with conserving urban heritage and monuments in Lahore. The contributions made by HCP to the conservational and developmental landscape of Lahore have been immense. From individual monuments to integrating multiple monuments by rehabilitating the infrastructure in between, HCP has demonstrated sophistication in terms of its creative approach to all aspects of this endeavor (Mumtaz, 2017).

Pakistan's conservation approach was following the British Victorian-era legislation pre-dating 1947 (Akbar, 2020); it was imperative to introduce a new system that provides autonomy and maintains a critical status for such historical sites as it is evident that Pakistan's principal laws on such subjects had failed to produce sustainable solutions in the past. Hence, before the Master Conservation and Redevelopment Plan (MCRP) was tabled, some institutional tweaking was necessary as a foundation.

By the last decades of the twentieth century, an understanding of the walled city of Lahore began to emerge as the character of the historic and urban center. In 1978, however, an initiative was taken to provide special status to the walled city of Lahore (Gazette, 2020), with the help of World Bank's infrastructure-oriented schemes between 1975-90, and as a result, the first conservation plan was drafted in 1988 (Donald, 1994). Nonetheless, these plans could only be executed with the financial support of the World Bank, as the residents could not afford to contribute financially because of their limited resources.

However, a more comprehensive plan was drafted in 2006, co-financed by the World Bank and the government of Punjab, focused on urban rehabilitation, monument conservation, and utility infrastructure improvement. To regulate the physical confines of the walled city, a new legislation was also enacted in 2010 by the government of Punjab, making an earlier ordinance obsolete. This legislation is known as the Walled City Act (WCL Act) (Government of Punjab, 2012). The act is Pakistan's first urban heritage and municipal governance legislation, which established the Walled City Lahore Authority (WCLA). The Act provided WCLA planning and execution autonomy while defining a holistic framework to be prepared for the walled city.

The act trusted the Walled city authority with various responsibilities to be carried out. As a result, the authority produced a comprehensive plan in collaboration with the Aga Khan Cultural Service Project, known as the Master Conservation & Redevelopment Plan (MCRP).

### **Components of MCRP**

The features outlined by the Master Conservation & Redevelopment Plan are as follows (Aga Khan Development Network, 2019):

1. Land-Use and Zoning Plan.
2. Heritage Conservation Plan for the Walled City.
3. Plan for improvement, development, and maintenance of municipal services.
4. Plan for improvement, development, and maintenance of public areas and passages.
5. Plan for the development and improvement of enterprise and economic activity.

### **Governance and Implementation Framework**

The governance framework for MCRP follows a collaborative approach to conserve the Walled City of Lahore. One of the distinct elements of this framework is the formation of a Heritage Conservation Board, which comprises professional experts in architecture, urban planning, cultural heritage, and related disciplines. This board is responsible for assisting, advising, and authorizing decisions related to conservation procedures and policies. To ensure that all plans and field action align with global best practices.

