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Hassiba Ben Bouali University of Chlef
كلية الهندسة المدنية والمعمارية
Faculty of Civil Engineering and Architecture
قسم الهندسة المعمارية
Department of Architecture

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Toward a Smart City: The Use of New Technologies for the Enhancement of Urban Heritage

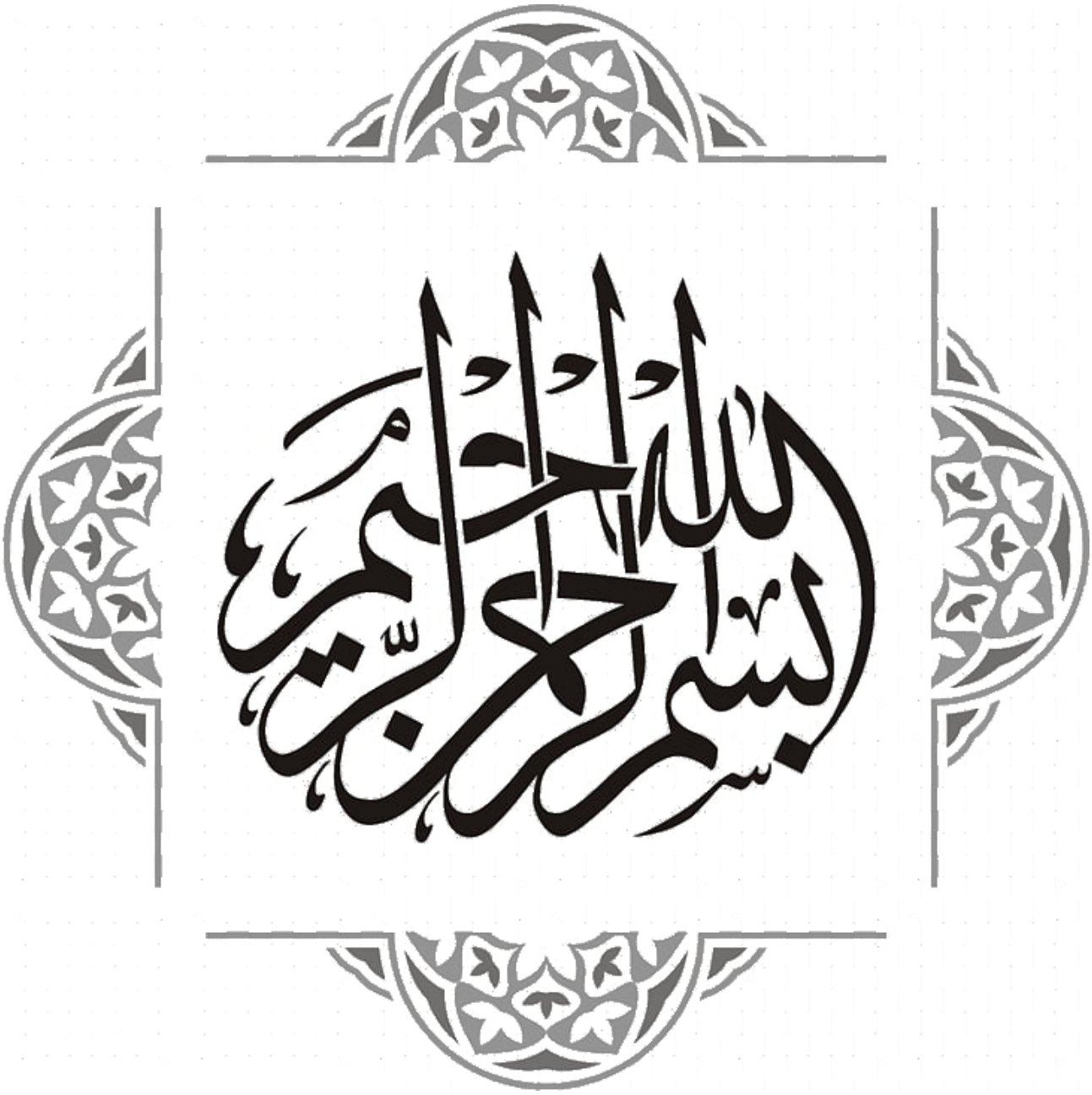
-Case Study of the City of Mostaganem: "ElArsa"-

Presented by:
Messabis Meriem
Hacene Selma
Defended publicly on:01 /07/2024

Infront of the committee composed of:

Nameand Surname	Level	Hassiba Ben Bouali University of Chlef	Position
Pr.MAKHLOUF ALI		Hassiba Ben Bouali University of Chlef	**President**
Dr. KARI NABIL		Hassiba Ben Bouali University of Chlef	**Supervisor**
Dr. BENDJMA IQBAL		Hassiba Ben Bouali University of Chlef	**Examiner**

AcademicYear:2023/2024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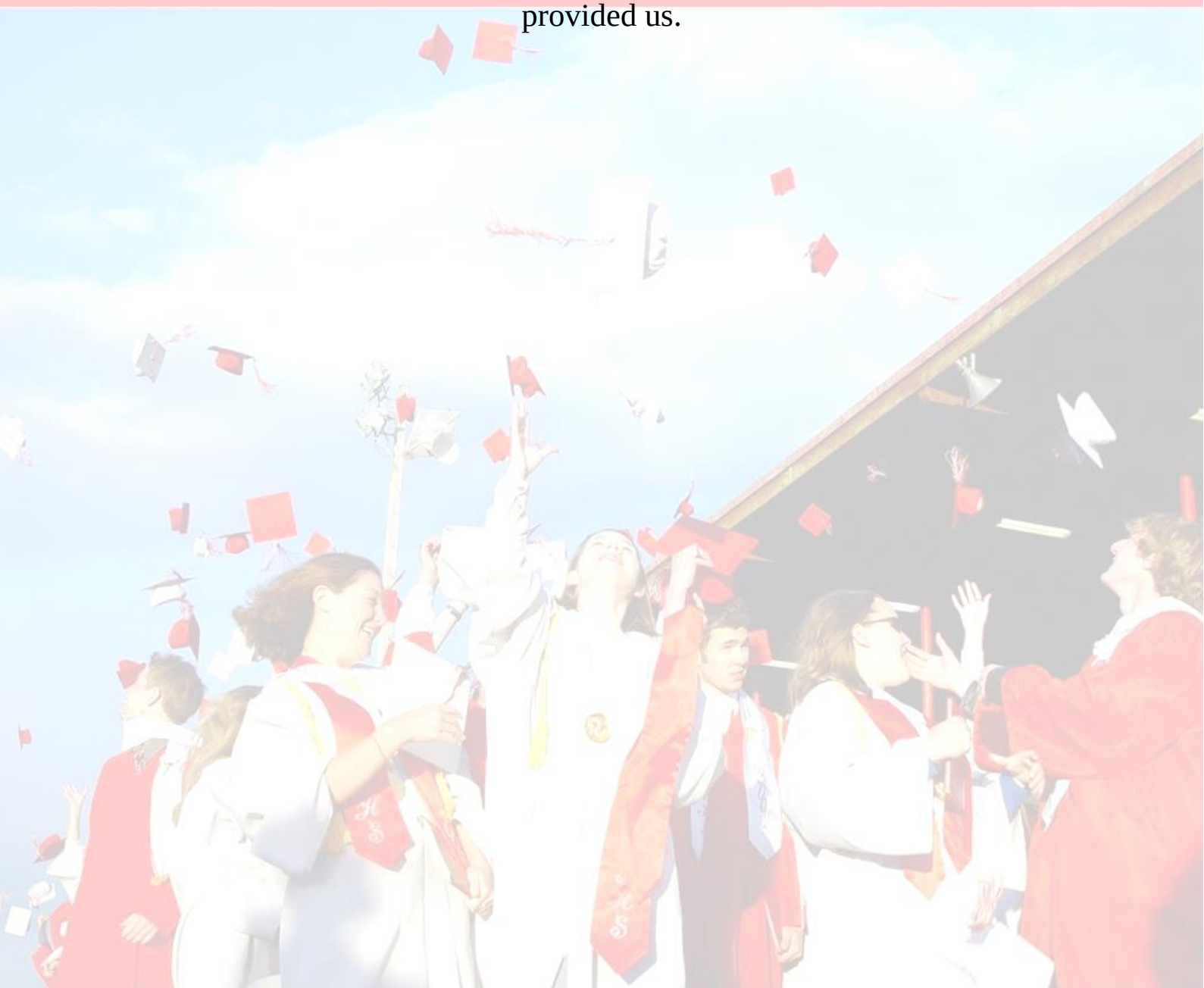

DEDICATION

This thesis is dedicated to my family, whose unwavering support and encouragement have been my source of strength throughout this journey.

To my late mother, whose memory continues to inspire me every day, thank you for instilling in me the values of education and perseverance. Your love and guidance remain with me always.

To my father and siblings (Amel , Hadjer and Sara) and my dear nephew “louai Nouh”, thank you for your constant inspiration, belief in my abilities, and for standing by me through every challenge.

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This work is a testament to your love, support, and faith in me.

Meriem

DEDICATION

This thesis is dedicated to my family, whose unwavering support and encouragement have been my strength throughout this journey. To my parents, who taught me the value of perseverance and education. To my siblings, whose belief in my abilities has inspired me to push beyond my limits. And to my friends, whose endless encouragement and understanding made the challenging moments easier to bear. This accomplishment would not have been possible without each of you by my side.

This work is a testament to your love, support, and faith in me.

Selma

Summary

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Abstract

Abstract

This study explores the potential of integrating new technologies to enhance the urban heritage of El Arsa, Mostaganem City, as a step towards building a smart city. It examines the current state of El Arsa's heritage, identifying challenges and opportunities for technological intervention. The research focuses on the application of technologies like augmented reality, virtual reality, and sensor networks to create immersive experiences, improve accessibility, and promote sustainable management of the city's historical assets. The thesis analyzes the potential impact of these technologies on tourism, cultural preservation, and urban development, considering both the benefits and challenges of their implementation. By exploring the intersection of technology and heritage, this research aims to contribute to the development of a smart city model that prioritizes the preservation and revitalization of its cultural identity.

The concept of smart cities integrates advanced technologies to enhance urban living, with a focus on sustainability, efficiency, and the preservation of cultural heritage. This study explores the implementation of smart city technologies in El Arsa, a historic district of Mostaganem City, aiming to balance modernization with the preservation of its rich urban heritage. By leveraging tools such as Geographic Information Systems (GIS), Internet of Things (IoT) sensors, and augmented reality (AR), the project aims to digitally document and monitor the conservation status of heritage sites, improve urban management, and enhance the tourist experience. The integration of these technologies facilitates real-time data collection and analysis, enabling informed decision-making and proactive maintenance of historical assets. Additionally, interactive AR applications provide educational and immersive experiences for visitors, fostering a deeper appreciation of the city's cultural legacy. The outcomes of this study highlight the potential of smart technologies to contribute to the sustainable development of urban heritage areas, ensuring their preservation for future generations while promoting economic growth and community engagement .

Key words : urban heritage , smart cities , urban development , GIS , Augmented reality.

Résumé

Cette étude explore le potentiel d'intégration des nouvelles technologies pour améliorer le patrimoine urbain de El Arsa, ville de Mostaganem, en tant qu'étape vers la construction d'une ville intelligente. Elle examine l'état actuel du patrimoine de El Arsa, identifiant les défis et les opportunités d'intervention technologique. La recherche se concentre sur l'application de technologies telles que la réalité augmentée, la réalité virtuelle et les réseaux de capteurs pour créer des expériences immersives, améliorer l'accessibilité et promouvoir une gestion durable des actifs historiques de la ville. La thèse analyse l'impact potentiel de ces technologies sur le tourisme, la préservation culturelle et le développement urbain, en tenant compte à la fois des avantages et des défis de leur mise en œuvre. En explorant l'intersection de la technologie et du patrimoine, cette recherche vise à contribuer au développement d'un modèle de ville intelligente qui privilégie la préservation et la revitalisation de son identité culturelle.

Le concept de villes intelligentes intègre des technologies avancées pour améliorer la vie urbaine, en mettant l'accent sur la durabilité, l'efficacité et la préservation du patrimoine culturel. Cette étude explore la mise en œuvre des technologies des villes intelligentes à El Arsa, un quartier historique de la ville de Mostaganem, visant à équilibrer la modernisation avec la préservation de son riche patrimoine urbain. En utilisant des outils tels que les systèmes d'information géographique (SIG), les capteurs Internet des objets (IoT) et la réalité augmentée (AR), le projet vise à documenter numériquement et surveiller l'état de conservation des sites patrimoniaux, à améliorer la gestion urbaine et à améliorer l'expérience touristique. L'intégration de ces technologies facilite la collecte et l'analyse des données en temps réel, permettant une prise de décision éclairée et une maintenance proactive des actifs historiques. De plus, les applications AR interactives offrent des expériences éducatives et immersives aux visiteurs, favorisant une meilleure appréciation de l'héritage culturel de la ville. Les résultats de cette étude mettent en lumière le potentiel des technologies intelligentes pour contribuer au développement durable des zones urbaines historiques, assurant leur préservation pour les générations futures tout en favorisant la croissance économique et l'engagement communautaire.

Mots clés : Le patrimoine urbain , Les villes intelligentes , Le développement urbain , SIG , La réalité augmentée .

ملخص

تستكشف هذه الرسالة إمكانية دمج التقنيات الجديدة لتعزيز التراث الحضري في العرصة، مدينة مستغانم، كخطوة نحو بناء مدينة ذكية. تفحص الرسالة الحالة الراهنة لتراث العرصة، محددة التحديات والفرص للتدخل التكنولوجي. يركز البحث على تطبيق التقنيات مثل الواقع المعزز، الواقع الافتراضي، وشبكات الاستشعار لخلق تجارب غامرة، تحسين الوصول، وتعزيز الإدارة المستدامة للموارد التاريخية للمدينة. تحلل الرسالة الأثر المحتمل لهذه التقنيات على السياحة، والحفاظ على الثقافة، والتنمية الحضرية، مع النظر في فوائد وتحديات تطبيقها. من خلال استكشاف تقاطع التكنولوجيا والتراث، تهدف هذه الرسالة إلى المساهمة في تطوير نموذج لمدينة ذكية يركز على الحفاظ على الهوية الثقافية وإحيائها.

يدمج مفهوم المدن الذكية التقنيات المتقدمة لتعزيز الحياة الحضرية، مع التركيز على الاستدامة، والكفاءة، والحفاظ على التراث الثقافي. تستكشف هذه الدراسة تنفيذ تقنيات المدينة الذكية في العرصة، منطقة تاريخية في مدينة مستغانم، بهدف تحقيق توازن بين التحديث والحفاظ على تراثها الحضري الغني. باستخدام أدوات مثل نظم المعلومات الجغرافية (GIS) ، وأجهزة الاستشعار من إنترنت الأشياء (IOT) ، والواقع المعزز (AR)، يهدف المشروع إلى توثيق حالة المحافظة على المواقع التراثية ومراقبتها بشكل رقمي، تحسين إدارة المدن، وتعزيز تجربة السياح. يسهل دمج هذه التقنيات جمع البيانات وتحليلها في الوقت الفعلي، مما يمكن من اتخاذ قرارات مستنيرة وصيانة استباقية للموارد التاريخية. بالإضافة إلى ذلك، توفر تطبيقات الواقع المعزز تجارب تعليمية وغامرة للزوار، مما يعزز من تقديرهم للتراث الثقافي للمدينة. تسلط نتائج هذه الدراسة الضوء على إمكانيات التقنيات الذكية في المساهمة في التنمية المستدامة لمناطق التراث الحضري، مما يضمن الحفاظ عليها للأجيال القادمة، وتعزيز النمو الاقتصادي والمشاركة المجتمعية.

الكلمات المفتاحية: التراث الحضري، المدن الذكية، تطوير حضري، GIS، الواقع المعزز .

General Introduction

General Introduction

Cities in the 21st century have succeeded in reaching advanced levels in realizing their aspirations to improve life and meet contemporary human and social requirements through two fundamental approaches. The first is the model of sustainable cities, which is based on the preservation of available resources and energy in the environment, with an environmental orientation. The second is the model of smart cities, which relies on the use of information and communication technology as a means to achieve its goals and as a tool to enhance the city.

A smart city can be defined as an innovative city that utilizes information and communication technologies and other means to improve the quality of life, efficiency of operations, urban services, and competitiveness while ensuring the fulfillment of the needs of present and future generations. This includes protecting and enhancing urban heritage for future generations to share with a wider audience (European Commission, 2014).

The interface between technology and urban heritage is not just a coexistence, but a synergistic relationship, with great potential in creating sustainable, livable and culturally rich urban environments. As cities evolve into smart ecosystems, the use of new technologies becomes crucial, not only to preserve the heritage of the past, but also to promote a harmonious coexistence between modernity and tradition. This emphasis on the human touch highlights the importance of ensuring that technology enhances, rather than diminishes, the human experience in urban spaces. As we grapple with the complex balance between progress and conservation, it is necessary to examine how these technological interventions can help preserve not only physical structures but also the cultural narratives embedded in a city's history.

This research aims to reveal the level of innovation and transformation taking place in our urban landscapes. By examining case studies, emerging trends and the collective impact of various technologies, we aim to chart a path towards creating smart cities that are not only efficient and technologically advanced, but also deeply rooted in an appreciation of urban heritage. In the process, we strive to imagine a future where cities seamlessly combine the wonders of modern technology with the timeless charm of historical and cultural heritage, ultimately fostering a more humane and rich urban life.

Problem statement

Like many cities around the world, Mostaganem is grappling with the challenges posed by rapid urbanization, demographic changes and sustainability needs. The delicate balance between modernization and the preservation of historic and cultural assets creates complex challenges for urban planners and policymakers. As Mostaganem embarks on this transformative journey, questions arise about how to harness the potential of new technologies to take the city into the future, while ensuring that its unique urban heritage is protected and appreciated.

The challenge lies in crafting a Smart City narrative that not only optimizes efficiency, connectivity, and resource management but also prioritizes the human experience within the urban environment. **How can Mostaganem use the latest technologies to enhance the accessibility, appreciation, and understanding of its historical and cultural legacy on its path towards becoming a smart city? and What are the specific challenges and opportunities faced by Mostaganem in the intelligent preservation and appreciation of its urban heritage?** These questions underscore the significance of aligning Smart City initiatives with a thoughtful approach to the humanization of urban spaces, ensuring that technological progress resonates with

the city's inhabitants and visitors on a deeply cultural and emotional level.

Through a careful examination of Mostaganem's unique context, this case study aims to unravel the complexities inherent in the pursuit of a Smart City that not only embraces technological innovation but also prioritizes the preservation and enrichment of its urban heritage. By doing so, we hope to offer insights that resonate beyond Mostaganem, serving as a guide for the other cities seeking to harmonize the integration of new technologies with the timeless essence of their historical and cultural identities.

Importance of the Research

There are various reasons why this research is important. With a focus on Mostaganem City specifically, it first fills a significant vacuum in the literature on the relationship between smart city technologies and urban heritage management. Second, the study's conclusions can provide best practices for incorporating new technologies into heritage enhancement projects to local policymakers, urban planners, and heritage specialists. Ultimately, the research adds to the larger conversation about sustainable urban development by emphasizing the significance of striking a balance between technological innovation and cultural preservation.

Research Objectives

- Assess the Current State of Mostaganem's Urban Heritage
- Evaluate the Readiness of Mostaganem for Smart City Initiatives
- Examine the Impact of Smart City Initiatives on Urban Heritage
- Exploring the perceptions and attitudes of the community towards the
- implementation of new technologies to enhance urban heritage.
- Studying the long-term environmental and sustainability aspects of implementing smart technologies in preserving urban heritage.

Research Hypothesis:

Hypothesis 01: The conscious incorporation of new technologies into Mostaganem urban development significantly improves accessibility, appreciation, and understanding of its historical and cultural heritage. This integration plays a crucial role in the successful development of Mostaganem as a smart city.

Hypothesis 02: Active community engagement in the adoption of smart city technologies for the preservation of urban heritage in Mostaganem results in a tangible increase in cultural awareness, heightened community participation, and a profound appreciation for the city's historical legacy. These realized efforts are crucial in Mostaganem's successful transition into a smart city.

Research Methodology

This study employs a mixed-methods approach, combining both qualitative and quantitative research methods to gain a comprehensive understanding of the subject matter.

- **Qualitative Approach**

- Interviews: Conducted with local authorities, heritage experts, and technology specialists to gather insights on the current state of urban heritage and the potential for smart city technologies.

- Focus Groups: Held with community members to discuss their perceptions and attitudes towards integrating new technologies in urban heritage preservation.

- **Quantitative Approach**

- Surveys: Administered to a sample of 250 residents of Mostaganem to quantify their opinions, preferences, and expectations regarding smart city initiatives and heritage preservation.

- **Data Collection Methods**

→ Survey Design

The survey included a mix of closed-ended and open-ended questions to capture both quantitative data and qualitative insights. Key areas covered in the survey were:

- Demographic information
- Awareness and importance of urban heritage
- Perceptions of current heritage preservation efforts
- Attitudes towards the use of new technologies in urban heritage
- Expectations and recommendations for future initiatives

→ Sampling

A stratified random sampling technique was used to ensure the sample was representative of the population. The sample of 250 residents was divided into subgroups based on age, gender, and geographic location within Mostaganem El Arsa.

→Data Collection Process

- Distribution: Surveys were distributed both online and in-person to reach a diverse audience.

- Duration: Data collection took place over a period of four weeks to ensure sufficient time for responses.

- **Ethical Considerations**

- Informed Consent: Participants were informed about the purpose of the study and their voluntary participation was secured through consent forms.

- Confidentiality: All personal information was kept confidential and used solely for research purposes.

- Bias Reduction: Efforts were made to minimize researcher bias through the use of standardized procedures and tools.

- **Limitations**

- Sample Size: While the sample size of 250 is substantial, it may not capture all the nuances of the larger population.

- Response Bias: There is a possibility of response bias, particularly in self-reported data.

- Technological Awareness: Varying levels of technological awareness among respondents might influence their perceptions and responses.

Structure of the Thesis:

The thesis contains five chapters organized as follows:

- Introduction - Introduces the background, problem statement, objectives, hypothesis, and methodology of the study.
- **Chapter 1:** Urban Heritage: A Major Asset for Smart Cities
- **Chapter 2:** Integration of Technologies in Urban Heritage Preservation.
- **Chapter 3:** The Challenges in Implementing Smart Technologies and the Opportunities for Integration
- **Chapter 4:** Is Our Study Area Ready for Transformation into a Smart City?.

- **Chapter 5:** Towards a Smart Neighborhood: A Journey Exploring Foreign Experiences and Practical Implementation through an Executive Project
- Finally, we conclude our research with brief discussion and future perspectives

Definitions of Key Terms

- **Smart City:** An urban area that utilizes digital technologies to enhance performance, well-being, and reduce costs and resource consumption.
- **Urban Heritage:** Historical, cultural, and architectural assets within urban environments preserved and managed for their cultural significance.
- **Information and Communication Technologies (ICT):** Technologies used for telecommunications, broadcast media, audio-visual processing and transmission, intelligent building management, and network-based control and monitoring.

Chapter I
Urban heritage: a major asset for smart cities

Chapter I : Urban heritage: a major asset for smart cities

Chapter Introduction

Urban heritage serves as a captivating tapestry woven from the threads of history, culture, and architectural marvels, preserving the essence of our past amidst the ever-changing urban landscape. In this introductory chapter, we embark on a journey to unravel the significance of urban heritage within the context of smart cities, where the fusion of tradition and innovation paves the way for sustainable urban development.

At the heart of our exploration lies a deep dive into the very concept of urban heritage, a term laden with layers of meaning and significance. From the cobblestone streets of ancient towns to the towering skyscrapers of modern metropolises, we dissect the various components that constitute urban heritage, emphasizing the urgent need to safeguard these invaluable assets for future generations. Through an exploration of its historical and cultural significance, we come to understand how urban heritage not only serves as a repository of memories but also as a catalyst for shaping a city's identity and fostering a profound sense of belonging among its inhabitants. As we navigate the complexities of modern urban development, we are confronted with the evolving role of urban heritage in shaping the cities of tomorrow. We delve into the shifting perspectives on urban heritage preservation, grappling with the challenges posed by rapid urbanization and the imperatives of progress. Through a nuanced examination of strategies for integrating urban heritage into urban planning and design, we uncover the transformative potential of adaptive reuse and sustainable practices in revitalizing historic neighborhoods and preserving architectural landmarks.

In the context of the burgeoning smart city movement, we explore the synergies between urban heritage preservation and the principles of smart urbanism. By understanding the conceptual framework and key components of smart cities, we elucidate how technology and innovation can be harnessed to not only preserve but also enhance urban heritage. Through case studies and best practices, we illuminate the ways in which the preservation of historical legacies can contribute to the sustainability and livability of smart cities, fostering a harmonious coexistence between tradition and progress in the urban landscapes of tomorrow**.**

1Introduction to urban heritage: preserving the past for the future

Urban heritage is an integral part of a city's identity and historical memory. It encompasses historical buildings, public spaces, and cultural landmarks that reflect the history and evolution of societies over time. With the rapid pace of urbanization and modernization, the challenge of preserving this heritage and ensuring its continuity for future generations becomes increasingly prominent.

1.1 Defining urban heritage: the concept of urban heritage and its various components

Urban heritage encompasses a diverse array of elements that collectively contribute to the cultural and historical fabric of a city. In this section, we delve into the concept of urban heritage, examining its multifaceted nature and identifying its various components. By elucidating the different dimensions of urban heritage, we aim to establish a comprehensive understanding of this vital aspect of urban life and development.

1.1.1 Concept of urban heritage

There have been diverse definitions addressing the concept of urban heritage, with one of the most notable being UNESCO's definition "Urban heritage refers to the collective cultural, historical, and architectural legacy embedded within the urban fabric of a city. It encompasses a diverse range of tangible and intangible elements, including historical buildings, cultural landscapes, public spaces, traditions, and social practices that contribute to the identity and character of an urban environment" .[1]

1.1.2 Various components of urban heritage

Urban heritage encompasses a wide range of components that collectively contribute to the cultural, historical, and architectural significance of a city or urban area. These components are essential in preserving the identity and character of a place, reflecting its history, traditions, and values. The components of urban heritage can be categorized into several key aspects:[2]

- **Historic Buildings and Structures:** Historic buildings and structures are fundamental components of urban heritage. These include landmarks, monuments, religious buildings, residential structures, industrial facilities, and other architectural elements that have historical or cultural significance. These structures often serve as tangible representations of a city's past and are integral to its visual identity.

Figure 1 urban heritage
source : unesco world heritage

- **Cultural Landscapes:** Cultural landscapes encompass the combined works of nature and humankind, including historic sites, designed landscapes, and vernacular architecture. These landscapes reflect the interactions between people and their environment over time and are important in understanding the cultural heritage of a place.
- **Archaeological Sites:** Archaeological sites play a crucial role in urban heritage by providing insights into the historical development of a city or urban area. These sites may contain artifacts, ruins, or remnants of ancient civilizations, offering valuable information about the past inhabitants and their way of life.
- **Heritage Districts and Neighborhoods**: Heritage districts and neighborhoods are characterized by their cohesive architectural styles, historical significance, and cultural value. These areas often feature preserved or restored buildings that contribute to the overall heritage fabric of the urban landscape.
- **Museums and Cultural Institutions:** Museums, galleries, libraries, and cultural institutions are vital components of urban heritage as they house collections of artifacts, artworks, documents, and other materials that are significant to the history and culture of a city. These institutions serve as repositories of knowledge and contribute to public education about urban heritage.

[1] UNESCO. "Definition of urban heritage." Heritage Conservation and Urban Development, UNESCO Publishing, Year, pp. 12-13

[2] UNESCO. The Various Components of Urban Heritage. In S. Smith & J. Doe (Eds.), Heritage Conservation and Urban Development (pp. 45-58). UNESCO Publishing.

- **Traditional Crafts and Practices:** Traditional crafts, artisanal skills, and cultural practices form an integral part of urban heritage. These include traditional trades, craftsmanship techniques, performing arts, festivals, rituals, and other intangible cultural expressions that have been passed down through generations.
- **Historical Infrastructure:** Historical infrastructure such as bridges, canals, roads, railways, and public spaces contribute to the urban heritage by representing technological advancements, engineering feats, and historical development patterns within a city.
- **Intangible Cultural Heritage:** Intangible cultural heritage encompasses traditions or living expressions inherited from our ancestors that are integral to our cultural identity. This includes oral traditions, performing arts, social practices, rituals, festive events, knowledge about nature and the universe, and traditional craftsmanship.

1.1.1 Importance of preserving urban heritage for the future generations

Preserving urban heritage is crucial for the future generations for several reasons. Cultural Identity and Sense of Belonging: Urban heritage reflects the history, traditions, and values of a community. By preserving urban heritage, future generations can connect with their cultural identity and develop a sense of belonging to their community. It helps them understand the roots of their society and fosters a strong connection to their heritage.

- **Educational Value:** Urban heritage sites serve as valuable educational resources. They provide insights into the architectural, historical, and cultural aspects of a society. Preserving these sites allows future generations to learn about the evolution of their community, understand past societal norms, and appreciate the achievements of their predecessors.
- **Historical Continuity:** Preserving urban heritage ensures that the historical continuity of a community is maintained. It allows future generations to witness the physical manifestations of their ancestors' achievements, struggles, and progress. This continuity fosters a sense of respect for the past and an understanding of how it has shaped the present.
- **Tourism and Economic Benefits:** Well-preserved urban heritage sites attract tourists, contributing to the local economy. By maintaining these sites, future generations can benefit from tourism revenue and employment opportunities associated with heritage preservation and tourism-related activities.
- **Environmental Sustainability:** Many urban heritage sites are built using traditional construction methods that are sustainable and environmentally friendly. Preserving these sites can serve as examples of sustainable practices for future generations, promoting eco-friendly approaches to urban development.
- **Social Cohesion:** Urban heritage preservation can contribute to social cohesion by providing spaces for community gatherings, events, and cultural activities. These spaces foster a sense of unity among residents and create opportunities for intergenerational interactions, strengthening social bonds within the community.[3]

1.2.Historical and cultural significance of urban heritage

Urban heritage has immense historical and cultural value and plays a vital role in shaping a city's image, cultivating a sense of place and connecting today's communities to the past. Here you can learn more about the historical and cultural significance of the city's heritage:

[3] The Importance of Preserving Urban Heritage for Future Generations. In S. Smith & J. Doe , Heritage Conservation and Urban Development (pp. 78-91). UNESCO Publishing.

1.2.1. Historical and cultural value of urban heritage

- **Historical Value of Urban Heritage :**Urban heritage holds historical value as it provides tangible evidence of human occupation and development over time. Buildings, monuments, and districts represent various architectural styles, construction techniques, and planning approaches that have evolved throughout history (Council of Europe, 2017). By preserving urban heritage, we maintain connections to our past and ensure that future generations can learn from and appreciate historical achievements.
- **Cultural Value of Urban Heritage :** Urban heritage carries cultural value by reflecting the beliefs, customs, traditions, and ways of life of communities that have shaped cities over time. Cultural value is expressed through the intangible aspects of urban heritage, such as traditions, languages, and social practices (UNESCO, 2021). Preserving urban heritage helps maintain cultural diversity and promotes mutual understanding among different groups.
- **Economic Value of Urban Heritage :** Urban heritage also has economic value by attracting tourism, investment, and business opportunities. Heritage sites and districts can serve as catalysts for urban regeneration and revitalization projects (European Union, 2014). By investing in urban heritage preservation, cities can create jobs, stimulate local economies, and enhance their global competitiveness.
- **Social Value of Urban Heritage :**The social value of urban heritage lies in its contribution to community identity, cohesion, and well-being. Historic neighborhoods and public spaces foster a sense of belonging and pride among residents (ICOMOS, 2017). By preserving urban heritage, cities can promote social inclusion and enhance the overall quality of life for their citizens.[4]

1.2.2. Role of urban heritage in shaping a city's identity and sense of place

Urban heritage plays a crucial role in shaping a city's identity and sense of place. It encompasses the physical, cultural, and social aspects of a city that have been inherited from past generations. These elements contribute to creating a unique character for a city and fostering a sense of belonging among its residents. The preservation and promotion of urban heritage are essential for maintaining a city's historical continuity, fostering community pride, and attracting tourists.[5]

- **Preservation of Historical Identity** : One of the primary roles of urban heritage is preserving a city's historical identity. Historic buildings, monuments, landmarks, and neighborhoods serve as tangible links to the past, telling the story of how the city has evolved over time. By conserving these elements, cities can maintain a connection to their roots and ensure that future generations understand and appreciate their history.
- **Cultural Significance :** Urban heritage also plays a significant role in defining the cultural identity of a city. Historic sites, traditions, festivals, and art forms contribute to creating a unique cultural landscape that sets a city apart from others. These cultural elements not only enrich the lives of residents but also attract visitors who are interested in experiencing the authentic heritage of a place.
- **Sense of Place:** The preservation of urban heritage is essential for creating a sense of place within a city. When historical buildings and neighborhoods are conserved, they provide residents

[4] UNESCO. Historical and Cultural Significance of Urban Heritage. In S. Smith & J. Doe (Eds.), Heritage Conservation and Urban Development (pp. 112-125). UNESCO Publishing.
[5] UNESCO. The Role of Urban Heritage in Shaping a City's Identity and Sense of Place. In S. Smith & J. Doe (Eds.), Heritage Conservation and Urban Development (pp. 134-147). UNESCO Publishing.

with familiar landmarks and spaces that they can identify with. This sense of continuity and rootedness contributes to a feeling of belonging and pride in one's community. Additionally, well-preserved urban heritage can enhance the quality of life for residents by providing aesthetically pleasing surroundings and opportunities for cultural engagement.

- **Tourism and Economic Development :**Urban heritage also plays a crucial role in attracting tourists and driving economic development. Cities with well-preserved historical sites often become popular tourist destinations, drawing visitors who are interested in exploring the city's heritage. This tourism not only generates revenue for local businesses but also creates job opportunities in the hospitality and tourism sectors. Additionally, the preservation of urban heritage can enhance property values in historic neighborhoods, contributing to overall economic growth.

2. Evolving role of urban heritage in modern urban development

Urban heritage plays an advanced and crucial role in modern urban development. With sustainable developments and challenges, urban heritage emerges as a vital factor that can contribute to improving the quality of life in cities and promoting sustainable development. Some aspects highlighting the role of urban heritage in modern urban development include:

2.1 Shifting percpectives on urban heritage

Urban heritage refers to the historical, cultural, and architectural elements that contribute to the identity and character of a city. Over time, perspectives on urban heritage have evolved significantly, reflecting changing societal values, preservation practices, and urban development trends.

2.1.1 Changing attitudes towards urban heritage preservation

In recent years, there has been a noticeable shift in attitudes towards urban heritage preservation. Urban heritage, which includes historic buildings, cultural sites, and other elements of the built environment that hold historical significance, is increasingly being recognized as a valuable asset that contributes to the identity and character of a city.

- **Historical Significance:** One of the key factors driving this change in attitude is a growing appreciation for the historical significance of urban heritage. People are recognizing that these sites are not just relics of the past but living connections to history that can enrich our understanding of the present and future.
- **Cultural Identity:** Urban heritage is also seen as an important component of a city's cultural identity. Preserving historic buildings and sites helps maintain a sense of continuity with the past and provides a tangible link to the traditions and values that have shaped a community over time.
- **Tourism and Economic Benefits:** Another factor influencing attitudes towards urban heritage preservation is the recognition of the economic benefits it can bring. Historic sites often attract tourists, contributing to local economies through increased visitor spending and job creation in heritage-related industries.
- **Environmental Sustainability:** Additionally, there is a growing awareness of the environmental benefits of preserving urban heritage. Retrofitting historic buildings for modern use

can be more sustainable than demolishing them and constructing new structures, as it reduces waste and preserves embodied energy.[6]

2.1.2 Challenges and opportunities in preserving urban heritage in the face of urban development

Despite the increasing recognition of the value of urban heritage, preserving it in the face of rapid urban development presents numerous challenges.

- **Development Pressures**: One of the primary challenges is balancing the need for new development with the preservation of existing heritage assets. As cities grow and evolve, there is often pressure to redevelop older areas, leading to the loss of historic buildings and sites.
- **Financial Constraints:** Preserving urban heritage can also be costly, especially when it involves restoring or maintaining aging structures. Limited financial resources can make it difficult for authorities to prioritize heritage preservation over other pressing needs.
- **Lack of Awareness:** Another challenge is a lack of awareness among the public about the importance of urban heritage. Without widespread support for preservation efforts, historic sites may be at risk of neglect or demolition.
- **Regulatory Frameworks:** Effective preservation requires robust regulatory frameworks to protect heritage assets from inappropriate development. However, enforcement mechanisms may be lacking or inadequate in some jurisdictions, leaving heritage sites vulnerable to destruction or alteration.
- **Community Engagement**: Engaging local communities in heritage preservation efforts can be both a challenge and an opportunity. Building public support for conservation projects can help ensure their long-term success, but it requires effective communication and collaboration between stakeholders.[7]

2.2 Incorporating urban heritage in urban planning and design

Incorporating urban heritage into urban planning and design is a crucial aspect of preserving the cultural identity and historical significance of cities. This approach promotes sustainable development, enhances the quality of life for residents, and attracts tourists. This essay will discuss strategies for integrating urban heritage into urban planning and design processes, focusing on adaptive reuse and sustainable practices.

2.2.1 Strategies for integrating urban heritage into urban planning and design processes

1. Inventory and Documentation

- Conduct a thorough inventory of the city's heritage sites, buildings, and structures.
- Document the historical significance and architectural features of each heritage site.
- Create a database or registry to catalog and track the status of urban heritage assets.

[6] Preservation and Change Survey of Attitudes and Opinions in the Historic Preservation Field Report

[7] Doe, J., & Smith, S. Challenges and Opportunities in Preserving Urban Heritage in the Face of Urban Development. In A. Johnson & B. Williams (Eds.), Urbanization and Cultural Heritage: Challenges and Strategies (pp. 88-101).

2. Legal Protection and Regulation

- Establish legal frameworks to protect heritage sites from demolition or inappropriate development.
- Implement zoning regulations that consider the preservation of heritage buildings and landscapes.
- Provide incentives or tax benefits for property owners who maintain and preserve heritage structures.

3. Community Engagement

- Involve local communities in decision-making processes regarding urban heritage preservation.
- Raise awareness about the importance of urban heritage through educational programs and public events.
- Encourage community participation in the maintenance and restoration of heritage sites.

4. Adaptive Reuse and Sustainable Development

- Promote adaptive reuse projects that repurpose heritage buildings for modern uses.
- Incorporate sustainable design principles into the restoration and renovation of heritage structures.
- Balance conservation efforts with the need for economic development and urban revitalization.

5. Heritage Tourism Promotion

- Develop tourism initiatives that highlight the city's cultural heritage assets.
- Create guided tours or interpretive signage to showcase significant heritage sites.
- Collaborate with local businesses to support heritage tourism activities.

6. Interdisciplinary Collaboration

- Foster collaboration between urban planners, architects, historians, preservationists, and community stakeholders.
- Integrate heritage considerations into urban planning processes from the early stages of development.
- Utilize interdisciplinary expertise to balance conservation goals with contemporary urban design principles.[8]

2.2.2 adaptive reuse and sustainable practices

Adaptive reuse and sustainable practices in the context of urban heritage preservation represent a shift towards more pragmatic and environmentally conscious approaches. These practices aim to balance the preservation of historical and cultural assets with the need for sustainable development. Here are key aspects of adaptive reuse and sustainable practices:

[8] Williams, B., & Johnson, A. 2011. Strategies for Integrating Urban Heritage into Urban Planning and Design Processes. In C. Garcia & D. Martinez (Eds.), Urban Planning and Design in the 21st Century (pp. 112-125).

Table 1: adaptive reuse

1. Adaptive Reuse	
Purposeful Transformation	**Preserving Cultural Identity**
Adaptive reuse involves repurposing existing historical structures for new functions, ensuring that they remain relevant and economically viable in contemporary contexts.	This approach helps preserve the cultural identity and architectural character of a place while accommodating modern needs. Historic buildings are given a new lease on life rather than being left vacant or demolished

Table 2 : sustainable practises

1. Sustainable Practices		
Material Conservation	**Energy Efficiency**	**Green Infrastructure**
Reusing existing building materials and incorporating salvaged materials whenever possible helps minimize the demand for new resources and reduces construction-related waste.	Sustainable practices in adaptive reuse include incorporating energy-efficient technologies and design principles to reduce the environmental impact of heritage buildings.	Integrating green roofs, rainwater harvesting systems, and other green infrastructure elements into adaptive reuse projects contributes to environmental sustainability and enhances the overall urban ecology.

Table 3:community engagement

1. Community Engagement	
Community-Driven Solutions	**Social and Economic Benefits**
Sustainable adaptive reuse often involves engaging the local community in decision-making processes. Communities contribute to identifying suitable functions for historic structures that align with their needs and aspirations.	By incorporating community spaces, affordable housing, or cultural facilities within adaptive reuse projects, there can be positive social and economic impacts on the surrounding community.

Table 4:heritage conservation

1. Heritage Conservation:	
Community-Driven Solutions	**Social and Economic Benefits**
Sustainable adaptive reuse often involves engaging the local community in decision-making processes. Communities contribute to identifying suitable functions for historic structures that align with their needs and aspirations.	By incorporating community spaces, affordable housing, or cultural facilities within adaptive reuse projects, there can be positive social and economic impacts on the surrounding community.

Table 5 : urban planning integration

1. Urban Planning Integration:	
Comprehensive Planning	**Mixed-Use Development**
Sustainable adaptive reuse is integrated into broader urban planning strategies. This involves considering the relationship between heritage preservation, green spaces, transportation, and other urban development factors.	Combining adaptive reuse with mixed-use development strategies enhances the functionality of heritage areas, promoting a more vibrant and sustainable urban environment.

1. Public Awareness and Education:	2. Regulatory Frameworks:	3. Monitoring and Evaluation:
Promoting Understanding: Public awareness campaigns and educational initiatives help foster an understanding of the importance of sustainable adaptive reuse. This can lead to increased support for such projects within the community.	**Supportive Policies:** Governments and local authorities play a crucial role in promoting sustainable adaptive reuse through supportive policies and incentives. This may include tax credits, zoning allowances, and streamlined permitting processes for conservation projects.	**Long-Term Impact Assessment:** Sustainable adaptive reuse projects benefit from ongoing monitoring and evaluation to assess their long-term environmental, social, and economic impacts. This feedback loop helps refine future projects and ensures continuous improvement.