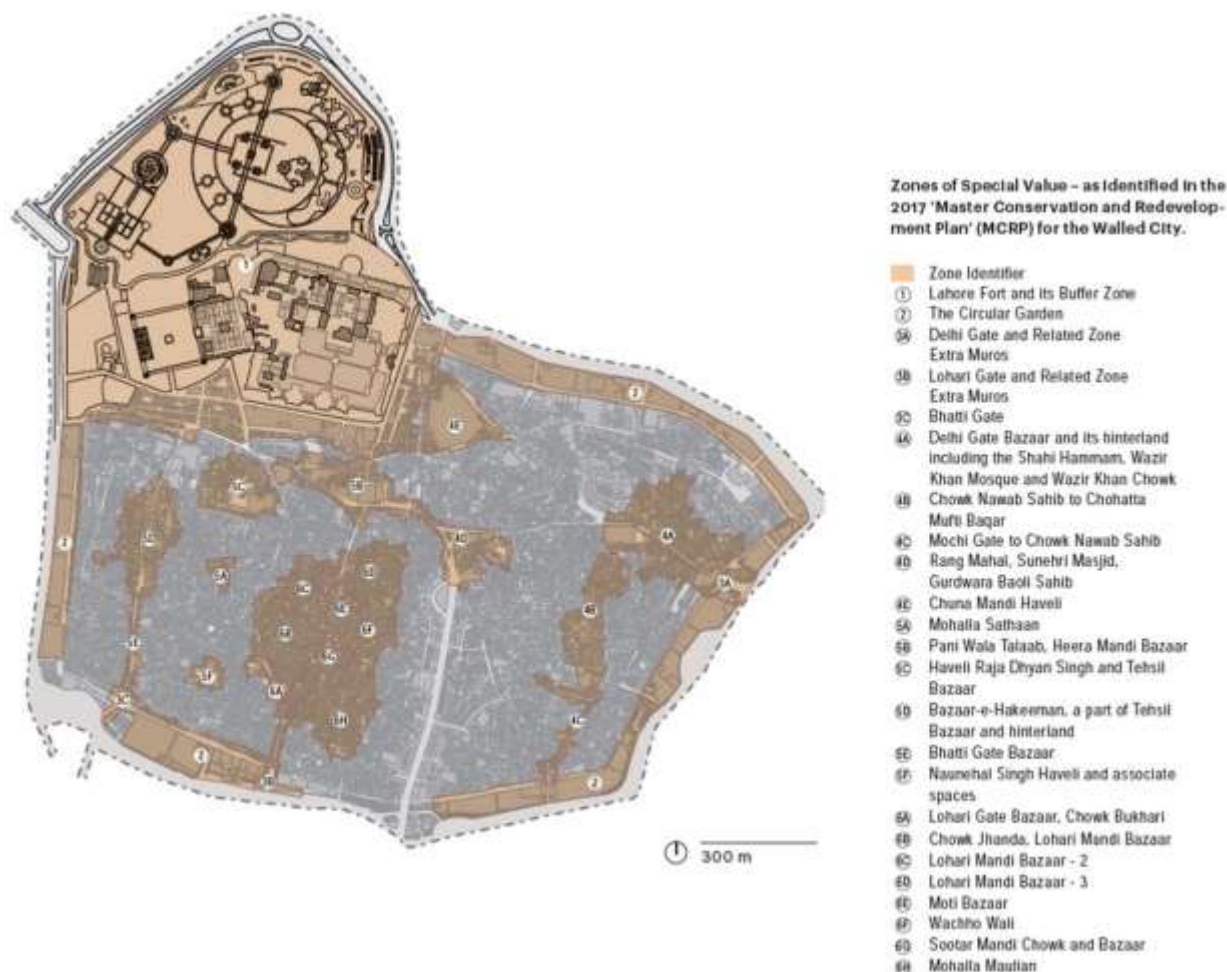
Knowledge is the foundation of sound planning (Miltin, 2019). A citizen's community and trade and business councils were established to gain authentic knowledge and insights to enable inclusive decision-making. These councils provide consultative representation, allowing residents, business owners, and other stakeholders to be heard and considered in the planning and implementation. This approach not only democratizes the conservation efforts but also ensures that the local community actively participates in shaping the future of their locality.

Comprehensive documentation and listings of heritage sites and zones of particular value within the Walled city were meticulously compiled. This documentation is the most basic yet critical tool for identifying and preserving historical and cultural significance, transforming the basis for surgically targeted conservation efforts.

---

**Figure 1: Special Value Zones in MCRP**


---



Source: [www.the.akdn/en.com](http://www.the.akdn/en.com)

The Walled City Lahore Authority (WCLA) played quite an important role in executing the MCRP. The WCLA was authorized and responsible for the preparation and implementation of quite a range of projects that aimed at holistic development of the Walled City. These projects include but are not limited to, tourism development initiatives to attract visitors and showcase the city's long heritage, infrastructure upgradation to improve living conditions, and the promotion of cultural activities or festivals to celebrate and preserve local traditions (Riaz, 2022).

Furthermore, the WCLA is committed to promoting the not only the built tangible heritage but also the intangible heritage within the Walled city. This includes efforts to restore and maintain historic buildings, promote contemporary artistic expressions, and integrate cultural heritage into the urban landscape. To address practical urban challenges, the WCLA also focuses on improving traffic flow, ensuring smooth transportation networks that respect the historic fabric of the city, and enhancing the health and education sectors for local residents.

This comprehensive governance and implementation framework ensured that the conservation and redevelopment of the Walled City of Lahore are carried out in a balanced, inclusive, and sustainable manner, that preserves its historical essence while fostering growth.



## Strategies and Policies

To develop a policy framework, the MCRP plan proposes strategic goals and steps corresponding to the intentions. The overarching idea was to take the Walled city as a historic asset with all the features it entails and embodies. As the Walled city has a distinct identity and an attachment with the people of Lahore, that cultural identity and historic character is to be preserved and cherished. The external and threats the Walled city confronts must be mitigated and negative developments in the vicinity is to be contained, such as encroachments and informal settlements (Haroon, 2019). Historic monuments are to be revitalized and sensitive historic heritage must be protected in a sustainable manner through strong regulatory frameworks that ensure quality craftsmanship, precise documentation and future usage guidelines. One of the flagship projects undertaken by the WCLA was of Wazir Khan Mosque (Agha, 2020). That stands as a testament to authenticity and commitment to quality restoration. Another component was of haphazard mobility conditions around the area. In order to proceed, it was imperative to alleviate traffic pressure and discipline the roads. Lastly, suitable socio-economic conditions are to be fostered for the promotion of tourism to move towards a better economic landscape.

**Figure 2: Documentation of existing land-use**



Source: [www.the.akdn/en.com](http://www.the.akdn/en.com)

The priority however was to document and produce listings of built areas and concerning actors in order to present accurate correlations, among buildings as well as the stakeholders for the initiation of pilot projects. Another pressing concern was to present the Walled city to the outside city as well-preserved historic center and to that end, the issues related to access and visibility of the fortification were to be thoroughly addressed. Hence policies were developed that were focused on improving the visibility, flow of traffic, management of the circular road at the periphery with the aim of converting the borders of Walled city into pedestrian areas by revocation of commercial and parking encroachment. Dedicated parking spaces and corners of commercial activity along

with municipal taxation and licensing fees (Ahmed, 2019) would be imposed on all the economic enterprises within the ambit of Walled city.

### **Strategy for Conservation**

Heritage conservation was subjected towards the entire of Walled city and it approached in a holistic treatment with reference to the individual components that make up the whole. Ranging from individual buildings, monuments to townscapes, historic landscapes and the surrounding areas as well. The development and design of new buildings would have to adhere to the building by-laws that are in accord to the cultural and historic values shared by the rest of the Walled city. For the historic residential buildings, financial participation of the owner was acquired, and such buildings either were, or will be rehabilitated, its utilities modernized and proactively conserved. For social uplifting, communities would be involved in the decision-making process by consultation teams and developmental priorities will be set accordingly agreed up by the concerning community. Special value zones were identified to coordinate overlapping planning and implementation procedures were paid adequate attention and distribution of resources.

The Heritage Conservation Board created under the act played an eminent and active role. Protection of public interest and supervision of intervention in high value zones was the primary concern for the board. It is important to highlight that the WCLA has been established not only ensure the ongoing projects, but to also keep track of maintenance and other activities that ensued after conservation. The impression is quite clear that the role of WCLA will surely be one that remains active in the coming days.