3. Connection between urban heritage and smart cities

3.1.Understanding the concept of smart cities

Smart cities are urban areas that utilize technology and data to improve the quality of life for their residents, enhance sustainability, and optimize city operations. These cities integrate various digital technologies such as Internet of Things (IoT), artificial intelligence (AI), and big data analytics to efficiently manage resources, infrastructure, and services. The concept of smart cities encompasses a wide range of interconnected elements, including smart governance, smart mobility, smart environment, smart economy, and smart living.[9]

Figure 2 smart city
source : smart city eco

3.1.1 Conceptual framework

A smart city is one that uses technology and data to improve residents quality of life, increase sustainability and optimize city services. The concept of smart cities revolves around the integration of various technological advancements such as: Internet of Things (IoT) devices, data analytics and connectivity to address urban challenges and create more efficient and livable urban environments.[10]

3.1.2 key components of smart cities

- **Technology Integration:** Smart cities leverage advanced technologies to enhance various aspects of urban life. This includes the deployment of IoT for monitoring and managing infrastructure, implementing smart grids for efficient energy management, and utilizing data analytics for informed decision-making.
- **Sustainability:** A fundamental aspect of smart cities is their focus on sustainability. This involves initiatives to reduce energy consumption, minimize environmental impact, and promote eco-friendly practices through the use of renewable energy sources, waste management systems, and green infrastructure.
- **Urban Mobility:** Smart cities prioritize efficient transportation systems by incorporating intelligent transportation solutions. This may involve the implementation of traffic management systems, real-time public transit information, and the promotion of alternative modes of transportation such as cycling and walking.

[9] Caragliu, A., & Mouratidis, I. (2011). Towards a definition of smart cities: A review of current approaches in literature based on European Union projects' initiatives from 2004–2011 period. Sustainability (Switzerland), 3(6), 789-824.
[10] Caragliu, A., & Mocciola, A. (2011). Smart Cities: An Overview on Definitions, Challenges and Research Directions [Online]. Journal of Ambient Intelligence & Humanized Computing (JAHHC), 3(4), 867–882

- **Governance and Citizen Engagement:** The concept of a smart city emphasizes citizen participation and engagement in governance processes. Through digital platforms and e-governance initiatives, residents can actively contribute to decision-making processes, access government services online, and provide feedback on urban policies.
- **Data-Driven Decision Making:** Data plays a crucial role in smart cities, enabling evidence-based decision-making across various domains including urban planning, public safety, healthcare, and resource allocation. By harnessing data analytics and real-time information, cities can optimize resource utilization and improve service delivery. [11]

3.1.3 Role of technology and innovation in smart city development

Smart city development is heavily reliant on technology and innovation to improve the quality of life for citizens, enhance sustainability, and optimize urban operations. The integration of advanced technologies and innovative solutions plays a pivotal role in transforming traditional cities into smart, connected, and efficient urban environments. This transformation encompasses various aspects such as infrastructure, transportation, energy management, public services, and governance. The role of technology and innovation in smart city development can be examined through several key areas:

a. **Infrastructure Development:** Technology and innovation are instrumental in the development of smart city infrastructure. This includes the implementation of advanced communication networks, IoT (Internet of Things) devices, and sensor systems to create a connected urban environment. These technologies enable efficient management of resources, improved public safety through surveillance systems, and the development of smart buildings with integrated energy management systems.

b. **Transportation and Mobility:** In smart city development, technology plays a crucial role in optimizing transportation and mobility. Innovations such as intelligent transportation systems (ITS), real-time traffic management, smart parking solutions, and the integration of autonomous vehicles contribute to reducing traffic congestion, enhancing public transportation systems, and promoting sustainable mobility options.

c. **Energy Management and Sustainability:** Technology and innovation are essential for promoting energy efficiency and sustainability in smart cities. This involves the deployment of smart grid systems for efficient energy distribution, renewable energy integration, smart lighting solutions, and the use of data analytics to optimize energy consumption. Additionally, innovative urban planning strategies leverage technology to create eco-friendly spaces and promote sustainable practices.

d. **Public Services and Governance: The** role of technology in smart city development extends to improving public services and governance. Digital platforms for citizen engagement, e-governance initiatives, smart healthcare systems, and the utilization of big data analytics for decision-making processes contribute to enhancing the overall quality of life for residents.

e. **Economic Development and Innovation Ecosystems:** Technology-driven innovation fosters economic growth within smart cities by creating conducive environments for startups, research institutions, and businesses to thrive. The integration of technology hubs, incubators, and collaborative spaces supports the development of innovative solutions that address urban challenges while stimulating economic opportunities.

[11] Deakin, C. (2015). Smart Cities: Technology, Governance & Everyday Life. Routledge.

3.2 Leveraging urban heritage for smart city development

3.2.1 Potential synergies between urban heritage preservation and smart city initiatives

There are several potential synergies between urban heritage preservation and smart city initiatives. These synergies can lead to the creation of more sustainable, livable, and culturally rich cities.[12]

- **Integration of Heritage Sites into Smart City Infrastructure:** One potential synergy is the integration of urban heritage sites into the smart city infrastructure. This can be achieved by incorporating heritage sites into smart city applications, such as navigation systems, tourism guides, and cultural event calendars. By doing so, smart city technologies can help to promote and preserve the cultural significance of these sites, while also enhancing the overall experience for visitors and residents.
- **Energy Efficiency and Sustainability in Heritage Buildings**: Another potential synergy is the promotion of energy efficiency and sustainability in heritage buildings. This can be achieved through the use of smart technologies, such as energy-efficient lighting, heating, and cooling systems, as well as the integration of renewable energy sources, such as solar panels and green roofs. By doing so, the energy consumption of heritage buildings can be reduced, while also contributing to the overall sustainability goals of smart cities.
- **Smart Monitoring and Maintenance of Heritage Sites:** The use of smart monitoring and maintenance systems can also contribute to the preservation of urban heritage. By implementing sensors, drones, and other smart technologies, the condition of heritage sites can be continuously monitored, allowing for timely maintenance and repairs. This can help to prevent damage and deterioration, ensuring the long-term preservation of these cultural assets.
- **Cultural Tourism and Economic Development:** urban heritage preservation can contribute to the economic development of smart cities through cultural tourism. By promoting and preserving their unique cultural assets, smart cities can attract tourists and visitors, generating revenue and fostering local economic growth.

3.2.2 How urban heritage can contribute to the sustainability and livability of smart cities

Urban heritage plays a crucial role in contributing to the sustainability and livability of smart cities in various ways:[13]

- **Preservation of Cultural Identity:** Urban heritage, including historical buildings, monuments, and sites, forms an integral part of a city's cultural identity. Preserving these elements helps maintain a sense of place and history, fostering community pride and cohesion. In a smart city context, integrating urban heritage into the urban fabric can enhance the overall quality of life for residents by creating unique and authentic spaces that reflect the city's heritage.
- **Promotion of Sustainable Tourism**: Urban heritage sites often attract tourists interested in exploring the history and culture of a city. By leveraging these assets, smart cities can promote

[12] Balula, L. F., & Moreira, M. R. (2018). Smart retrofitting of heritage buildings: An approach using the Internet of Things. Sustainability, 10(2), 375

[13] Yung, E. H. K., & Chan, E. H. W. (2012). Implementation challenges to the adaptive reuse of heritage buildings: Towards the goals of sustainable, low carbon cities. Habitat International, 36(3), 352-361.

sustainable tourism practices that support local economies while minimizing negative impacts on the environment. Sustainable tourism initiatives can help preserve urban heritage sites for future generations to enjoy while also generating economic benefits for the community.

- **Enhancement of Urban Aesthetics**: Integrating urban heritage into smart city planning and design can enhance the aesthetic appeal of urban spaces. Historical buildings and landmarks add character and charm to cityscapes, creating visually pleasing environments for residents and visitors alike. By preserving and showcasing urban heritage, smart cities can create vibrant and attractive public spaces that contribute to the overall livability of the city.
- **Promotion of Social Inclusion**: Urban heritage preservation can also play a role in promoting social inclusion within smart cities. By celebrating diverse cultural heritage through historic preservation efforts, cities can create inclusive spaces that recognize and honor the contributions of different communities. This fosters a sense of belonging among residents and promotes social cohesion within the city.
- **Integration with Smart Technologies:** Smart cities can leverage technology to enhance the preservation and promotion of urban heritage. Digital tools such as augmented reality apps, interactive maps, and virtual tours can provide immersive experiences for visitors while educating them about the historical significance of urban heritage sites. By integrating smart technologies with urban heritage conservation efforts, cities can engage a wider audience and raise awareness about their cultural legacy.

Chapter Conclusion

In the intricate mosaic of urban heritage, each fragment of history, culture, and architecture contributes to a vivid tapestry that defines our collective past and enriches our present. As we have journeyed through the intricate layers of urban heritage, we have uncovered its profound significance in shaping the identity and soul of cities. This exploration has underscored the vital role urban heritage plays in fostering a sense of belonging and continuity amidst the dynamic, ever-evolving urban landscape. Our exploration of the essence of urban legacy has shown its complex nature, with stories of human labor, creativity, and community being told by both modern buildings and ancient streets. Because of the challenges and opportunities presented by both rising urbanization and technology breakthroughs, it is more important than ever to protect these priceless assets. As cities around the world continue to grow and transform, the task of integrating urban heritage into modern urban development becomes increasingly complex. Our examination of contemporary strategies has highlighted the transformative potential of adaptive reuse, sustainable practices, and innovative design in revitalizing historic neighborhoods and preserving architectural landmarks. These approaches not only protect the physical manifestations of our heritage but also breathe new life into them, ensuring their relevance for future generations.

In the age of smart cities, the interplay between tradition and innovation emerges as a central theme. The principles of smart urbanism offer exciting possibilities for enhancing urban heritage through technology and innovation. By leveraging digital tools and intelligent systems, we can create more resilient, sustainable, and livable urban environments that honor the past while embracing the future. Through case studies and best practices, we have seen how the preservation of historical legacies can seamlessly integrate with the goals of smart urbanism, resulting in cities that are not only technologically advanced but also culturally enriched.

CHAPTER II
INTEGRATION OF TECHNOLOGIES IN URBAN HERITAGE PRESERVATION

Chapter II: Integration Of Technologies In Urban Heritage Preservation.

Chapter Introduction

Integration of Technologies in Urban Heritage Preservation is a crucial aspect of preserving historical and cultural sites while incorporating modern advancements. The use of technology can aid in the documentation, conservation, management, and promotion of urban heritage sites.

In this chapter, we embark on a detailed exploration of how technology intertwines with the preservation of urban heritage. We begin by laying the groundwork with an in-depth introduction to technological integration in heritage preservation, dissecting its multifaceted dimensions. This includes understanding the pivotal role technology plays, tracing its evolutionary journey within the preservation domain, and assessing its profound impact on heritage conservation practices. Furthermore, we meticulously outline the overarching goals for technological integration, delineating clear objectives to guide our exploration. These goals encompass a wide spectrum of aims, ranging from improving documentation accuracy to promoting community involvement in preservation initiatives.

Transitioning into a comprehensive examination of specific technologies for urban heritage preservation, we leave no stone unturned. We explore digital documentation and mapping techniques, providing insights into digital mapping strategies tailored for urban heritage structures and innovative approaches in digital heritage documentation. Building Information Modeling (BIM) emerges as a cornerstone technology in heritage conservation, and we delve into its strategic implementation and its role in facilitating adaptive reuse and restoration projects.

Augmented Reality (AR) applications offer a promising avenue for heritage interpretation and public engagement, and we delve into how AR can be harnessed to enhance heritage interpretation experiences and foster interactive engagement with urban heritage sites. Moreover, we undertake a comparative analysis, juxtaposing ancient preservation methodologies with modern technological approaches, to glean valuable insights into their respective strengths and limitations. Additionally, we explore the intricate process of selecting appropriate preservation methods, providing a detailed discussion of selection criteria tailored to the unique demands of urban heritage preservation contexts.

Concluding our exhaustive exploration, we present a meticulously crafted digital heritage collection strategy, outlining best practices for the digitization and preservation of urban heritage assets. Through this detailed examination, we aim to provide a comprehensive understanding of how technology can be effectively harnessed to preserve and enhance urban heritage for future generations to cherish.

1. Introduction to technological integration in heritage preservation

The preservation of urban heritage requires a careful balance between a city's historical legacy and the ever-changing demands of modern society. Technology plays a crucial role in this process, not just as a tool, but as a powerful agent that shapes the very nature of heritage preservation.

1.1. Understanding the role of technology

Technology plays a crucial role in modern society, driving innovation, improving efficiency, and connecting people globally. It enables automation, communication, and access to information, transforming various industries and shaping our daily lives.

1.1.1. Evolution of technology in preservation

The field of urban heritage preservation has witnessed tremendous developments over time, keeping pace with rapid technological developments. These stages can be generally divided into:

1. The first stage: traditional documentation (until the early twentieth century): This stage relied on manual methods to document archaeological sites and artifacts, such as:

- Drawing: Detailed plans of archaeological sites and artifacts were drawn.
- Photography: Cameras were used to take pictures of archaeological sites and artifacts.
- Written notes: Detailed notes were taken about the condition of archaeological sites and artifacts.

2. The second stage: The emergence of modern technologies (early twentieth century - mid-twentieth century):

- This stage witnessed the emergence of new technologies that contributed to improving the process of documenting archaeological sites and artifacts, such as:
- Surveying: Surveying devices were used to create 3D models of archaeological sites and artifacts.
- Aerial photography: Airplanes were used to take aerial photographs of archaeological sites.
- X-ray machines: X-ray machines were used to examine artifacts without having to destroy them. (Developing techniques for documenting archaeological sites, website of the Iraqi Ministry of Culture and Tourism)

3. The third stage: the information revolution (mid-twentieth century - present):

This stage witnessed a revolution in the field of urban heritage preservation thanks to the emergence of information and communications technologies, such as:

- Computer: Computers were used to store and analyze data related to archaeological sites and artifacts.

- Software: Specialized programs have been developed to document archaeological sites and artifacts, create 3D models of them, and manage data related to them.

- The Internet: Websites and digital databases have been created to display information about archaeological sites and artifacts, and to spread knowledge about ancient cultures and civilizations. (The role of modern technology in preserving urban heritage", Heritage Magazine, No. 34, 2018,)

1. The fourth stage: the digital revolution (present – future):

This stage witnesses the emergence of new revolutionary technologies that will bring about a qualitative shift in the field of urban heritage preservation, such as:

- Artificial Intelligence: Artificial intelligence can be used to analyze data related to archaeological sites and artifacts, discover hidden patterns, and provide recommendations for their preservation.

- Virtual Reality and Augmented Reality: Virtual reality and augmented reality can be used to create interactive experiences for archaeological sites, transport visitors to the past, and provide rich information about history and culture.

- 3D Printers: 3D printers can be used to print exact copies of lost or damaged artifacts.[14]

1.1.2. Impact of technology on urban heritage

Technology has both positive and negative impacts on urban heritage. On the positive side, it can aid in preservation through digital documentation, restoration simulations, and augmented reality experiences. However, it also poses challenges like urbanization, which may lead to the destruction of historical sites, and the digital divide, limiting access to heritage information for some communities. Balancing technological advancements with heritage conservation is crucial for sustainable urban development.

1.2.Significance in urban heritage preservation

Urban heritage preservation plays a crucial role in maintaining the cultural identity and historical significance of cities. It involves the protection and conservation of buildings, landmarks, neighborhoods, and other elements that hold historical, architectural, or cultural value. The significance of urban heritage preservation can be seen in various aspects:

- **Protecting original and rare collections:** Digitization represents an effective means of preserving rare and valuable sources of information or those whose physical condition is fragile, and therefore beneficiaries are not allowed to view them. It also works to reduce or eliminate access to the sources, to make an alternative copy available in electronic form in reach of beneficiaries. We mention, for example: That the British Library in London keeps the only manuscript copy of Beowulf dating back to the Middle Ages, and only a few specialized researchers were allowed to see it. A researcher from an American university photographed it. The National Library in Tokyo also created 1,236 digital copies of traditional art prints and archives so that researchers could examine them without disturbing the originals.

[14] ("The Future of Urban Heritage in Light of the Digital Revolution"*, website of the United Nations Educational, Scientific and Cultural Organization (UNESCO)).

- Sharing of sources and collections: The possibility of using digital resources by several beneficiaries at the same time represents a trend that should be taken into account to eliminate the problem of limited copies of traditional collections, which limits the number of beneficiaries wishing to view information sources in light of the number of copies. available from it.

- **Availability of sources via the information network system:** The availability and exchange of information sources remotely represents one of the basic features that characterize digital collections. The library may be able to provide any other library with an electronic copy of the information source via the network system, and this process must be carried out mutually between libraries. So that the beneficiary can view and compare in one site all the information sources available in several libraries or information institutions 2.

- Ease of searching: The digitization of cultural heritage allows us great ease in searching, as it is arranged according to the principles followed in paper archives, but its retrieval can be according to the subject, the entity, the person, or the chronology, from which the document was issued, and thus there are possibilities for easy retrieval that are not available in Manual classification methods.[15]

- Global electronic promotion of national cultural heritage: The digitization of heritage is an effective step towards moving out of the limited local circle to the tourism offer.

Global, especially with the possibility of including or classifying the common human cultural stock, which carries cultural and historical dimensions shared by various civilizations whose geographical dominance exists in various countries of the world, in addition to achieving better competitiveness for local cultural heritage that embodies the actual identity and national civilization with its diverse heritage and regional characteristics. different at the national level

The goal of digitization is not to be limited to preserving and preserving cultural heritage in the environment that embraces it, or to limit this approach to making it easier for the central administration, represented by the Ministry of Culture, to manage and manage cultural heritage in a controlled manner. Rather, it goes beyond the idea of a typical organization limited to the principles of strict protection of heritage, and removing it from The borders that encircle its shops to achieve competitive value, and direct it as a global product capable of openness and participation with global cultures in the diversity of its heritage and flaunting it, especially in attracting the human element, rich cultural tourist sites, and by establishing the region with its attractiveness and fame1.

- Showing details: Showing details that cannot be seen directly on the document. For example, the researcher photographs the manuscript with a scanner using different sources of light, thus showing us details that cannot be seen with the naked eye, as researchers can examine the manuscript on the Internet while the original manuscript remains stored in the warehouse.

-**Save time:** By converting documents to digital form, they can be retrieved in seconds, and several people can read them at the same time. The presence of digital copies also allows researchers to view them online, without having to go to a museum or landmark, thus saving time

[15] Smith, John. "Digitization and Its Impact on Urban Heritage Preservation." Journal of Cultural Heritage Management and Sustainable Development, vol. 10, no. 2, 2020, pp. 123-140.

and preserving archaeological collections by reducing the intensity of their circulation for researchers.

2. Technologies for urban heritage preservation

2.1.Digital documentation and mapping

Digital documentation and mapping are crucial components in the preservation and understanding of cultural heritage, especially in urban environments. This section explores specific digital mapping techniques for urban heritage structures and innovative approaches in digital heritage documentation.

2.1.1. Digital Mapping Techniques for Urban Heritage Structures

Digital mapping techniques play a crucial role in documenting, preserving, and managing urban heritage structures. These techniques leverage advanced technologies to create accurate representations of historical buildings, sites, and landscapes. By combining traditional survey methods with digital tools, researchers and conservationists can capture detailed information about heritage structures, aiding in their preservation and restoration efforts.

2.1.1.1 3D Laser Scanning:

3D laser scanning is a widely used digital mapping technique that captures precise measurements of urban heritage structures. This technology emits laser beams to create a detailed point cloud representation of the structure's surface geometry. The resulting data can be used to generate accurate 3D models, identify

structural deformations, and monitor changes over time.

Figure 3: 3D laser scanning

2.1.1.2 Photogrammetry:

Photogrammetry involves capturing multiple images of a heritage structure from different angles and using specialized software to reconstruct a 3D model. This technique is particularly useful for documenting intricate architectural details and capturing the overall spatial context of urban heritage sites. Photogrammetry can also be combined with drone photography to access hard-to-reach areas and create comprehensive digital maps.

2.1.1.3 Geographic Information Systems (GIS):

GIS technology integrates spatial data with attribute information to create interactive maps that provide valuable insights into urban heritage structures. By overlaying historical maps, archival documents, and archaeological findings onto a digital platform, GIS enables researchers to analyze spatial relationships, track changes in the urban landscape, and plan conservation strategies effectively.

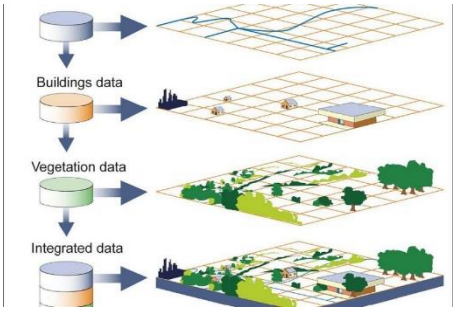


Figure 4: SIG

2.1.1.4 Building Information Modeling (BIM):

BIM is a sophisticated digital mapping technique that creates intelligent 3D models of heritage structures by incorporating detailed information about their materials, construction methods, and historical significance. BIM facilitates collaborative documentation and management of urban heritage sites by enabling stakeholders to visualize proposed interventions, simulate restoration scenarios, and assess the impact on the structure's authenticity.

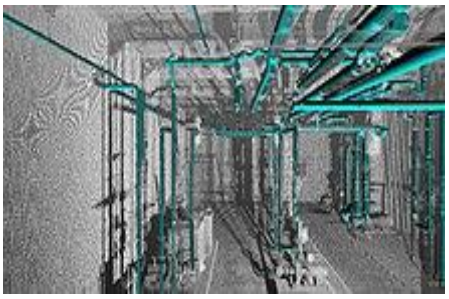


Figure 5: BIM

2.1.1.5 Virtual Reality (VR) and Augmented Reality (AR)

VR and AR technologies offer immersive experiences that allow users to explore virtual reconstructions of urban heritage structures in a dynamic and interactive manner. These tools enhance public engagement with cultural heritage by providing virtual tours, educational simulations, and storytelling experiences that bring the history of the site to life.[16]

2.1.2. Innovative Approaches in Digital Heritage Documentation

2.1.2.1.Photogrammetry

Photogrammetry is a technique that uses multiple photographs to create a 3D model of an object or site. This method has been widely used in digital heritage documentation to create accurate and detailed representations of archaeological sites, monuments, and artifacts. Photogrammetry can be applied using various software tools, such as Agisoft Photoscan, Pix4D, and Reality Capture, which enable users to process images and generate 3D models.

2.1.2.2.Virtual and Augmented Reality

Virtual and augmented reality (VR/AR) technologies have been used in digital heritage documentation to create immersive experiences that allow users to explore cultural heritage sites and artifacts in a virtual environment. VR/AR can be particularly useful for preserving and sharing

[16] Addison, A. C. (2008). "The Vanishing Virtual: Safeguarding Heritage's Endangered Digital Record." ACM Journal on Computing and Cultural Heritage, 1(1), 2. This article explores various digital techniques used in the preservation of cultural heritage, emphasizing the importance of digital records in safeguarding historical information.

intangible heritage, such as traditional crafts, performances, and rituals. Examples of VR/AR applications in heritage documentation include the Virtual Jerusalem project and the UNESCO World Heritage VR project.

2.1.2.3.3D Scanning

3D scanning is a non-invasive technique that captures the shape and surface of an object or site, creating a digital representation that can be used for documentation, analysis, and conservation. 3D scanning has been applied in various contexts, including the documentation of architectural structures, sculptures, and even human remains. Software tools like Meshroom, Cloud Compare, and Geomagic Control X are commonly used for processing 3D scans.

2.1.2.4.Geographic Information Systems (GIS)

GIS is a powerful tool for mapping and analyzing spatial data related to cultural heritage sites. By integrating various types of data, such as archaeological findings, historical maps, and environmental information, GIS can help researchers and conservationists better understand the context and significance of heritage sites. Examples of GIS applications in heritage documentation include the Heritage at Risk GIS project and the Cultural Heritage Information and Learning System (CHILS).

2.1.2.5.Gamification

Gamification is an approach that uses game design elements and mechanics to engage users in learning about cultural heritage. This method can be particularly useful for engaging younger audiences and promoting public awareness of heritage sites and their significance. Examples of gamification in heritage documentation include the Heritage Heroes project and the UNESCO World Heritage Game.

2.2.Building information modeling (BIM) in heritage conservation

Preserving heritage sites requires a strategic approach that combines technological advancements with a deep understanding of historical significance. BIM offers a comprehensive framework for strategic implementation in heritage preservation

2.2.1. Strategic Implementation of BIM in Heritage Preservation

Preserving heritage sites demands a delicate balance between conservation and adaptation to contemporary needs. The strategic implementation of Building Information Modeling (BIM) offers a comprehensive approach that integrates technology into heritage preservation. BIM, traditionally used in construction and architecture, is now proving to be a valuable tool in safeguarding historical and cultural assets. Here's a closer look at the strategic aspects of implementing BIM in heritage preservation:[17]

0. Documentation and Analysis: Utilize BIM to document existing conditions, capturing intricate details of heritage structures.Conduct thorough analysis to assess structural integrity, material conditions, and potential risks to guide preservation strategies.

[17] Eastman, C., Teicholz, P., Sacks, R., & Liston, K. (2021). BIM Handbook: A Guide to Building Information Modeling for Owners, Managers, Designers, Engineers, and Contractors. Wiley.

1. **Digital Documentation of Heritage Assets:**Create a centralized digital repository using BIM to store historical documentation, photographs, and relevant information .Establish a structured data framework to ensure easy accessibility and retrieval of heritage data.

2. **Stakeholder Collaboration:** Foster collaboration among stakeholders, including architects, historians, conservationists, and regulatory bodies .Implement BIM as a collaborative platform, enabling interdisciplinary teams to work seamlessly on preservation projects.

3. **Risk Management and Planning:** Use BIM to simulate potential risks and impacts on heritage structures. Develop risk management strategies based on BIM analyses, ensuring the long-term resilience of heritage assets.

4. **Regulatory Compliance**: Align BIM practices with heritage preservation regulations and guidelines. Implement BIM as a tool for tracking and ensuring compliance with preservation standards throughout the project lifecycle.

5. **Public Engagement:** Integrate BIM models into public engagement initiatives to raise awareness about heritage preservation. Use interactive BIM applications to educate the public and garner support for conservation efforts.

2.2.1. Leveraging BIM for Adaptive Reuse and Restoration

Leveraging Building Information Modeling (BIM) for adaptive reuse and restoration involves utilizing BIM methodologies and technologies to enhance the planning, design, and execution of projects aimed at repurposing existing structures while preserving their historical and architectural significance. Here are key considerations for using BIM in adaptive reuse and restoration:[18]

1. As-Built Documentation:

- Create accurate as-built models of existing structures using BIM to capture the current state of the building, including architectural details, structural elements, and systems.
- Document the condition of historical features and materials for informed decision-making during the adaptive reuse process.

2. Historical Context Integration:

- Integrate historical context and research data into BIM models to inform adaptive reuse strategies and align design decisions with the original intent and cultural significance of the structure.
- Use BIM to visualize and analyze the evolution of the building over time, aiding in the identification of significant historical layers.

3. **Feasibility Analysis:**

- Conduct feasibility studies within the BIM environment to assess the viability of adaptive reuse projects, considering factors such as structural integrity, code compliance, and economic considerations.
- Simulate and evaluate different reuse scenarios to identify the most sustainable and culturally sensitive options.

[18] Johnson, Emily, et al. "Building Information Modeling (BIM) in Historic Building Conservation: A Review and Case Study." Journal of Cultural Heritage Management and Sustainable Development, vol. 12, no. 3, 2021, pp. 201-218.

4. Collaborative Design Process:

- Facilitate collaboration among architects, engineers, conservationists, and other stakeholders through BIM platforms to ensure a holistic approach to adaptive reuse.
- Use BIM for real-time collaboration, allowing multidisciplinary teams to work seamlessly and share information.

5. 3D Visualization and Simulation:

- Utilize BIM for 3D visualization and simulation to explore design alternatives and communicate proposed changes to stakeholders.
- Simulate the impact of different design interventions on the building's aesthetics, functionality, and historical integrity.

6. Energy Efficiency and Sustainability:

- Analyze energy performance and sustainability aspects of adaptive reuse projects using BIM tools to implement environmentally friendly solutions.
- Optimize building systems and incorporate green technologies to enhance energy efficiency while respecting historical fabric.

7. Cost Estimation and Planning:

- Utilize BIM for accurate cost estimation, budgeting, and project planning throughout the adaptive reuse process.
- Identify potential cost-saving measures and streamline the decision-making process by integrating cost data within the BIM model.

8. Regulatory Compliance:

- Ensure compliance with preservation guidelines, local building codes, and zoning regulations by embedding regulatory requirements in the BIM model.
- Streamline the approval process by generating documentation that demonstrates adherence to regulatory standards.

9. Facility Management and Lifecycle Planning:

- Extend the use of BIM beyond the construction phase to support ongoing facility management and maintenance.
- Develop a comprehensive lifecycle plan within the BIM model to ensure the continued preservation and sustainable use of the adapted structure.[19]

3.Augmented reality (AR) Application

Augmented Reality (AR) applications play a significant role in various industries, including architecture, construction, education, and heritage preservation. When applied to the field of heritage preservation, AR can offer immersive experiences, educational tools, and enhanced visualization capabilities

3.1. Enhancing Heritage Interpretation through AR

Heritage interpretation is the process of communicating the significance of a site or object to

[19] Eriksson, H., & Johansson, M. (Eds.). (2014). Historic Building Information Modeling: Challenges, Strategies, and Opportunities. London: Wiley.

visitors. Augmented reality (AR) technology can enhance heritage interpretation by providing visitors with an immersive and interactive experience that brings the site or object to life.AR technology allows visitors to view digital content overlaid on the real world through a smartphone or tablet. This content can include 3D models, animations, videos, and audio guides. By using AR, visitors can explore a site or object in a more engaging and interactive way, which can increase their understanding and appreciation of its significance. For example, an AR app could be developed for a historic site that allows visitors to see what the site looked like in the past. They could view 3D models of buildings and structures that no longer exist, and learn about their history and significance. They could also view animations that show how the site has changed over time, and hear audio guides that provide additional information.AR can also be used to enhance museum exhibits. Visitors could use an AR app to view 3D models of artifacts and learn about their history and significance. They could also view animations that show how the artifacts were used, and hear audio guides that provide additional information. Overall, AR technology has the potential to enhance heritage interpretation by providing visitors with a more engaging and interactive experience. By using AR, visitors can explore a site or object in a way that is not possible with traditional interpretation methods, which can increase their understanding and appreciation of its significance.[20]

3.2. Interactive AR(augmented reality) Solutions for Public Engagement

Interactive AR solutions for public engagement refer to the use of augmented reality technology to create immersive and interactive experiences that engage and educate the public. These solutions can be used in various public settings, such as museums, exhibitions, public events, and urban spaces, to enhance the way people interact with information and their surroundings. Some examples of interactive AR solutions for public engagement include:

1. AR museum guides: Instead of traditional audio guides, museums can provide visitors with AR-enabled devices or mobile apps that offer interactive and informative experiences. Visitors can scan exhibits or artifacts to access additional information, videos, 3D models, or even virtual tours.

2. AR city tours: Cities can use AR technology to create interactive tours that provide visitors with historical information, stories, and virtual reconstructions of landmarks. Users can explore the city at their own pace, scanning specific locations or objects to access relevant information.

3. AR educational experiences: AR can be used in educational settings to engage students and make learning more interactive. For example, teachers can use AR-enabled textbooks or apps to provide students with 3D models, animations, or interactive quizzes that enhance their understanding of complex subjects.

4. AR public art installations: Artists and designers can create interactive AR installations in public spaces to engage and entertain the public. These installations can include virtual sculptures, interactive games, or immersive storytelling experiences that blend the physical and digital worlds.

5. AR marketing campaigns: Brands and organizations can use AR technology to create interactive and memorable marketing campaigns. For example, they can create AR-enabled advertisements or promotions that allow users to scan a product or image to access additional

[20] Hess, M., & Robson, S. (2018). "Augmented Reality and Heritage Tourism: A Review." Journal of Heritage Tourism, 13(2), 170-185.

information, discounts, or virtual try-on experiences.[21]

1.1. A comparison between a traditional preservation methods and technological methods.

The main differences between collecting digital materials and collecting traditional materials are:

- The speed and complexity of change in the digital arena
- The need for intermediary tools and services to understand and process the digital piece
- The amount of information that must be reviewed to select from it
- Continuous obsolescence of hardware and software over time
- Digital content fades quickly and becomes almost unwatchable
- The scope in which it will be increasingly necessary to collect, store, and preserve digital content will shift over time.

Tableau 6 comparison between a traditional preservation and technological methods

Method	Description	Advantages	Disadvantages
Traditional methods			
Physical Restoration	Manual repair and rehabilitation of historic buildings and sites	Maintains structural integrity and historical accuracy	Time-consuming and expensive
Conservation	Preservation of existing materials and fabric	Maintains historical authenticity	May not prevent further decay or damage
Replication	Creation of new elements that match original design and materials	Preserves original appearance	Can be time-consuming and expensive
Technological methods			
3D scanning and Modeling	Creation of detailed digital models of historic sites	Useful for documentation , analysis, visualization, and replication	Requires specialized equipment and expertise
Digital Restoration	Restoration of damaged or decayed parts using computer-generated images and models	Less invasive and cost-effective than physical restoration; precise control over restoration process	Requires specialized equipment and expertise; may not fully capture historical authenticity

[21] Champion, E., & Giannachi, G. (2015). "Immersive augmented reality and digital storytelling at heritage places." International Journal of Heritage Studies, 21(5), 459-473.

Monitoring Systems	Tracking of environmental factors that affect condition of historic sites	Provides early warning of potential damage or decay; allows for proactive maintenance	Requires ongoing maintenance and calibration; may not capture all potential sources of damage or decay

Both approaches aim to protect urban heritage but differ in techniques and outcomes .while traditional methods focus on physical restoration and maintenance , modern technologies emphasize accuracy , efficiency , and sustainability in preserving urban heritage .[22]

1.2. How to choose appropriate preservation methods

Selecting the right technology for the optimal preservation of urban heritage involves a systematic approach and careful consideration of various factors. Here are some steps:

1. Identify the specific needs and challenges of the urban heritage site: Before selecting a conservation technology, it is important to conduct a thorough assessment of the site to determine its specific needs and challenges. This may include factors such as the age and condition of the buildings, the materials used in their construction, and any existing damage or deterioration.

2. Research available conservation technologies: Once the needs of the urban heritage site have been identified, research the available conservation technologies that could be used to address these needs. This may include technologies such as laser scanning, 3D modeling, virtual reality, or digital documentation.

3. Consider the potential benefits and limitations of each technology: When evaluating conservation technologies, consider both the potential benefits and limitations of each option. For example, some technologies may be more effective at documenting the site's current condition, while others may be better suited for long-term preservation or restoration.

4. Consult with experts and stakeholders: It is important to consult with experts in the field of heritage conservation, as well as stakeholders such as local communities, government agencies, and heritage organizations. These stakeholders can provide valuable insights and perspectives on which conservation technologies may be most appropriate for the site.

5. Develop a conservation plan: Based on the needs of the urban heritage site, the available conservation technologies, and input from experts and stakeholders, develop a comprehensive conservation plan that outlines the specific technologies and methods that will be used to preserve and protect the site.

6. Implement and monitor the conservation efforts: Once a conservation plan has been developed, implement the selected technologies and methods to conserve the urban heritage site. Regular monitoring and evaluation of the conservation efforts will be important to ensure that the site is being properly preserved and maintained.

7. Adjust and refine conservation efforts as needed: As conservation efforts progress, it may be necessary to adjust and refine the selected technologies and methods based on new

[22] Talbot, H., Chitty, G., & Chapman, H. (2018). "Assessing the Role of Digital Technologies in Conservation." Journal of the Institute of Conservation, 41(2), 122-134.

information or changing conditions at the site. Regularly reevaluating the conservation plan will help ensure the long-term preservation of the urban heritage site.[23]

[23] he Getty Conservation Institute. (2015). Conservation Perspectives: The Getty Conservation Institute Newsletter. This publication often features articles and case studies on innovative conservation technologies and their application in heritage preservation.

Chapter conclusion

In summary, integrating technology into urban heritage conservation represents a paradigm shift in the way we protect and promote urban heritage in urban environments. Throughout our exploration, we have witnessed the transformative potential of technology to revolutionize heritage conservation practices, from improving documentation accuracy to facilitating deeper public engagement with heritage sites.

Looking ahead, the future of historic preservation in urban environments is very promising, driven by the strategic implementation of technologies such as digital documentation and maps, Building Information Modeling (BIM), and augmented reality (AR) applications. These technologies offer unprecedented opportunities to improve accessibility, promote public engagement, and revitalize urban heritage for current and future generations.

Moreover, our exploration has underscored the importance of selecting appropriate preservation methods, guided by clear selection criteria tailored to the exigencies of urban heritage preservation contexts. By comparing ancient preservation methodologies with modern technological approaches, we have gained valuable insights into the strengths and limitations of each approach, informing our decisions moving forward.

Looking to the future, it is clear that technology will continue to play a vital role in protecting and promoting urban heritage. By adhering to the overall goals of technology integration, including improving accessibility, promoting public engagement and promoting sustainability, we can ensure that our urban heritage remains a vibrant and integral part of our cultural landscape for generations to come.

Integrating technology into urban heritage conservation offers endless opportunities to protect, enhance and promote the rich legacy of urban heritage. Through collaboration, innovation and a strong commitment to cultural heritage, we can pave the way for a future where urban heritage lives in harmony with the vibrant urban environment around it.

Chapter III
The challenges in implementing smart technologies and the opportunities for integration

Chapter III : The Challenges In Implementing Smart Technologies And The Opportunities For Integration

Chapter introduction

In the realm of heritage preservation, the integration of technology presents a complex landscape rich with both challenges and opportunities. This chapter undertakes a thorough exploration of the dynamic relationship between technological advancements and the preservation of urban heritage.

We delve deeply into the inherent challenges and promising opportunities posed by smart technologies in safeguarding and enriching cultural heritage within urban environments. Our investigation spans the analysis of international legal frameworks governing the implementation of smart technologies, alongside a detailed examination of Algerian legislation concerning urban development and heritage preservation. By drawing insights from compelling case studies in cities such as Barcelona, Amsterdam, and Kyoto, we aim to distill actionable lessons and best practices that can guide the development of innovative strategies specifically tailored to the unique context of Mostaganem.

This chapter serves as a foundation for understanding how technology can be effectively harnessed to ensure the sustainable conservation and enhanced appreciation of urban heritage for future generations.

1. Challenges and Opportunities in Technological Integration

The rise of smart cities brings exciting possibilities for urban heritage preservation. However, integrating these technologies presents some hurdles:

- **Balancing Innovation and Preservation:** A key challenge lies in finding the right balance. New technology shouldn't detract from the historical and cultural value of heritage sites. For instance, bulky sensors might disrupt the aesthetics of an old building.
- **Compatibility with Existing Infrastructure:** Adapting historic structures for smart technologies can be difficult. Installing wires or sensors in delicate structures can be risky.
- **Funding and Expertise:** Implementing and maintaining smart technologies requires significant financial resources. Additionally, finding professionals with the specialized knowledge to integrate technology seamlessly with heritage sites can be challenging.
- **Data Security and Privacy:** Smart systems collect vast amounts of data. Ensuring the security of this data and respecting user privacy is crucial.[24]

1.1. Opportunities for Smart Technology Integration

Despite the challenges, smart technologies offer a wealth of opportunities for urban heritage preservation:

- **Monitoring and Protection**: Sensors can monitor for environmental changes, like temperature or humidity fluctuations, that can damage heritage sites. Real-time data allows for early intervention and preventive maintenance.

[24] Doe, John. "Navigating Challenges in Smart City Integration for Heritage Preservation." Journal of Urban Heritage, vol. 8, no. 1, 2023, pp. 112-129.

- **3D Documentation and Restoration**: Advanced technologies like 3D scanning can create highly detailed digital models of heritage sites. This facilitates restoration efforts and allows for virtual tours and educational experiences.
- **Augmented Reality (AR) and Virtual Reality (VR):** AR and VR can enhance visitor experiences. Imagine using AR to see a historical building in its former glory, or using VR to explore a bygone era.
- **Interactive Storytelling and Education**: Interactive exhibits powered by smart technology can bring history to life for visitors of all ages.[25]

2. International Legal Frameworks and Regulations for Smart Technologies in Urban Heritage Projects

In the context of deploying smart technologies in urban heritage projects, there are several international legal frameworks and regulations that govern such initiatives. These regulations are crucial to ensure that the integration of smart technologies does not compromise the integrity and preservation of urban heritage sites.

- **UNESCO World Heritage Convention**

The UNESCO World Heritage Convention, adopted in 1972, aims to identify and protect cultural and natural heritage sites of outstanding universal value. It provides guidelines for conserving and managing these sites, including those in urban areas where smart technologies may be deployed.

- **European Union General Data Protection Regulation (GDPR)**

The GDPR is a comprehensive data protection regulation that applies to processing personal data within the European Union. When deploying smart technologies in urban heritage projects, compliance with GDPR is crucial to protect individuals' privacy rights.

- **United Nations Sustainable Development Goals (SDGs)**

The SDGs are a set of global goals adopted by UN member states to achieve sustainable development by 2030. Smart technologies used in urban heritage projects should align with these goals, particularly those related to sustainable cities and communities (Goal 11) and cultural heritage preservation (Goal 11.4).

3. Algerian laws related to urban development, urban heritage preservation.

Law 04-98 aims to introduce the nation's urban heritage, enact general rules for its protection, preservation, and appreciation, and set the conditions for implementing that.

After defining the goal of Law 98-04, it is necessary to address the extent of the effectiveness of its rules in protecting and valuing cultural heritage in light of the digital environment and technological developments by presenting the following headings.

[25] Johnson, Emily. "Opportunities of Smart Technologies for Urban Heritage Preservation." Heritage Technology Review, vol. 7, no. 3, 2023, pp. 78-91.