### **Strategy for Improving the Quality of Life**

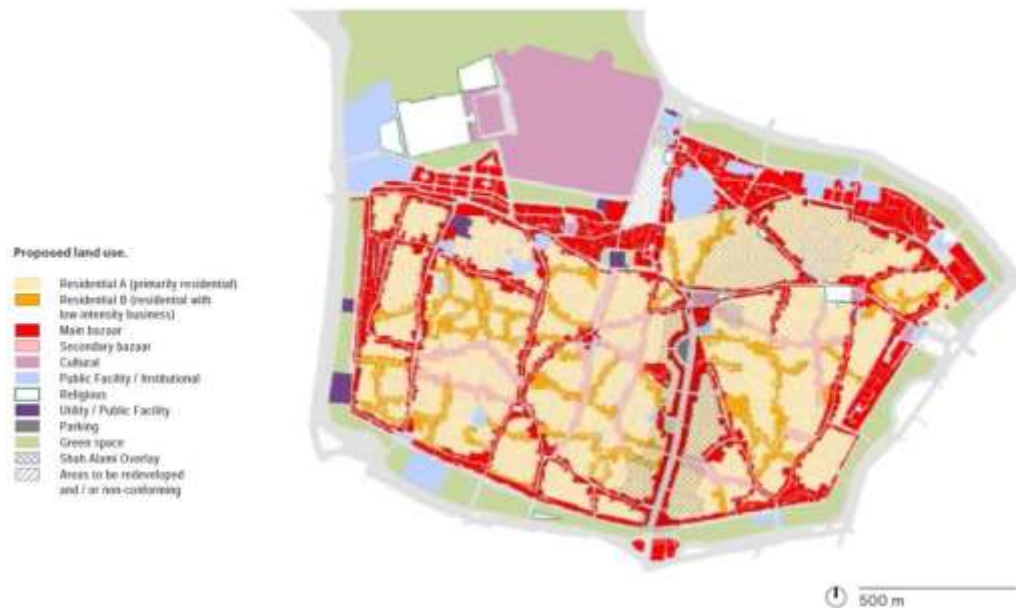
For the improvement of social landscape, special attention is being paid in the areas of education, culture, community health, parks & recreation and other related aspects that are essential for a livable city. A more balanced aggregate of income resident groups is the larger objective here. To that end, initiatives are taken of early childhood development, assistance to small local schools being operated by residents with a particular focus on primary and secondary education (Ali, 2019). Public schools have been improved, and technical training institutions have been established for the unemployed to partake in the local economy. Technical skills would also be imparted with the conservation and restoration projects through participatory processes.

Cultural institutions, forums and festivals were revived and each year, these events continue to display with more rigor and at local heritage venues, so that a vibrant heritage can be revived (Amjad, 2017). Events such as 'History by Night' (Walled City of Lahore, 2024) take place at the Lahore Fort almost every weekend, showcasing a range of eateries from the 12 gates of Lahore and dance performances that are accompanied by traditional music. It is also important to praise specifically these restoration efforts as it has had a significant impact on the local markets, may it be of food, spices and so on. In addition, access to green and open spaces for women is to be ensured and home-based working women will be facilitated to partake in opportunities presented to the new market.

---

**Figure 3: Proposed land-use plan of the walled city**


---



Source: [www.the.akdn/en.com](http://www.the.akdn/en.com)

### Land-use and Municipal Services Plan

The primary objective of introducing a land-use plan for the Walled city of Lahore is to protect its heritage, tangible and intangible. These historical assets have been under threat for decades due to unregulated land use, resulting in significant damage. The land-use plan is crucial as it documents what exists and aims to mitigate the threats and reverse some of the long-term damage. Although developed traditionally, the plan projects land-use aspirations for the next ten years. It provides realistic yet ambitious timelines, monetary compensation for relocation, and relocation facilities to readjust certain buildings, ensuring a smooth transition.

The plan incorporates patterns and divisions through detailed schedules, by-laws, and documentation of each building and land parcel. The schedules, by and large, include prohibited land use and prohibited building types, non-residential use permissible in the residential zone, non-residential use permissible in markets, and vice versa. In addition, land use in commercial zones, land use in the proximity of heritage sites, and land use in the vicinity of monuments. All the features above combined create a holistic and robust mechanism to reverse and pave a sustainable way forward for the generations of the local community.

On the other hand, the municipal services plan aligns with the necessities of any neighborhood, addressing the unique challenges faced by the Walled City of Lahore, where essential utilities were often missing or unattended. One of the MCRP's objectives is to rehabilitate and redevelop infrastructure that has long been neglected and often at the cost of public health. Some essential features of this plan include the supply of clean drinking water, proper disposal and drainage of wastewater, absorption and drainage of stormwater, seamless electricity supply to high and medium voltage networks, installation of streetlights in residential, commercial, and public spaces, provision of gas connections for household utilities, and installation of the robust electronic communication network.

These initiatives aim to restore essential services, improve living conditions, and ensure the sustainable development of the Walled city, preserving its historical and cultural significance while



meeting modern needs. Such measures are necessary for any business to thrive and for any area to attract investment and maintain retention. If one points out future generations' needs, learning from the environment is as essential as learning from a school. It is evident through interviews and site visits that the area has significantly improved. Still, these efforts may bear better fruits in the medium to long term.

## Conclusion

Following the implementing of the Master Conservation & Redevelopment Plan (MCRP) from 2012 onwards, the Walled City Lahore Authority (WCLA) has efficiently managed the process with commendable flexibility, merging public and private sector partnerships. This collaborative approach has generated increasing awareness of the Walled City as a historic center, leading to economic uplift and preservation of the area. The MCRP's impact extends beyond the physical space to encompass broader societal issues such as education, inequality, and health, illustrating that territorial solutions must address more than just the physical arrangement of space.

The connection between the Walled city and the rest of Lahore has been unprecedented, with a significant increase in the footprint of both locals and tourists. The attachment to the city's history is essentially the attachment to oneself and one's meaning to life or the values one holds (Zahid, 2021). The identity of the Walled city has transformed from an unpleasant, densely crowded, chaotic area with precarious buildings to a well-managed system thriving on collaboration and historical education. Culturally, the Walled city has always been a hub for quality craftsmanship in construction, food, music, and arts, influencing the rest of the city. The MCRP has provided a platform for these significant activities to continue and prosper, fostering a sense of historical significance that had been missing for decades due to a lack of maintenance and mass urbanization. The successful implementation of the MCRP highlights the importance of inclusive planning and community involvement in urban redevelopment projects. By actively engaging residents, business owners, community members, and leaders, the WCLA ensured that the voices of those most affected by the redevelopment were heard and catered for. This approach democratized the conservation efforts and strengthened community pride and identity. Preserving historic architecture and revitalizing cultural heritage have instilled a renewed sense of belonging among the residents.

Moreover, the MCRP has demonstrated that urban redevelopment projects can catalyze social and economic change. The enhanced infrastructure, improved public services, and promotion of cultural activities have created new opportunities for economic development and tourism. The plan's emphasis on sustainable development has also ensured that these benefits will be long-lasting, contributing to the overall resilience of the Walled city. However, the redevelopment process has been challenging. One significant risk is the touristification of the Walled city, where increased tourism could lead to the commodification of cultural heritage, potentially undermining the authenticity and integrity of the historic environment.

While tourism brings economic benefits, it is essential to manage it carefully to avoid adverse effects on the local community and the preservation of cultural assets. In addition, there are concerns about inadequate stakeholder engagement and socio-economic disparities, which need to be addressed to ensure that the benefits of redevelopment are equitably distributed. The transformation of the Walled City of Lahore serves as a model for other historic urban centers facing similar challenges. It highlights the need for a holistic approach to urban conservation that balances the preservation of cultural heritage with the demands of modern urban living. By

integrating historical conservation with sustainable development practices, cities can protect their unique identities while fostering innovation and growth outside the historic walls.

Regardless of geographical location, Walled cities have a deep association with their surroundings and inhabitants. These historic assets help people orient their identities, define their beliefs, and foster communal values. The Walled City of Lahore illustrates that preservation is not just about maintaining physical space but also about protecting intangible traditions that subsequently shape individuals, communities, and nations. The success of the MCRP demonstrates the importance of comprehensive urban conservation strategies that integrate cultural heritage with sustainable development, providing valuable lessons for policymakers, urban planners, and conservationists worldwide. As cities evolve, the lessons learned from the Walled City of Lahore will remain crucial in guiding future efforts to balance development with preserving our shared cultural heritage. Addressing the potential risks and ensuring sustainable and inclusive growth will be critical to maintaining the delicate balance between development and conservation, ensuring that the Walled city remains a vibrant, living heritage for generations. Despite criticism, there is no doubt that the philanthropic efforts of the Aga Khan Development Network and the warm spirit of WCLA are, at the very least, stories of triumph.