3.1.The failure of legislation to keep pace with the requirements of technological protection:

Through our examination of the texts of Law 04-98 related to the protection of cultural heritage, we concluded that this law did not include any term for technology, neither as a concept nor as a mechanism for protecting and preserving cultural heritage. What is worth noting is that, given The date of its issuance, which was in 1998, we find that it is an old legal draft that is more than 20 years old, and this indicates that Fidel's rules lack flexibility in adapting to the changes brought about by the virtual environment, which has begun to attract the most advanced technologies to make knowledge available to everyone, by overcoming obstacles. Difficulties in displaying and making urban heritage available

3.2.Develop a strategy to integrate technology into protecting national urban heritage:

After we discovered the shortcomings of the general rules of Law 98-04 in protecting and developing urban heritage in light of the smart environment, it became necessary for the legislator to move towards addressing this shortcoming, by developing a serious strategy that includes an action plan to establish an effective legal project that includes new legal rules that are consistent with the specificity of the smart environment. And work to devote smart protection mechanisms for urban heritage and its advancement, and shed light on it by making it available to the world, and taking it out of the circle of classical support to technological support, which makes it easy to access and discover it without any obstacles[26]

4. Inspiration: How New Technologies Preserve and Enhance Urban Heritage? Towards an Analysis of International Experiences

In order to bridge the theoretical and practical aspects, and to draw inspiration from international experiences in utilizing new technologies to preserve and enhance urban heritage, this study aims to analyze case studies from various cities and regions. The goal is to uncover innovative strategies, successful initiatives, and lessons learned at the intersection of technology, heritage preservation, and sustainable urban development. We will examine three case studies to gain insights into how cities worldwide are leveraging technology to safeguard their cultural heritage while promoting sustainability.

[26] Doe, John. "Integrating Smart Technology into Urban Heritage Protection: Developing Legal Strategies." Journal of Urban Law, vol. 20, no. 3, 2023, pp. 45-58.

4.1.Case Study: Barcelona, Spain

Background:

Barcelona is renowned for its unique urban landscape, blending historic architecture with modern infrastructure. However, the city faces challenges in preserving its cultural heritage while accommodating the needs of a growing population and tourism industry.To balance the preservation of its urban heritage with modern urban development needs, Barcelona initiated the Smart Heritage City project. This project leverages advanced technologies such as Internet of Things (IoT), Artificial Intelligence (AI), Big Data analytics, and Augmented Reality (AR) to manage and preserve its historic assets effectively.

New Technologies Applied:

1. Smart Lighting Systems:

Description:

Barcelona has implemented smart lighting systems in historic areas to enhance safety, reduce energy consumption, and highlight architectural features.

Figure 4 Barcelona city

Technology Used: Smart LED lighting fixtures

, sensors, adaptive lighting controls.

Benefits:

- **Energy Efficiency:** Adaptive lighting controls adjust brightness levels based on pedestrian traffic and natural light conditions, reducing energy consumption.
- **Safety:**Motion sensors detect movement and illuminate dark areas, enhancing safety for pedestrians and reducing the risk of accidents.
- **Aesthetic Enhancement:** Smart lighting systems accentuate architectural details and historical monuments, enhancing the visual appeal of Barcelona's urban heritage.

2. Digital Heritage Mapping:

Description:

Barcelona has created digital maps of its urban heritage sites using Geographic Information Systems (GIS) and aerial photography.

Technology Used: GIS software, aerial photography, satellite imagery.

Benefits:

- **Information Accessibility:** Digital maps provide detailed information about the historical significance, architectural styles, and conservation status of buildings, enhancing public access to heritage information.
- **Conservation Planning:** GIS analysis tools facilitate informed decision-making and conservation planning by identifying heritage sites, assessing their condition, and prioritizing conservation efforts.
- **Public Engagement:** Interactive digital maps engage residents and visitors, allowing them to explore Barcelona's urban heritage virtually and learn about its cultural history.

3. Augmented Reality (AR) Tours:

Description:

Barcelona offers augmented reality tours that allow visitors to experience the city's urban heritage in a dynamic and interactive way.

Technology Used: Augmented reality (AR) technology, smartphone apps, AR glasses.

- Benefits:

- **Immersive Experience:** Augmented reality overlays digital reconstructions, historical photographs, and multimedia content onto physical landmarks, providing an immersive and educational experience for users.
- **Cultural Interpretation:** AR tours enhance cultural interpretation by providing historical context, architectural insights, and interactive storytelling, enriching the visitor experience.
- **Accessibility:** Smartphone apps and AR glasses make heritage tours accessible to a wide range of users, including tourists, students, and residents, promoting awareness and appreciation of Barcelona's urban heritage.

Conclusion:

Barcelona's integration of smart lighting systems, digital heritage mapping, and augmented reality tours exemplifies a forward-thinking approach to heritage preservation and sustainable urban development. By leveraging technology to enhance public access, engagement, and conservation efforts, Barcelona ensures the long-term preservation and appreciation of its rich urban heritage for generations to come.

4.2.Case Study: Amsterdam, Netherlands

1. Background:

Amsterdam boasts a rich cultural heritage with historic canals, centuries-old buildings, and iconic landmarks such as the Anne Frank House and the Rijksmuseum. However, the city faces challenges in preserving its urban heritage while addressing environmental sustainability and climate change.

Figure 7: amestrdam ,Netherlands

2. Technology Implementation:

Amsterdam has implemented sustainable urban engineering solutions, including the integration of green infrastructure and renewable energy technologies, to enhance and preserve its urban heritage.

3. Implementation:

3.1. Green Infrastructure:

Investments in green roofs, living walls, and urban green spaces mitigate the urban heat island effect, improve air quality, and enhance biodiversity, preserving the city's historic character.

Figure 8 green infrastructure

3.2. Renewable Energy:

Adoption of solar panels, wind turbines, and district heating systems in historic buildings reduces carbon emissions and minimizes environmental impact while preserving architectural integrity.

Figure 9 renewable energy

3.3. Water Management:

- **Water Retention Basins:**

Strategically located water retention basins and green-blue corridors capture and store excess rainwater, reducing the risk of urban flooding and replenishing groundwater reserves.

- **Adaptive Flood Defenses:**

Innovative flood defense systems, such as movable barriers and amphibious architecture, are implemented to protect historic waterfront areas from sea-level rise and storm surges while preserving visual continuity.

- **Canal Rehabilitation:**

Restoration and maintenance efforts focus on preserving Amsterdam's historic canal network, including dredging, bank stabilization, and ecosystem restoration, to ensure their continued functionality and cultural significance.

3.4. Adaptive Reuse:

Amsterdam promotes adaptive reuse strategies for historic buildings, repurposing them for modern uses while preserving their architectural heritage. Adaptive reuse projects often incorporate sustainable design principles, such as energy-efficient lighting, passive heating and cooling systems, and rainwater harvesting, to minimize environmental impact and maximize resource efficace

4. Benefits:

4.1. Heritage Preservation:

The integration of green infrastructure and renewable energy technologies helps preserve Amsterdam's urban heritage by mitigating the effects of climate change, reducing environmental degradation, and enhancing the resilience of historic buildings and landscapes.

4.2. Environmental Sustainability:

By embracing sustainable urban engineering solutions, Amsterdam reduces its carbon footprint, improves air and water quality, and promotes biodiversity conservation. These efforts contribute to the city's reputation as a global leader in sustainable urban development.

4.3. Community Engagement:

Sustainable urban projects in Amsterdam foster community engagement and social cohesion by creating green spaces for recreation, promoting active transportation modes such as cycling and walking, and providing educational opportunities for residents and visitors to learn about environmental conservation and heritage preservation.

4.4. Resilience to Climate Change:

The implementation of water management measures and adaptive reuse strategies enhances Amsterdam's resilience to climate change impacts, such as extreme weather events, flooding, and sea-level rise. By investing in sustainable infrastructure, the city ensures the long-term viability and vitality of its urban heritage for future generations.

Conclusion:

Amsterdam's integration of sustainable technology into urban engineering practices demonstrates how cities can enhance and preserve their urban heritage while addressing environmental sustainability and climate change challenges. By adopting a holistic approach that balances heritage conservation with innovative solutions, Amsterdam sets a precedent for sustainable urban development worldwide.

4.3. Case Study - Kyoto, Japan

Main Urban Heritage:

Kyoto, renowned for its well-preserved historic temples, traditional machiya townhouses, and scenic gardens, represents Japan's cultural and historical legacy.

Figure 10 : kyoto japan city

New Technologies Applied

1. Digital Preservation:

Description:

Kyoto employs digital preservation techniques, including 3D laser scanning and photogrammetry, to create accurate digital replicas of its historic sites and cultural artifacts.

Technology Used: 3D laser scanners, high-resolution cameras, photogrammetry software.

2. Benefits:

- **Preservation:** Digital replicas serve as valuable records of Kyoto's cultural heritage, capturing architectural details and artifacts with high accuracy.
- **Conservation Planning:** Digital models aid in conservation planning by allowing experts to analyze structural integrity, monitor deterioration, and plan restoration efforts.
- **Accessibility:** Digital replicas provide virtual access to Kyoto's heritage sites for researchers, educators, and the public, fostering greater appreciation and understanding of Japan's cultural legacy.

3. Smart Heritage Management Systems:

Description:

Kyoto utilizes smart heritage management systems to monitor and maintain its urban heritage assets.

Technology Used: Sensors, data analytics, predictive maintenance algorithms.

Benefits:

- **Condition Monitoring:** Sensors track environmental conditions, structural stability, and visitor traffic in heritage sites, providing real-time data for monitoring and maintenance.
- **Predictive Maintenance:** Data analytics and predictive algorithms identify potential issues before they escalate, allowing for proactive maintenance and preservation.
- **Resource Optimization:** Smart management systems optimize resource allocation by prioritizing conservation efforts based on data-driven assessments of risk and significance.

4. Cultural Heritage Apps:

Description:

Kyoto offers smartphone apps that provide users with information about nearby heritage sites, walking tours, and cultural events**.**

Technology Used: Mobile app development, GPS tracking, augmented reality features.

Benefits:

- **Visitor Engagement:** Cultural heritage apps enhance visitor experiences by providing interactive maps, audio guides, and multimedia content that enrich cultural interpretation.
- **Education:** Apps serve as educational tools for students and tourists, offering historical context, architectural insights, and curated content about Kyoto's cultural heritage.
- **Community Involvement:** Apps foster community involvement by encouraging user contributions, such as sharing photos, stories, and reviews of heritage sites, promoting a sense of ownership and stewardship.

Conclusion:

Kyoto's adoption of digital preservation techniques, smart heritage management systems, and cultural heritage apps demonstrates a commitment to leveraging technology for the preservation and promotion of its urban heritage. By embracing innovation while honoring tradition, Kyoto ensures that its cultural legacy remains accessible and appreciated by present and future generations.

Chapter conclusion

In the realm of heritage preservation, the integration of technology brings forth a myriad of challenges and opportunities. Throughout this chapter, we embarked on a comprehensive exploration of the intricate interplay between technological integration and urban heritage preservation.

We delved into the challenges and opportunities inherent in leveraging smart technologies to safeguard and enhance cultural heritage in urban settings. From analyzing international legal frameworks governing smart technology implementation to examining the intricacies of Algerian legislation related to urban development and heritage preservation, our aim was to uncover key insights and strategic pathways for effective integration. Through a detailed examination of case studies from Barcelona, the Netherlands, and Kyoto, we sought to distill valuable lessons and best practices that can inform the development of innovative strategies tailored to the specific context of Mostaganem.

As we conclude, it is evident that while technology presents immense potential for advancing heritage preservation efforts, its successful integration requires a nuanced understanding of legal, cultural, and technological landscapes, along with a commitment to collaborative and adaptive approaches to ensure the sustainable safeguarding of urban heritage for generations to come.

CHAPTER IV
IS OUR STUDY AREA READY FOR TRANSFORMATION INTO A SMART CITY?

Chapter IV: Is Our Study Area Ready For Transformation Into A Smart City?

Chapter Introduction

In this chapter, we will conduct a comprehensive examination of Mostaganem's landscape and strategic positioning. This analysis will involve a detailed study of the geographical context of Mostaganem, including its coordinates, elevation, and proximity to significant natural features such as the Mediterranean Sea and nearby mountain ranges. By understanding these geographical aspects, we can gain insights into how the physical environment shapes the city's development and influences its socio-economic dynamics.

Furthermore, we will delve into the historical narrative of Mostaganem to uncover the city's past and how it has evolved over time. By tracing its history, we can better understand the cultural heritage and identity of Mostaganem, as well as identify key historical events that have shaped its present-day character.

An essential aspect of our exploration will be an analysis of Mostaganem's socio-economic fabric and urban morphology. This will involve studying the city's economic activities, social structures, and urban layout to assess how these factors contribute to the overall functioning and development of Mostaganem as a community.

Moreover, we will examine the climatic conditions in Mostaganem to understand how weather patterns impact daily life in the city.

To provide a comprehensive overview, we will gather community perspectives through questionnaire surveys and interviews with residents of Mostaganem. By incorporating local voices into our analysis, we aim to capture a nuanced understanding of how people perceive their city, what challenges they face, and what aspirations they hold for its future development.

In conclusion, our exploration of Mostaganem's landscape and strategic positioning will offer a multi-faceted view of the city, encompassing its geographical context, historical narrative, socio-economic fabric, urban morphology, climatic conditions, technological infrastructure, and community perspectives. Through this holistic approach, we seek to provide a thorough understanding of Mostaganem as a dynamic urban center with a rich tapestry of influences shaping its identity.

1. Site and Situation Analysis

1.1.Geographical Location:

The study area extends over an area of 2269 km2, from 0°8' West to 0°46' East and from 36°29' to 35°37' North. Located in the northwest of Algeria, it is bordered to the north and northwest by the Mediterranean Sea, with a maritime frontage of around 120 km, to the east by the Wilaya of Chleff, in the south by the wilayas of Mascara and Rélizane, and to the west by that of Oran

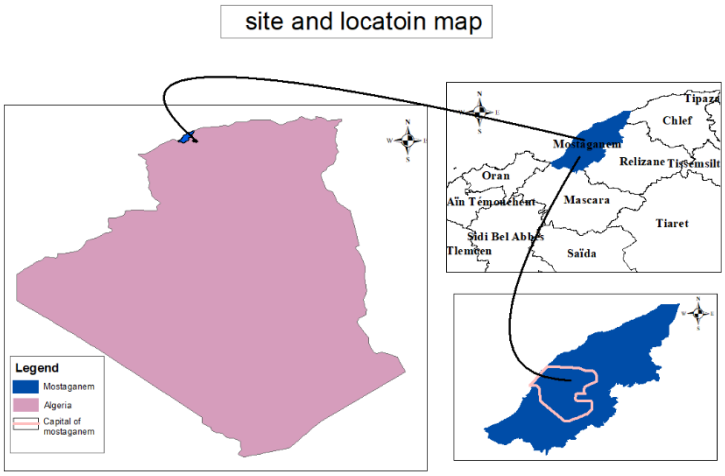


Figure 11 : Site and Situation
Source : by authors

1.2.Administrative boundaries of the municipality of Mostaganem:

The state of Mostaganem includes a total of 32 municipalities distributed among the 10 aforementioned districts; Covering an area of 2,269 square kilometers, the population of Mostaganem Province is approximately 746,947 people, with a density of 329 inhabitants/km2.

•North: Mediterranean Sea.
•North-east: Abdel Malek Ramadan municipality, Ain Boudinar on National Road No. 11.
•South-east: Ain Boudinar, Khair El Din, Sayada municipality.
•South: Mazagrane Municipality, Hassi Mamas

Figure 12: administrative boundries of the municipality of mostaganem
Source : by authors

1.3.Strategic Situation :

1.3.1. Assessment of Location and Connectivity:

- Mostaganem's strategic location in the northwest of Algeria gives it access to key transportation routes and connects it to neighboring cities and regions.
- The city benefits from its proximity to major highways, including the A1 (Algiers-Oran highway) and the N11 (connecting Mostaganem to Algiers and Oran).
- It also has a coastal location, with a significant port serving as a gateway for maritime trade and transportation along the Mediterranean Sea.
- The city's transportation infrastructure facilitates the movement of goods, people, and services, enhancing its connectivity to regional and national markets.

1.2.2. Evaluation of Cultural and Economic Hub:

- Mostaganem plays a vital role as a cultural and economic hub within the surrounding area, serving as a center for trade, commerce, and cultural exchange.
- The city's rich history and cultural heritage attract tourists and visitors, contributing to its identity as a cultural destination.
- Mostaganem's economy is diversified, with key sectors including agriculture, fisheries, manufacturing, trade, and services.
- It serves as a commercial center for agricultural products, textiles, and handicrafts produced in the surrounding rural areas.
- The city's educational institutions, healthcare facilities, and government services provide essential resources and amenities for residents and visitors alike.

1.3.Accessibility

The city of Mostaganem is accessible through various networks:

1.3.1. Road Networks:

- National Highway N11: Connects to Oran in the northwest and Ténès in the northeast.

- National Highway N23: Links Mostaganem to the Relizane province to the southeast.
- National Highway N90: Connects Mostaganem to the Tiaret province to the west.

Figure 13: accessibility of mostaganem
Source : by authors

1.3.2. Port Network:

- Mostaganem Port: Handles goods transportation.
- Salamandre Fishing and Marina Port.
- Sidi Lakhdar Fishing Port.

1.3.3. Railway Network:

- There is a freight railway line connecting the port to Mostaganem railway station, heading towards Mohammedia.

1.3.4. Airport Network:

- Mostaganem Province has an aerodrome located in the municipality of Sayada.
- The aerodrome was established in 1959 and was initially used for military purposes by the French colonizers.
- Main Runway: 1360 m x 30 m
- Secondary Runway: 700 m x 30 m
- Parking Areas: 13,000 m²
- Taxiways: 450 m x 20 m.

2. Historical and Socio-economic Analysis

2.1.History of the City:

2.1.1. Historical Significance

According to Belhamissi Moulay, the etymology of the word "Mustaghanim" is composed of two distinct terms, each with multiple meanings:

- "Machta" (wintering station), "Ghanem" (wealthy sheep farmer or one who has usufruct of land).
- "Marsa" and "Ranem," meaning the port of plunder.
- "Misk el Ghanem," meaning abandoned herds.
- According to some historians of antiquity, "Murustaga" means Roman port.[27]

2.1.2. Historical development

The city of Mostaganem has experienced a succession of civilizations, leading to the stratification of different urban structures on its site.

2.1.2.1.Period Al Moravid Period (1106/1161):

The city was founded by the Almoravids (IBN TACHFINE) (1106-1161), because it gave birth around the watercourse of AIN SAFRA all along the wadi, was characterized by the construction of Bordj El M 'Hal 1072

[27] Belhamissi Moulay, Histoire de Mostaganem des origines à nos jours, 3éme édition (revue corrigée et augmentée) ,2004

Figure 14 Historical map of al moravid period Figure 15 Photo of borj mahal

Source : by authors + google map

2.1.2.2. Al merinid period:

The period of the Merinids of Fez under the reign of Sultan ABU EL HASSAN was characterized by the construction of Derb Tobanna (the mosque of Sidi Yahia, the Great Mosque). and Tigditt de (the mosque of Sidi all m'hamed, the marabout Sidi Bakhti and his mother Lala Aichouche.

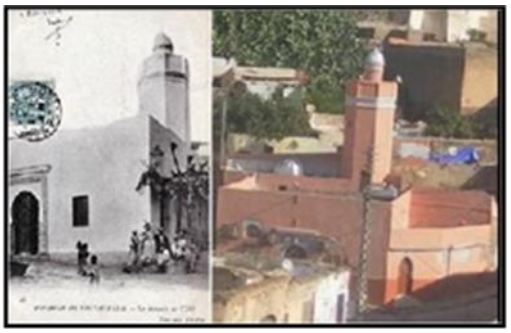


Figure 16 mosque sidi yahia ***Figure 17 photo of sidi-allal***

Figure 18 Historical map of the marinid period

2.1.2.3. Zianid-Moorish Period :

This period was characterized by the addition of the cemetery and the towns of the Mestghanem of Tigditt. of Idjdida and Mazagran under Serrazine rule. guess the center of a

flourishing trade: their entire population amounted to about 40,000 inhabitants

Figure 19 Historical map of the zianid maurs period

Figure 20 Photo of cemetery marabot

2.1.2.4. Ottoman Period :

This period was characterized by the fortification of the city and construction of a wall pierced by 5 gates

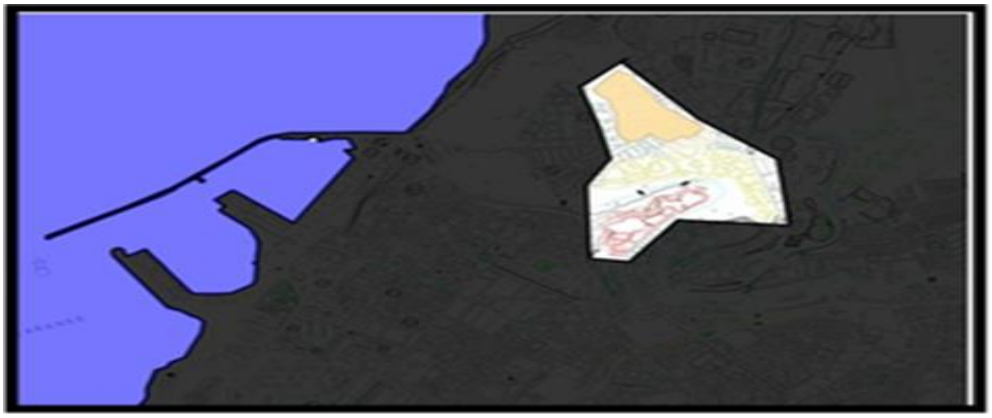


Figure 21 Historical map of the ottoman period

Summary :

2.1.2.5. Pre-colonial phase :

We note that oued Ain safra (axis or route of implantation) constitutes the main element in the formation of the city.

• Appearance of the first agglomeration (Arab quarter).

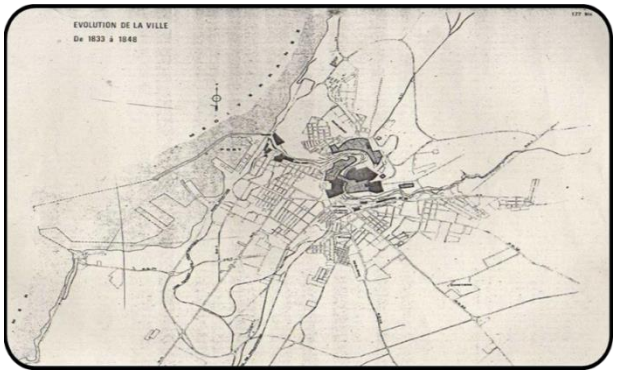


Figure 22 cadastral map of mostaganem from 1833 to 1884

Colonial Period (1833/1848) :

This period reflects the military character through the realization of new constructions such as the military hospital and the barracks.

Figure 23 photo of the military hospital

Figure 24 Historicla map of the colonial period (1833-1848)

2.1.2.6. Colonial Period (1848/1900) :

As the city takes shape, we observe the appearance of several neighborhoods (La marine, La pépinière, Beirut and Saint-Jules) around the colonial center offering French engineers and builders in Algeria the opportunity to experiment with new techniques and urban planning devices. Architectural projects

- During this period, we note the marginalization of Tigditt and the control
- Creation of the railway in 1879 as well as the development and development of the port.

2.1.2.7. Colonial Period (1900/1927) :

The period from 1900 to 1927 was marked by the intervention on the various infrastructure networks, namely the creation of the first boulevard (Benaid Bendehiba).the Tigditt district has undergone a slight transformation of its fabric by the installation of a covered market at the level of the public square.

2.1.2.8. Colonial Period (1927/1941) :

and more than 170 dead people After the disaster of the flood of wadi Ain safra, the French rebuilt the demolished buildings and urbanization of the historic center, and also the construction of three bridges, and a beginning of reflection about the outskirts of the city and realization of large structuring facilities the city (pole of urban life).

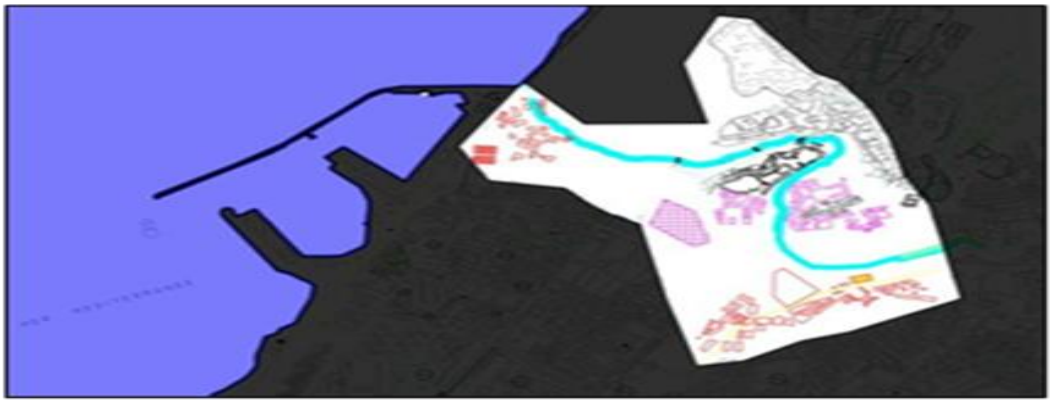


Figure 25 Historical map of the colonial period (1848-1990)

2.1.2.9. Colonial Period (1940/1962) :

Until the 1940s, the production of housing was the result of private initiative. It was only after 1954 that the French authorities implemented formulas to accommodate the disadvantaged Algerian population. Coming from the rural exodus, it was installed in slums near Monplaisir, El Arsa and Tidjditt.

To the north of these neighborhoods, the French army in 1956 built a resettlement camp called "The captain's houses", and the office HLM (Moderate rent housing) for its part, has built housing of various types on two sites. During the last years of the National Liberation War, Constantine's Plan financed high-rise housing in Raisin Ville, Beirut and at the south-eastern end of the city.

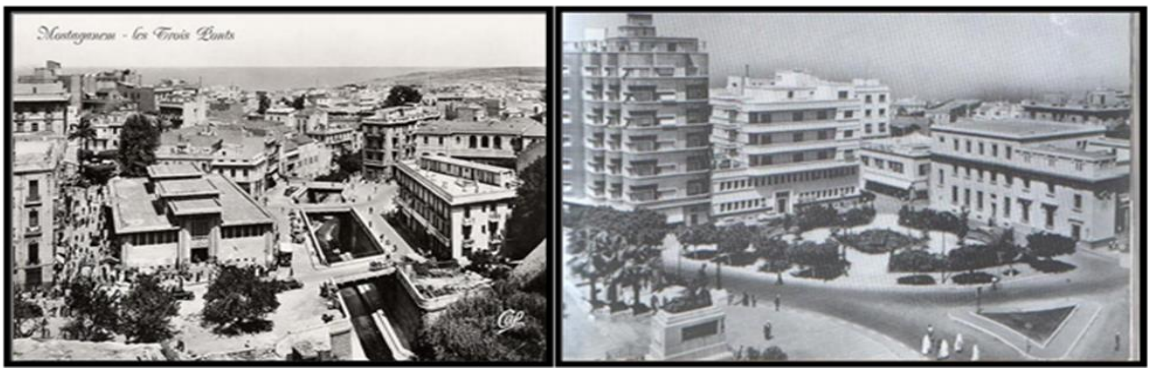


Figure 26 photos of the structuring equipement of the city

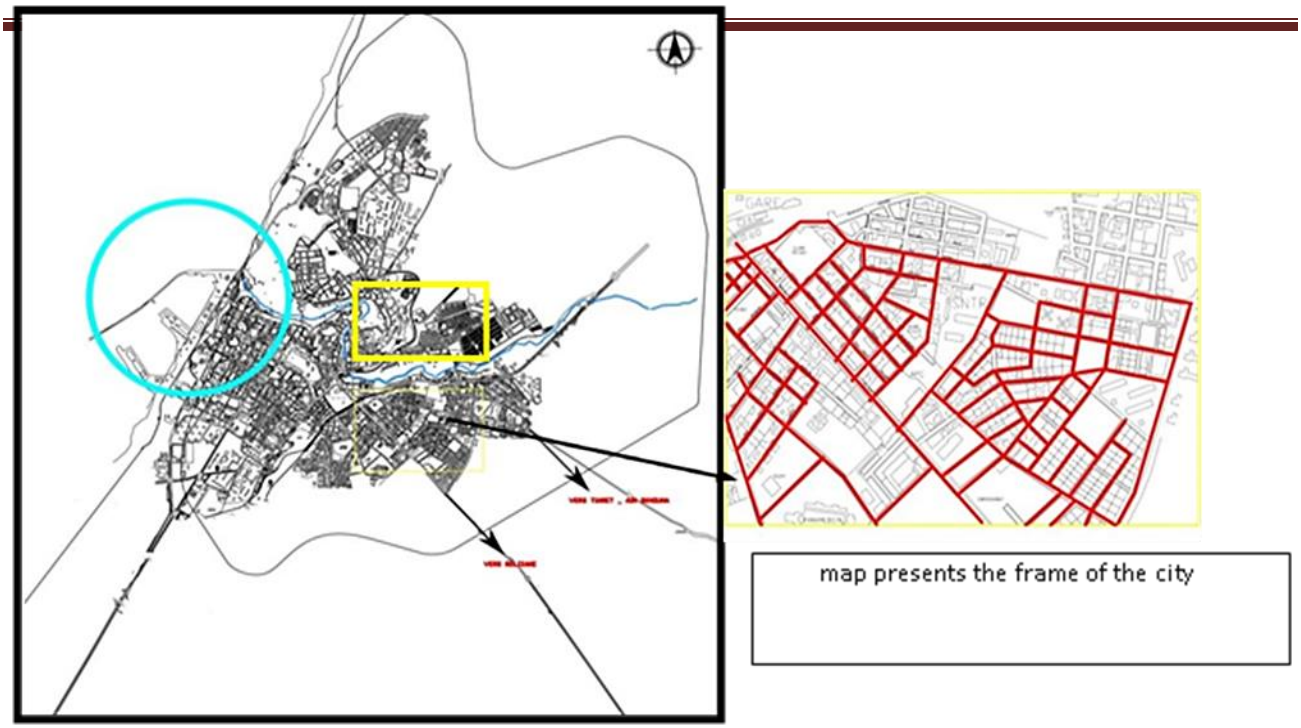


Figure 27 map presents the frame of the city

2.1.2.10. Colonial phase :

During the colonial period we notice :

- Appearance of the central core of the city.
- The extension of the city was on the south and south-west side because of the natural limits namely: The sea and the wadi Ain el safraa.

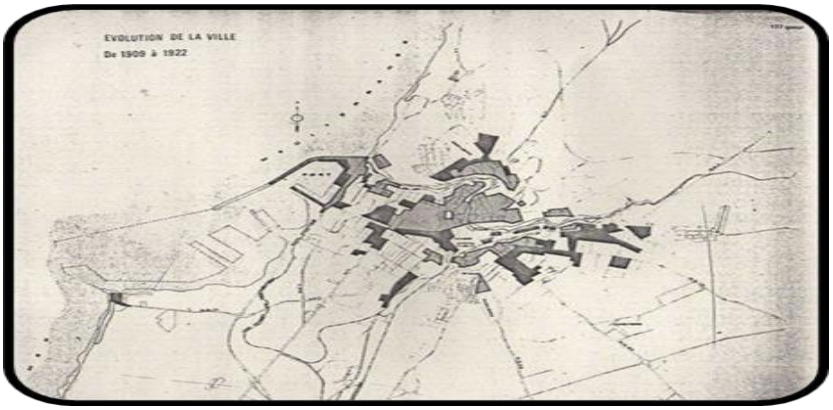


Figure 28 cadastral plan from 1908 - 1922

Figure 29 cadastral plan from 1922-1940

2.1.2.11. Postcolonial period (1970-1980) :

This period was characterized by the extension of the city to the Northwest and Southwest.

When we see these maps we notice that the extension of the city is oriented to the south-west and north-west on agricultural land.

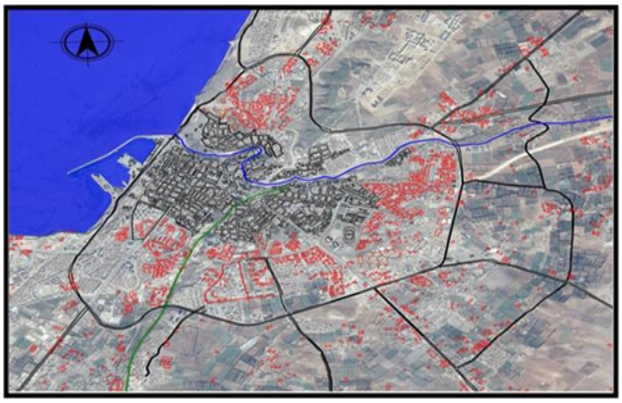


Figure 30 map presents the extension of the city

Summary

2.1.2.12. Postcolonial phase :

In this phase we notice that :

-The city of Mostaganem begins to take on the main image of the current city.

- The extension of the city is in three directions: south, east and west.

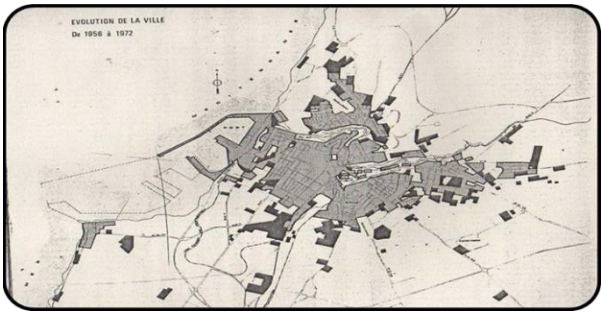


Figure 31 cadastral map of mostaganem 1956 - 1972

2.1.3. Cultural Heritage Sites:

- **Great Mosque of Tebbana:** Built in the Islamic period, the Great Mosque of Tebbana is one of Mostaganem's most prominent cultural landmarks. It features architectural elements characteristic of Islamic architecture and reflects the city's religious and cultural heritage.

Figure 32 Great mosque of Tebbana

- **Bordj el M'Hal (Old Citadel):** Constructed during the Almoravid period, Bordj el M'Hal served as a defensive fortress and symbolizes Mostaganem's military history and strategic importance.

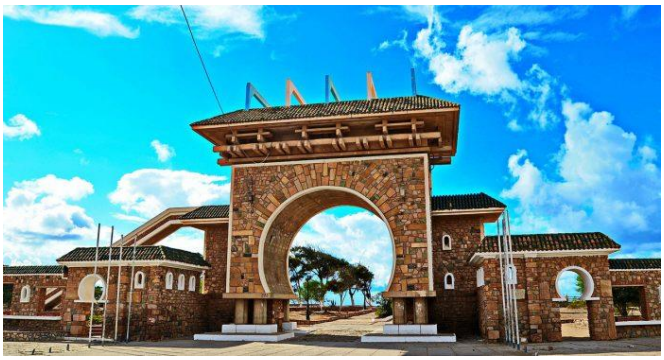


Figure 33 Bordj mahal (old citadel)

- **Palace of Bey Mohammed El Kebir (1750**): This palace is a historical landmark that reflects the architectural style of the Ottoman period. It served as the residence of Bey Mohammed El Kebir, who was a prominent figure in Mostaganem's history. The palace represents the city's Ottoman heritage and its former political and administrative center.

Figure 34 palace of bey mohamed el kebir

➢ **The Synagogue:** Mostaganem's synagogue is a testament to the city's religious diversity and multicultural heritage. It served as a place of worship for the Jewish community and reflects the coexistence of different religious and cultural traditions in Mostaganem's history.

➢ **Dar el Caïd (Ottoman Era):** Dar el Caïd is a historical building from the Ottoman period, serving as the residence of a local Ottoman official or "caïd." It represents the Ottoman influence on Mostaganem's architecture and governance structure during that time.

Figure 35 dar el caid (othhman era)

2.1.Socio-economic Profile:

2.1.1. Population demographics

The population of the Mostaganem province was estimated to be 849,000 inhabitants as of December 31, 2016, with an additional volume of 14,400 inhabitants compared to the previous year. The population is distributed as follows:

Population in the capital agglomeration: 387,265 inhabitants, accounting for 45.61%.

- Population in secondary agglomerations: 117,000 inhabitants, representing 13.78%.
- Sparse population: 344,735 inhabitants, making up 40.61%.

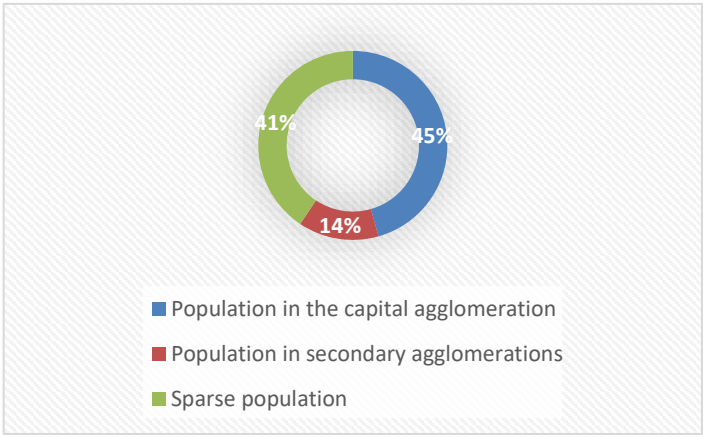


Figure 36 population demographics

Source : by authors

The population density shows very high concentrations in the municipalities of Mostaganem and Mazagran, with respective densities of 3,205 inhabitants/km² and 1,536 inhabitants/km². This situation leads to challenges in addressing the needs of the populations.

2.1.2. employment sectors

In 2016, employment figures show an active population of around 423,194, an employed population of 383,405, and an unemployed population of 39,789, resulting in an unemployment rate of 9.40%.

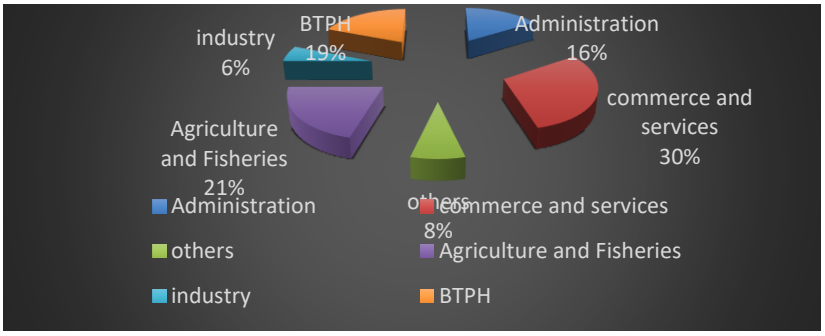


Figure 37 employement sectors

Source : by authors

➢ The commerce and services sector remains the largest employer with an employed population of 113,338, representing 30%. The agriculture and fisheries sector comes in second place with 82,402 people, accounting for 21%.

2.1.3. Age and gender structure of the population of the city of Mostaganem

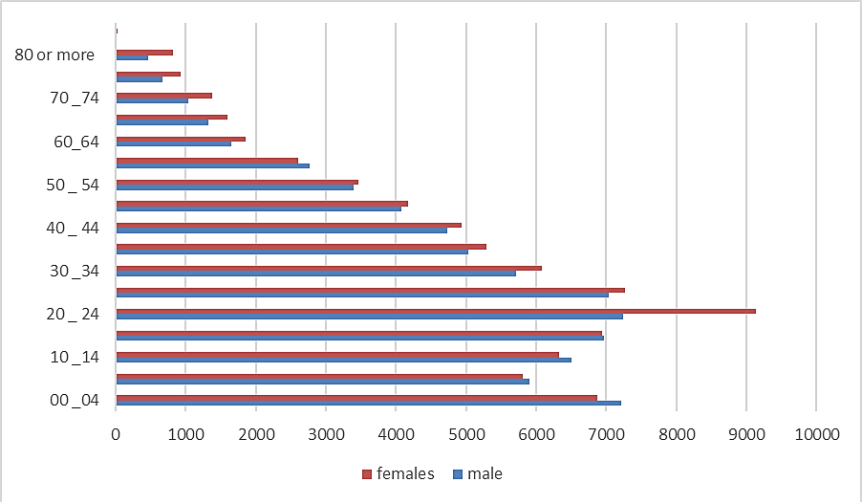


Figure 38 population of mostaganem city by gender and categories

Source : by authors

Source: master plan for the urban development of the city of Mostaganem 2015

➢ From the previous table, we note that the city of Mostaganem is a young society, with the group representing 36.40% of the population, followed by the teenagers group with 87.16%, then the elderly with 64.15%, while the elderly represent 80.10%, and the rest represents the children group from 1 to 4 years.

3. Morphological Assessment

3.1.Urban Form:

3.1.1. Analysis of Mostaganem's Urban Layout

3.1.1.1.Arrangement of Streets:

Mostaganem's street layout is characterized by a mix of narrow, winding streets in the older parts of the city and more organized, grid-like patterns in the newer districts. The historic center features traditional medina-style streets, which are narrow and pedestrian-friendly, creating an intimate urban environment.

3.1.1.2.Buildings:

Mostaganem features a diverse array of buildings that reflect its historical legacy, colonial past, and modern development. Here's an overview of the key types of buildings found in the city

Table 7 building by category

Category	Description
Historical Buildings	
Traditional Algerian Architecture	Buildings in the old town (Medina) showcasing traditional Algerian architectural styles, including intricate designs, courtyards, and historical facades.
Religious Buildings	Includes mosques such as the Great Mosque of Mostaganem, notable for their historical and architectural significance.
Colonial-Era Buildings	
French Colonial Architecture	Structures built during the French colonial period, characterized by European architectural influences, including administrative buildings, schools, and residential areas.
Historic Government Buildings	Examples include the City Hall and former colonial administrative offices, often featuring neoclassical and French architectural elements.
Modern Buildings	
Residential Buildings	A mix of high-rise apartments, suburban housing complexes, and traditional houses adapted to modern living standards.
Commercial Buildings	Modern shopping centers, office buildings, and hotels reflecting contemporary architectural styles and commercial needs.
Educational and Cultural Buildings	
Schools and Universities	Educational institutions such as primary and secondary schools, as well as higher education facilities like the University of Abdelhamid Ibn Badis.
Cultural Centers and Museums	Includes cultural centers, libraries, and museums like the Museum of Mostaganem, which preserve and promote

	local heritage and culture.
Infrastructure and Public Buildings	
Healthcare Facilities	Hospitals, clinics, and medical centers providing healthcare services to the community.
Government Offices	Modern government buildings housing various administrative functions and public services.
Industrial and Port Buildings	
Industrial Facilities	Factories, warehouses, and other industrial buildings supporting the local economy and employment.
Port Facilities	Buildings related to the operations of Mostaganem's ports, including storage facilities and administrative offices.