## References

- Aga Khan Development Network. (2019). In Lahore: A Framework for Urban Conservation. In *Integrated Planning and Monument Conservation (2013-17)*, by Philip Jodidio, 150-209. Munich: Prestel.
- Agha, S. B., & Khubaib, M. (2020). The three Mosques of Pakistan as an Islamic Heritage Architecture. *Al-Azhaar Research Journal* 86-94. <https://www.al-azhaar.org/index.php/alazhar/article/view/32>
- Ahmed, V. (2019). Lahore Walled City Upgrading Project." In *Reaching the Urban Poor*, 16-28. Oxfordshire: Taylor & Francis.
- Akbar, S. M., Iqbal, N., & Cleempoel, K. V. (2020). Re-reading the heritage legislations of Pakistan. *7th International Conference on Heritage and Sustainable Development*. Lisbon: Green Lines Bookseries on Heritage Studies. 3-10.
- Akbar, S. M., Plevoets, B., & Iqbal, N. (2022). Preserving the Tangible and Intangible Values of the Baltit Fort in Gilgit-Baltistan Pakistan, through Adaptive Reuse. *Space International Journal of Conference Proceedings*. London: SPACE intl. Journal. 1-9.
- Ali, S., & Khawaja, M. Z. (2019). Barriers to girl education in Walled city, Lahore. In *Inclusiveness Because We Can*, by Milton A. George, Yasmin Hikmat Hannouna Sergio Saleem Scatolini, 107-123. Oman: Euro-Khaleeji Research and Publishing House.
- Amjad, P. (2017). *Old-city Lahore: Popular Culture, Arts and Crafts*. Independent Research, Lahore: Department of Urdu, University of Punjab, 21-33.
- Bonfantini, G. B. (2012). Planning the historic centers in Italy: for a critical outline. *The journal of Urbanism* 02-19.
- Caccarelli, P. (2017). Considerations about Heritage Conservation in a Fast Changing World. *Journal of Built Heritage* 1-12. <https://doi.org/10.1186/BF03545671>
- Donald, H. (1994). *Case study : Lahore, Pakistan : conservation of the walled city*. Washington, D.C. : South Asia Infrastructure Sector Unit, World Bank.
- Hankey, D. (1994). *Case study : Lahore, Pakistan : conservation of the walled city*. Washington, D.C. : South Asia Infrastructure Sector Unit, World Bank, 1994.

- Harmain., R. (2022). *Regenerating cultural quarters in Pakistan: The case study of Lahore*. MSc. Thesis, Istanbul: Middle East Technical University.
- Haroon, F. Nawaz, M. S., Khilat, F., & Arshad, H. S. M. (2019). Urban heritage of the walled city of Lahore: Critical analysis and the way forward for policy. *Journal of Architectural and Planning Research* 289-302. <https://www.jstor.org/stable/27098713>
- Gazette, The Punjab. (2020). *Notification: The Walled City of Lahore*. Government Notification, Lahore: Government of the Punjab.
- Government of Punjab. (2012). *The Walled City of Lahore Authority Act 2012*. Lahore: walledcitylahore.gop.pk.
- Malik, A. M., Rashid, M., Shah, M. W., & Iftikhar, A. (2020). Bridging the gap, Walled cities: Peshawar and Lahore. *Journal of Asian Civilizations* 137-157. <https://jac.qau.edu.pk/index.php/jac/article/view/28>
- Mehmood, M. A. (2018). A Study of Disintegration of Lahore from a City of Gardens to a City of Congestion. *Journal of Art, Architecture and Built Environment*. <https://doi.org/10.32350/jaabe.12.02>
- Miltin, M., Bennett, J., Horn, P., King, S., Makau, J., & Nyama, G. M. (2019). Knowledge Matters: The Potential Contribution of the Co-production of Research to Urban Transformation. *Social Science Research Network* 1-37. <https://doi.org/10.1057/s41287-020-00277-w>
- Nigar, M. S. (2017). Community based urban area: Conservation lessons from Pakistan. *Journal of Research in Architecture & Planning* 26-33.
- Rana, I. A., & Bhatti, S. S. (2018). Lahore, Pakistan – Urbanization challenges and opportunities. *Cities - Elsevier* 348-355.
- UNESCO. (2006). *Lahore Fort Master Plan, 2006-2011*. Documentation, Islamabad: unesdoc.unesco.org.
- United Nations. (2017). *Lahore / Population*. data.un.org.
- Walled City of Lahore. (2024). *History by Night*. Lahore, July.
- Zahid, A., & Misirlisoy, D. (2021). Measuring place attachment, identity, and memory in urban spaces: case of the walled city of Lahore, Pakistan. *Journal of Architecture and Urbanism* 171-182. <https://doi.org/10.3846/jau.2021.15183>