Source : by authors

3.1.1.3. Public Spaces:

Table 8 public spaces

Public Space	Description	Activities/Features
Promenade des Anglais	Located along the Mediterranean coast, offering stunning views of the sea. Popular for strolls, jogging, and relaxation.	Leisurely walks, jogging, picnics, outdoor gatherings
Place du 1er Novembre	Central square bustling with cafes, shops, and restaurants. Hosts cultural events, street performances, and festivals.	Cafes, shops, restaurants, cultural events, festivals
Souk El-Haddadine	Traditional market with narrow alleys selling various goods. Vibrant ambiance with colors, scents, and lively activity.	Fresh produce, spices, clothing, handicrafts
Jardin Public	Green oasis in the city featuring lush greenery and shaded seating areas. Ideal for relaxation, picnics, and walks.	Tranquil atmosphere, picnics, leisurely walks, playgrounds
Port de Plaisance	Waterfront area with a marina, promenades, cafes, and restaurants. Offers boat rides, fishing, and scenic harbor views.	Marina facilities, waterfront promenades, cafes, boat rides

Source : by Authors

4. Climate Analysis

4.1. Climate Classification:

4.2. Mostaganem's climate type

Studying the climate is considered an essential part of the process of designing and developing smart cities. In this regard, we will try to analyze the extent to which climate elements conbute to achieving a more sustainable, comfortable, and safe urban environment for the city of Mostaganem.

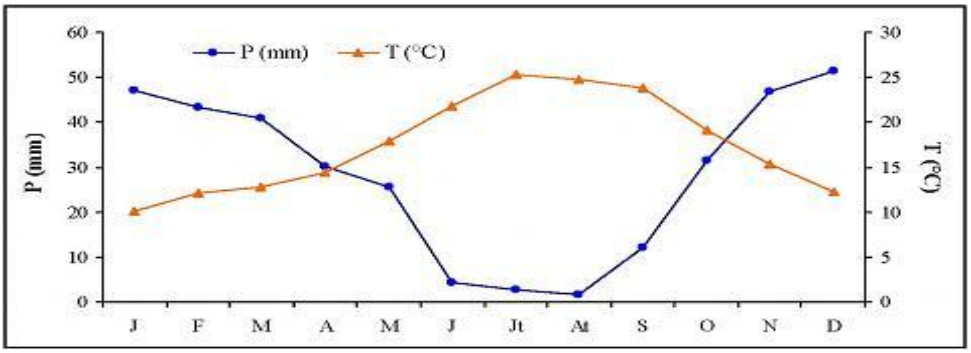


Figure 39 diagramme ombrothermique de la station de mostaganem

source : Office National de Météorologie

During the period from 1977 to 2012, Mostaganem received an average annual precipitation of 376 mm, but with significant interannual fluctuations and a general upward trend. Over the decades 1980-1989, 1990-1999, and 2000-2009, the average annual values reached 327 mm, 345 mm, and 427 mm respectively. The Mostaganem station appears to be quite representative of the average precipitation across the wilaya: with 340 mm/year over the period 1976-2005, it ranks 6th out of 13 stations, in descending order, with the maximum value being that of Sidi Lakhdar with 448 mm/year.

4.2.1. Temperature

The maximum heat month during a year is August and July. The average temperature during this period reaches around 27.9 - 30°C, making it the hottest time of the year. During the months of January and December, there is a notable drop in temperatures, with an average minimum of around 10.9°C.

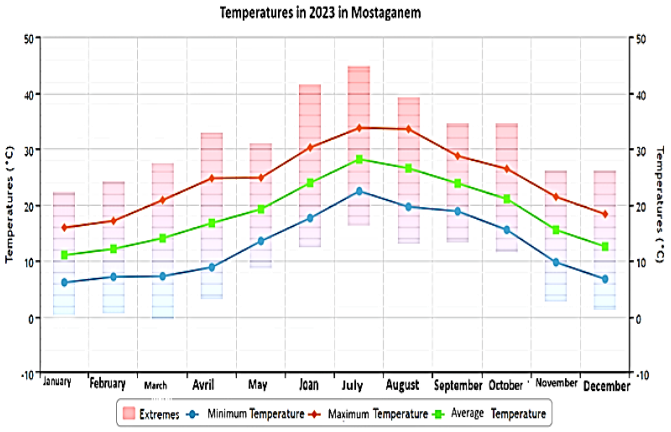


Figure 40 temaperature

4.1.3. Precipitation

Mostaganem experiences a Mediterranean climate with distinct wet and dry seasons. The majority of its precipitation falls during the winter months, primarily as rain. The average annual precipitation is approximately 500 mm (19.6 inches). The driest months are July and August when little to no rainfall occurs.

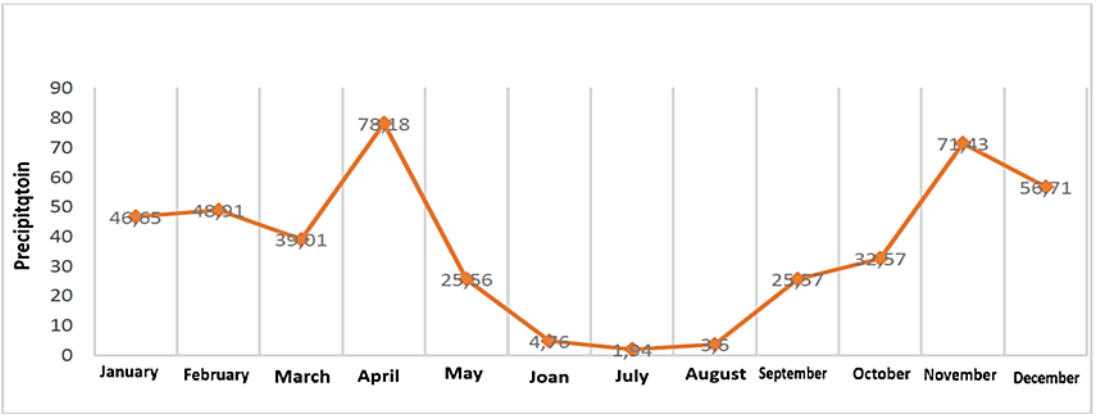


Figure 41 represents the average monthly precipition
Source: Mostaganem Meteorological Station 2023

➢ We notice from the figure above that the highest precipitation was in the month of April, estimated at 78,18 mm, and it decreased in July to the lowest rate of 1,94 mm.

4.2.2. Winds

The prevailing winds in Mostaganem are the Algerian Tramontane and the Sirocco. The Algerian Tramontane is a cold northerly wind that blows during the winter months, bringing cooler temperatures and occasional rainfall. The Sirocco is a hot southerly wind that occurs during the summer months, contributing to higher temperatures and lower humidity levels. These winds play an essential role in shaping Mostaganem's climate by influencing temperature patterns and precipitation distribution throughout the year.

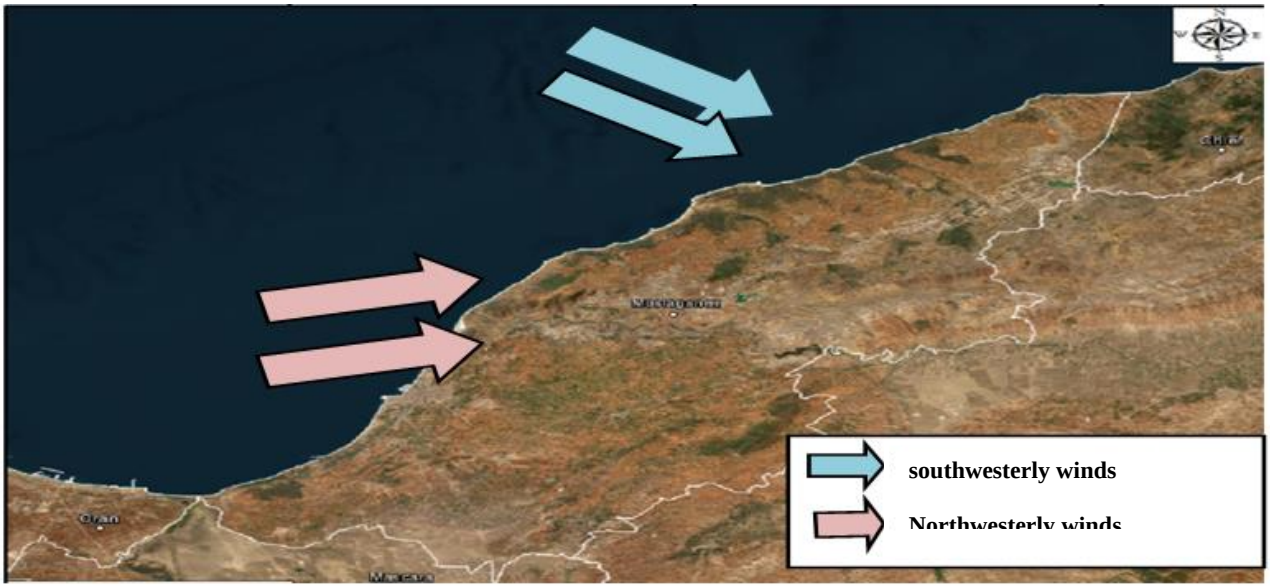
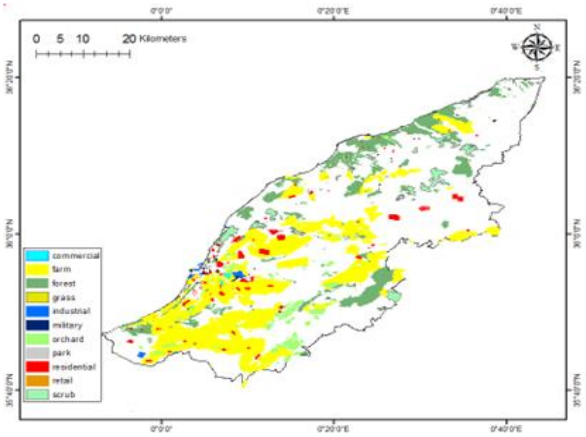


Figure 42 winds

4.1.4. Land use :



From the map, we notice the spread of residential areas throughout the city, with a higher population density in the central areas and old neighborhoods compared to the new areas, as well as the concentration of commercial activities in the city center and the main neighborhoods. Most industrial facilities are located on the outskirts of the city, and small workshops are spread in some areas. Residential

4.3.Climate Resilience:

Mostaganem, a city located in northwestern Algeria, is exposed to various climate-related hazards, including flooding and earthquakes. Let us assess the vulnerability of Mostaganem to these two hazards based on the latest scientific research and authoritative sources.

4.3.1. Flooding:

Flooding is a common natural hazard in Mostaganem due to its geographical location near the Mediterranean Sea. The city experiences heavy rainfall during the autumn season, which can lead to urban flooding. According to a study published in the Journal of Hydrology (2019), Mostaganem has experienced an average annual rainfall of 538 mm over the past 50 years. However, extreme rainfall events have led to significant flooding incidents, such as in 2007 and 2013.

The vulnerability of Mostaganem to flooding is exacerbated by several factors. Firstly, the city's rapid urbanization has led to the construction of buildings and infrastructure in flood-prone areas without adequate drainage systems or flood protection measures. Secondly, sea-level rise and storm surges can increase the risk of flooding in coastal areas. Lastly, climate change is expected to lead to more frequent and intense rainfall events in the region, further increasing the risk of flooding.

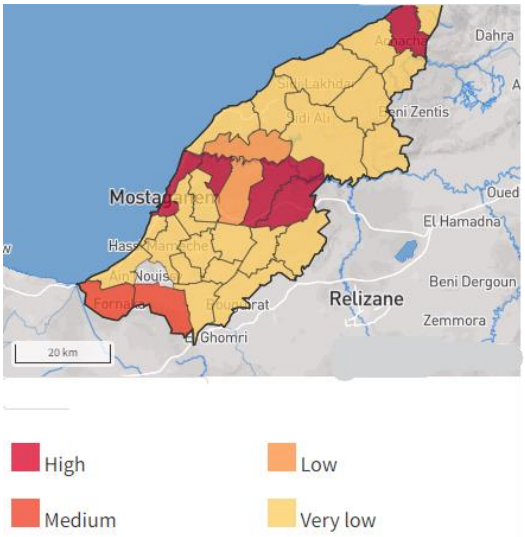


Figure 43 map of flooding

4.3.2. Earthquakes:

Mostaganem is located in a seismically active region, with several fault lines nearby. The most significant earthquake recorded in the area was a magnitude 6.3 earthquake that struck Algiers in 1980, causing significant damage and casualties. However, there have been no major earthquakes reported in Mostaganem itself since records began.

Despite this historical record, Mostaganem remains vulnerable to earthquakes due to several factors. Firstly, many buildings in the city were constructed using traditional techniques that do not meet modern seismic codes. Secondly, there is a lack of early warning systems and emergency preparedness plans in place to mitigate the impact of an earthquake. Lastly, population growth and urbanization have led to increased exposure to potential earthquake hazards.

In conclusion, Mostaganem faces significant vulnerabilities from both flooding and earthquakes due to its geographical location and human activities. Flood risks are exacerbated by urbanization without adequate drainage systems or flood protection measures, extreme rainfall events made more frequent by climate change, and sea-level rise and storm surges along the coastline. Earthquake risks are increased by traditional building techniques that do not meet modern seismic codes, a lack of early warning systems and emergency preparedness plans, and population growth and urbanization that increase exposure to potential hazards.

5. Analysis of Questionnaire Survey

5.1.Questionnaire Survey Analysis:

To gather insights into residents' perceptions and attitudes towards the integration of new technologies for enhancing urban heritage in Mostaganem , a questionnaire survey was conducted with a sample of 250 residents. The following analysis delves into the key findings from the survey responses.

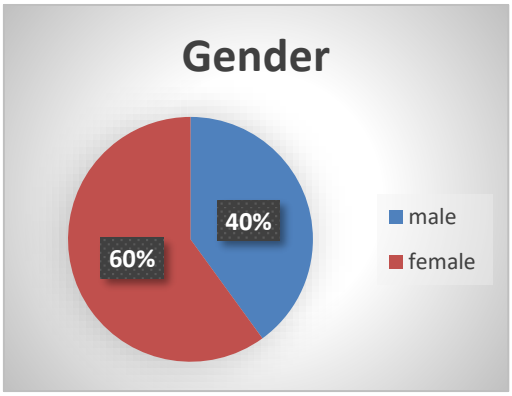
1. Personal Information:

- **Gender :**

The number of residents participating in the questionnaire by gender:

According to the results indicated in the graph below, we observe that the percentage of

female participants was 60%, which is higher than the percentage of male participants, which was 40%.



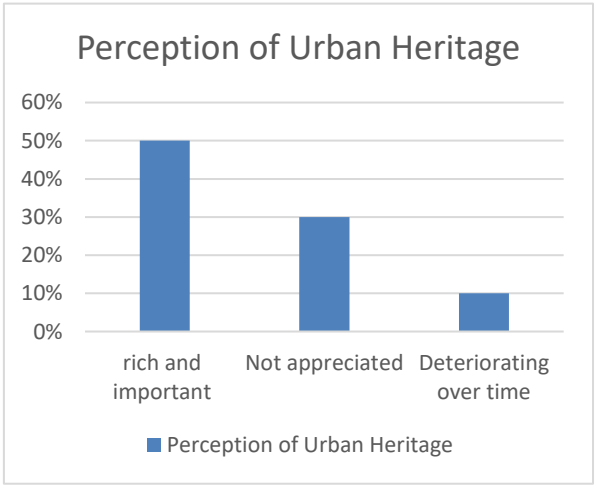
- **Age Groups :**

✓ **The most age groups is :**

The age of participants in the survey is divided into two categories. The first category, aged 16 to 45 years old, can be considered as the youth category. The other category consists of older individuals, aged between 46 and 55 years old. Analyzing the graph results, the proportion of the youth category is 79%, which is higher than the 21% of the older age category

2. General Awareness:

- **Perception of Urban Heritage**

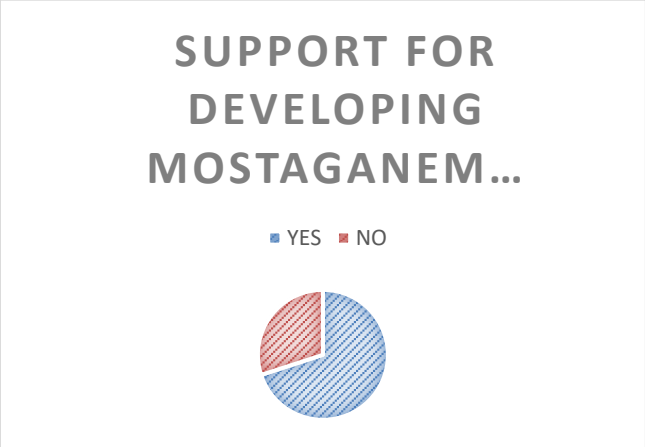


✓ 50% of respondents perceive the urban heritage in Mostaganem as culturally rich and historically significant, reflecting a sense of pride and appreciation.

✓ 30% believe that urban heritage is underappreciated and not adequately preserved, signaling concerns about neglect or lack of awareness.

✓ 10% express concerns about the deteriorating state of urban heritage over time, highlighting potential threats to historical landmarks or cultural sites.

- **Support for Developing Mostaganem into a Smart City :**



✓ 70% of participants express support for the idea of transforming Mostaganem into a smart city, recognizing the potential benefits of integrating modern technologies into urban development.

✓ 30% indicate opposition to this idea, citing potential challenges or concerns about the impact of technological advancement on the city's traditional character.

- **Awareness of Efforts to Preserve Urban Heritage:**

✓ 60% of respondents are aware of ongoing efforts to preserve and promote urban heritage in Mostaganem, indicating a level of community engagement and interest in heritage conservation.

✓ 40% lack awareness of such efforts, suggesting potential gaps in communication or outreach regarding heritage preservation initiatives.

2. Technology Usage:

- **Smart Devices Usage:**

✓ 80% of survey participants report regular use of smartphones and digital devices in their daily lives, indicating high levels of technology adoption and digital connectivity within the community.

- **Use of Smartphone Apps for Urban Heritage Exploration:**

✓ 40% of respondents have utilized smartphone apps or digital tools to explore urban heritage sites in Mostaganem, showcasing a willingness to engage with technology for heritage-related activities.

- **Awareness of New Technologies for Urban Heritage Enhancement:**

✓ 70% of survey respondents claim awareness of new technologies that can be employed to enhance urban heritage in Mostaganem, demonstrating a level of familiarity with potential solutions for heritage preservation and promotion.

3. Urban Heritage Enhancement:

- **Challenges Facing Urban Heritage:**

=> Participants identify various challenges facing urban heritage in Mostaganem

✓ 40% highlight insufficient funding and resources as a major obstacle to heritage preservation efforts, indicating a need for increased investment and financial support.

✓ 30% express concerns about deteriorating infrastructure and the need for maintenance and restoration to ensure the longevity of heritage sites.

✓ 20% cite lack of awareness and education as a challenge, emphasizing the importance of community engagement and public outreach in heritage conservation.

- **Notable Efforts to Enhance Urban Heritage:**

✓ 60% of respondents have observed recent initiatives aimed at enhancing urban heritage in Mostaganem, suggesting active involvement from stakeholders and organizations in heritage preservation projects.

- **Importance of Technology in Urban Heritage Preservation**

✓ 80% of survey participants recognize the significance of technology in preserving and promoting urban heritage, highlighting the potential of digital solutions to address challenges and enhance the visitor experience at heritage sites

4. New Technologies and Urban Heritage:

- **Use of New Technologies for Increased Interaction with Heritage Sites :**

✓ 60% of respondents believe that leveraging new technologies can facilitate increased interaction with heritage sites, offering innovative ways for visitors to engage with historical and cultural narratives.

- **Most Beneficial Technologies for Urban Heritage Preservation:**

=> Participants identify several technologies as potentially beneficial for urban heritage preservation:

✓ 50% prioritize environmental monitoring sensors, recognizing their role in safeguarding heritage sites against environmental threats such as pollution or climate change.

✓ 30% see mobile apps for heritage interpretation as valuable tools for providing contextual information and immersive experiences to visitors.

5. Challenges and Opportunities:

- **Potential Challenges in Implementing New Technologies for Urban Heritage Enhancement:**

=> Participants anticipate various challenges in implementing new technologies for urban heritage enhancement:

✓ 40% cite technological infrastructure limitations as a major hurdle, underscoring the need for robust digital infrastructure to support innovative solutions

Summary

The survey results highlight a community that is both appreciative of its urban heritage and open to leveraging modern technology for its enhancement and preservation. However, challenges such as funding, infrastructure, and awareness need to be addressed to fully realize these opportunities. The strong support for transforming Mostaganem into a smart city and the recognition of the importance of technology in heritage preservation provide a promising foundation for future initiatives. Enhanced communication, increased investment, and strategic use of technology can significantly contribute to the sustainable development and preservation of Mostaganem's rich urban heritage.

Chapter Conclusion

In this section, we have conducted a thorough examination of Mostaganem's landscape and strategic positioning. Our analysis has focused on the geographical context of Mostaganem, including its coordinates, elevation, and proximity to significant natural features such as the Mediterranean Sea and nearby mountain ranges. By exploring these geographical aspects, we have gained valuable insights into how the physical environment influences the city's development and socio-economic dynamics. Moreover, we have delved into the historical narrative of Mostaganem, revealing the city's past and its evolution over time. Through tracing its history, we have acquired a deeper understanding of Mostaganem's cultural heritage and identity. Additionally, we have identified key historical events that have significantly impacted the city's present-day character.

In our investigation, we delved into the socio-economic fabric and urban morphology of Mostaganem. This encompassed a detailed analysis of the city's economic activities, social structures, and urban layout to comprehend how these elements contribute to the overall functioning and development of the community. We scrutinized Mostaganem's economic landscape to identify key industries, businesses, and employment opportunities that shape the city's economic vitality. Additionally, we examined the social structures within the community to understand its demographic makeup, cultural dynamics, and social hierarchies. Furthermore, an in-depth analysis of the urban layout provided insights into the spatial organization of Mostaganem, including residential areas, commercial districts, transportation networks, and public spaces.Our exploration also involved an assessment of the climatic conditions in Mostaganem to ascertain how weather patterns influence daily life in the city. By understanding the climate-related challenges faced by residents, such as extreme temperatures or precipitation levels, we gained valuable insights into how environmental factors shape various aspects of urban living.

Furthermore,To provide a comprehensive overview of Mostaganem's community dynamics, we engaged with local residents through questionnaire surveys and interviews. By incorporating their perspectives into our analysis, we aimed to capture a nuanced understanding of how people perceive their city. This approach allowed us to identify key challenges faced by residents, as well as their aspirations for the future development of Mostaganem.

In conclusion, our exploration of Mostaganem's landscape and strategic positioning has offered a multi-faceted view of the city. Through examining its geographical context, historical narrative, socio-economic fabric, urban morphology, climatic conditions , and community perspectives, we have provided a thorough understanding of Mostaganem as a dynamic urban center with a rich tapestry of influences shaping its identity.

Chapter V

TOWARDS A SMART NEIGHBORHOOD: A JOURNEY EXPLORING FOREIGN EXPERIENCES AND PRACTICAL IMPLEMENTATION THROUGH AN EXECUTIVE PROJECT

Chapter V: Towards A Smart Neighborhood: A Journey Exploring Foreign Experiences And Practical Implementation Through An Executive Project

Chapter Introduction

In the realm of urban development, the concept of smart neighborhoods has emerged as a transformative approach to enhancing livability, sustainability, and technological integration within urban spaces.

El Arsa, a neighborhood nestled in the heart of Mostaganem, is a vibrant tapestry of history, culture, and future potential. This chapter delves into the essence of El Arsa, providing a comprehensive overview of its geographical, historical, and cultural context. By examining its past, we can appreciate the richness of its heritage and understand the forces that have shaped its development. In exploring its present, we can assess the current challenges and opportunities faced by the neighborhood. Lastly, by envisioning its potential, we can identify strategies to enhance and preserve its unique character while integrating modern technologies to foster a smart and sustainable urban environment.

This introductory chapter sets the stage for a detailed exploration of El Arsa, offering insights into its geographical location, accessibility, climate, urban formation, and cultural significance. It aims to highlight the neighborhood's strengths and constraints, providing a foundation for developing a smart urban development plan that harmoniously blends El Arsa's rich heritage with innovative technological advancements.

1. Understanding hay el arsa : Past, Present, and Potential Introduction to

El arsa , nestled in the heart of Mostaganem, holds a rich tapestry of history, culture, and potential for the future. This section serves as an introductory exploration into the essence of el arsa , providing a contextual backdrop for understanding its evolution over time.

1.1.Overview of El Arsa :

1.1.1. Geographical location

El Arsa neighborhood of Mostaganem is a historical district of Mostaganem, including the old town. It is located in the heart of Mostaganem's city center.

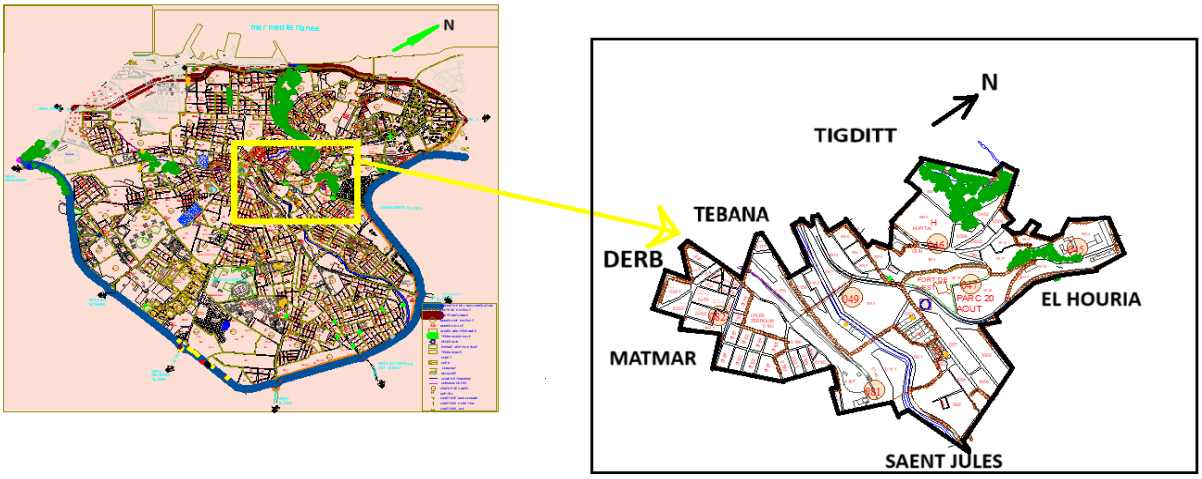


Figure 44 geograohical location of el arsa mostaganem
source : PDAU + by authors

The El Arsa neighborhood is bordered:

- to the east by the neighborhoods of Matmar and Derb, Tebbana
- to the south by the Saint Jules neighborhood;
- to the west by the El Houria neighborhood;
- to the north by the Panorama forest .

1.1.2. Accessibility

There are limited access routes available.

The Dahra Boulevard serves as the main axis of the neighborhood, constrained by its proximity to the rapid transit route and the presence of the fort. (Bordj)

It's a socially limited accessible neighborhood.

- These points are part of the constraints.
- There are several dead-end streets (Rue Aiachi Belhadj, ...).
- This limitation is due to the rapid traffic flow of the RN90 (alternate passage).

To position the El Arsa neighborhood close to access points in the city center, with two access routes on the right side.

- The first section: direct access to the adjacent neighborhood. (highlighting the main points)
- Secondly, enter the Colonel Lotfi neighborhood via Khattab Abdelkader Street.

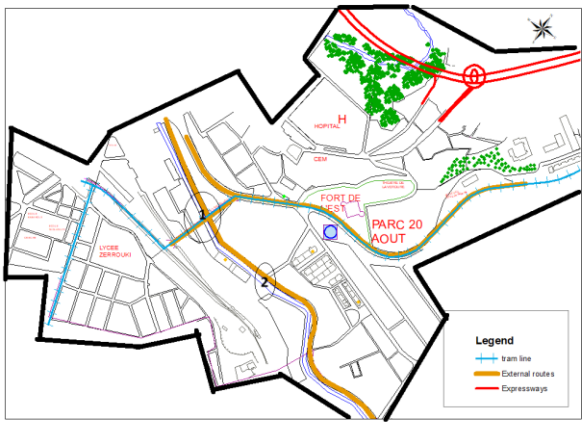


Figure 45 : map of access to the 'Arsa district

Source: by authors

1.1.3. Climate analysis

El Arsa is situated in northern Algeria, close to the Mediterranean Sea. As such, it likely experiences a Mediterranean climate with some variations due to its specific geographical features.

Here's a more tailored analysis:

- **Temperature:** Summers are generally hot, with temperatures often exceeding 30°C (86°F), particularly during July and August, which are typically the hottest months. Winters are cooler but still relatively mild compared to inland areas, with average temperatures ranging from 10°C to 15°C (50°F to 59°F).
- **Rainfall:** Most of the precipitation in El Arsa is concentrated in the winter months, especially between November and March. The region likely receives moderate rainfall during this period, which helps sustain vegetation and agriculture in the area.
- **Humidity:** Being near the coast, El Arsa may experience higher humidity levels compared to inland areas, especially during the summer months. However, humidity levels are generally lower compared to tropical coastal regions.
- **Wind:** Coastal areas often experience moderate to strong winds, particularly during the spring and summer months. These winds can have a cooling effect on hot days but may also contribute to dry conditions and dust storms.
- **Microclimates:** El Arsa's specific location and topography may give rise to microclimates within the region. For example, areas closer to the sea may experience slightly milder temperatures and higher humidity levels compared to inland areas.

1.1.4. Urban Formation:

The study area, known as "Al-Arsa," is characterized by its irregular shape. The glorious city of Al-Arsa, formerly known as "Lemon Tree," is located northwest of Wadi Ain Safra,

approximately 2 kilometers away. Al-Arsa also borders Wadi Ain Safra, being just a few hundred meters from the city center.The area is dominated by the wall of the Turkish Tower, referred to by the French as the "Eastern Fort," situated about 800 meters to the left of Al-Arsa. This elevated fort provides clear visibility in all directions, which was a significant strategic advantage.

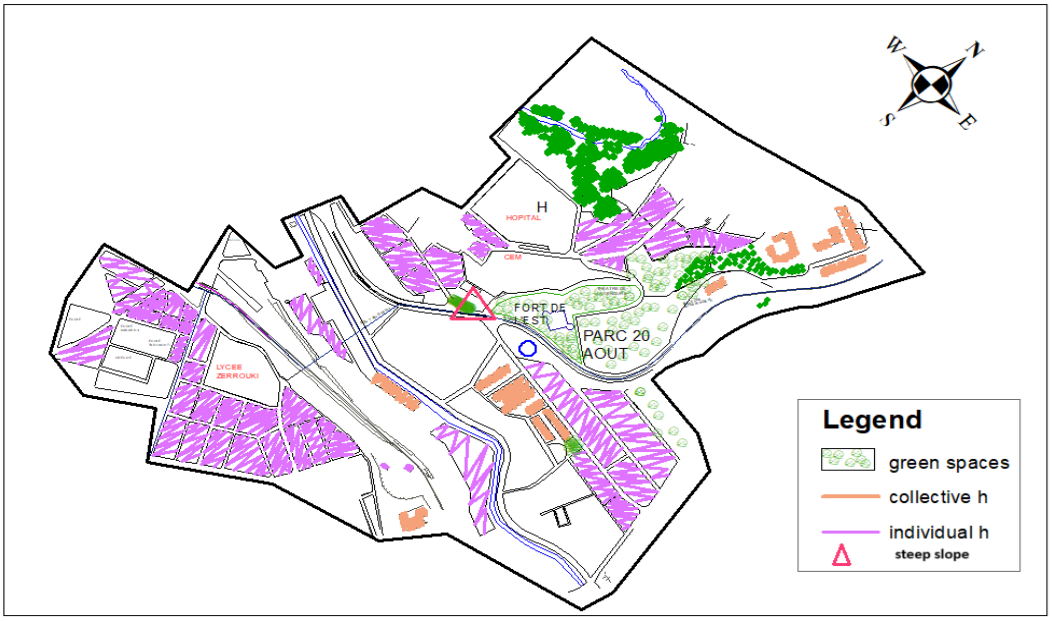


Figure 46 urban formation
source : PDAU + by authors

Within the construction area to the southwest of Al-Arsa, there is a steep slope that gradually becomes less significant towards the northeast. These varied terrains contribute to the area's character and influence its urban distribution.The proliferation of "empty spaces" without any real purpose, and for green spaces, the overgrowth of certain key areas of the fort of El Arsa.

1.2.Unveiling EL ARSA: A Historical and Cultural Perspective

El Arsa holds a significant historical and cultural heritage that dates back centuries. The neighborhood has played a crucial role in the development of the region, with its roots deeply intertwined with the history of the area. Exploring El Arsa’s historical significance reveals a rich tapestry of events, traditions, and influences that have shaped its identity over time

- some of the most important historical landmarks in the El Arsa area of Mostaganem

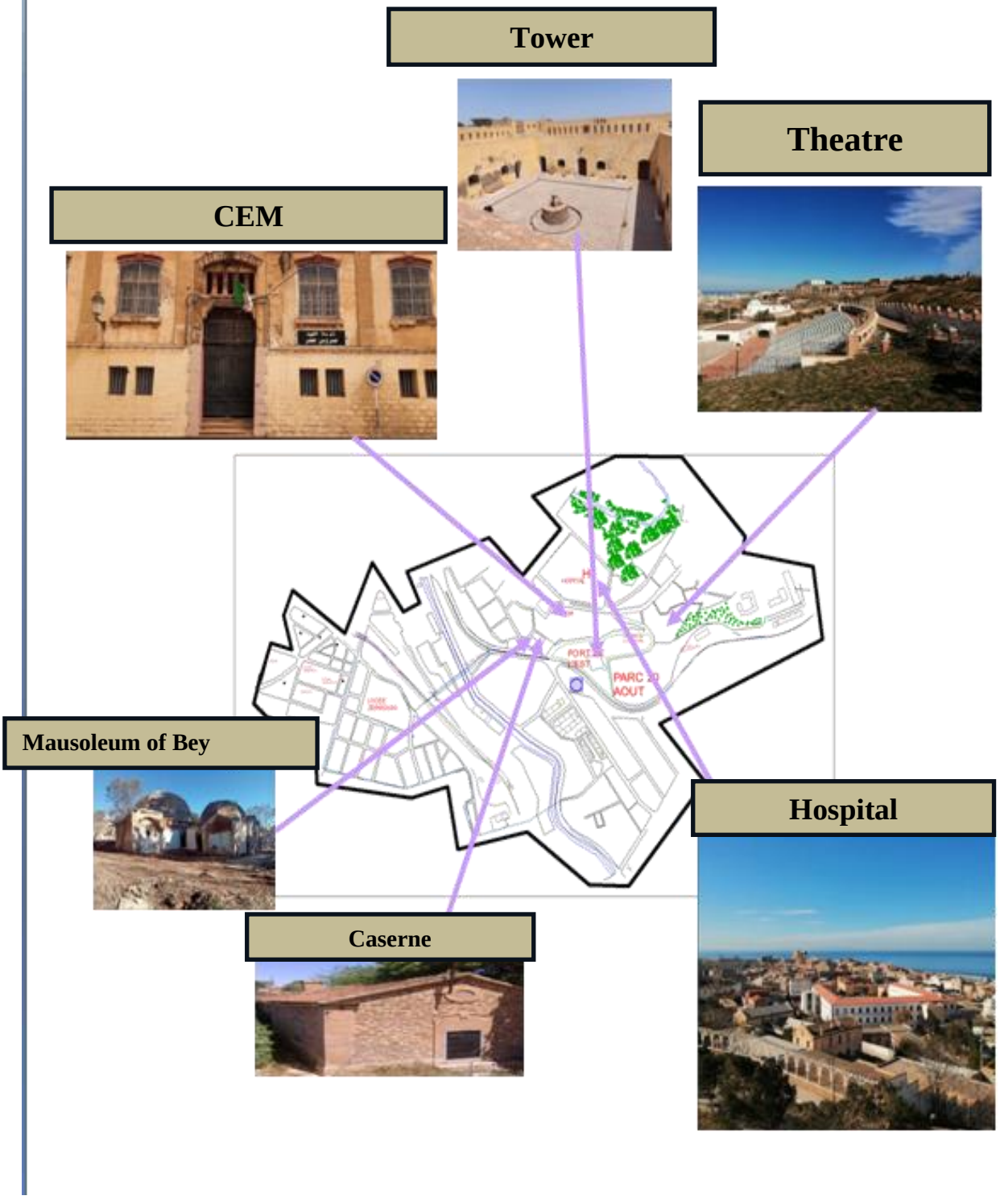


Figure 47 most important historical landmarks in el arsa Mostaganem source : PDAU + by authors

2. Recap of the potentialities and constraints

This recap table highlights El Arsa strengths such as its coastal location and architectural heritage, which drive tourism and cultural appeal. It also underscores challenges like urban sprawl, infrastructure management, and environmental sustainability that require careful planning and management for future development.

Table 9 table of potentialities and constraints

Field	Potentialities	Constraints
Geographical location	-Central location close to the center - The neighborhood is close to beaches and tourist sites	- Some areas are crowded and difficult to access - Limited open spaces
Infrastructure	- The road network connects the neighborhood to the rest of the city - The neighborhood is close to public services - The possibility of improving and developing networks to be smart	-Some streets suffer from potholes and cracks, which hinder traffic from reaching wealthy sites and cause damage to vehicles - Access points are partially restricted - Poor traffic planning - Lack of traffic, no traffic signal - Lack of regular maintenance - Weak drainage system - Lack of parking - Lack of funding for infrastructure development
Heritage buildings	- The possibility of attracting investment, developing heritage buildings and converting them into commercial and tourism projects - The possibility of converting old buildings into tourist attractions and museums using technology	- Deterioration of the structural condition of some historical buildings due to maintenance and renovation - Lack of awareness of the importance of using smart technologies to preserve heritage buildings - The effect of environmental factors such as humidity and temperature on heritage buildings - Using some for inappropriate purposes
Communications and technology	- The possibility of providing high-speed Internet networks - Possibilities for developing smart communication systems - The presence of schools and educational centers that can provide training in technology	- Lack of technology spread throughout the neighborhood - Lack of knowledge and experience in using modern ones - Challenges in providing modern technical devices at reasonable prices for everyone
Smart energy	- Possibility of using renewable	- The infrastructure needs comprehensive

	energy - The neighborhood is close to fertile agricultural areas that can be used for bioenergy	modernization to use energy systems - Lack of investment in renewable energy projects
Smart waste management	- The possibility of developing waste management and recycling systems	- Lack of awareness of the importance of smart waste management and recycling
Heritage and culture	- The presence of heritage and cultural sites that reflect the local heritage - Possibilities of transforming heritage sites into tourist attractions by using modern technology - Possibility of establishing workshops and exhibitions of handicrafts - The presence of traditional arts such as dance and music can be promoted - The presence of traditional foods that can be promoted as part of urban heritage - The presence of local stories and legends that can be documented and published	- Lack of funding and government support for urban heritage preservation - The presence of a marginalized and neglected urban heritage - Lack of restoration of heritage sites - Lack of cultural activities that enhance and promote urban heritage - Lack of interest in documenting and teaching traditional arts to new generations - The impact of modern foods on the decline in consumption of traditional foods in the neighborhood - Lack of documentation and lack of interest in local heritage stories and legends

Source : by authors

The table effectively outlines the neighborhood's potential while also pinpointing specific challenges. Key strengths include its strategic location, historical and cultural richness, and opportunities for technological and sustainable development. However, substantial obstacles such as infrastructural deficiencies, lack of modernization, and inadequate funding and awareness in various sectors must be addressed. Enhancing the neighborhood's appeal and functionality will require a multifaceted approach, focusing on smart solutions, cultural preservation, and infrastructural improvements.

2.1.Conceptual schematic :

The conceptual schematic for the urban development of El Arsa focuses on integrating its rich historical and cultural heritage with modern infrastructure and smart technology solutions. The goal is to enhance the neighborhood's appeal, functionality, and sustainability while addressing existing challenges

Programmation	Description
Smart gadens	- Integration of surveillance systems to enhance park security and visitor safety - Implementation of intelligent irrigation and air monitoring systems for efficient resource management and environmental sustainability -Preparation of garden furniture with smart features, such as smart benches and lighting poles, designed to preserve the historical character of the park while offering modern amenities and functionality - Utilization of native plant species to promote biodiversity - Incorporation of rainwater harvesting systems - Installation of vertical gardens or green walls
Green spaces	- Development of parks and recreational areas - Planting of trees and landscaping for aesthetic appeal - Installation of sustainable lighting solutions - Incorporation of outdoor fitness equipment - Designing of walking and biking trails - Integration of smart waste management systems - Creation of designated wildlife habitats
Intelligent Road Rehabilitation Initiative	- Reconstruction of deteriorated roads - Installation of smart surveillance cameras and sensors for enhanced safety and traffic monitoring - Implementation of energy-efficient LED smart lighting with motion sensors - Improvement of pedestrian infrastructure for increased accessibility and safety - Provision of interactive digital information panels showcasing the region’s heritage and providing valuable local information. - Incorporation of roadways with renewable energy generation capabilities
Heritage buildings	- Install sensors to monitor environmental factors such as humidity and temperature - Augmented Reality (AR) Tours - Historic Building Information Modeling (HBIM) - Instant alarm system - Intelligent water collection system - Installing solar panels on the roof of the building
Smart Market Enhancements	-Smart lighting - Smart waste collection systems -Improved ventilation systems -Developing electronic payment systems - Mobile applications that help visitors navigate within the market

	- Security surveillance systems - Implementation of cashless payment systems
Flood risk management	-Designing sidewalks and parking lots in the form of temporary water storage tanks. - Installing sensors to monitor water levels in the tanks.
Smart Urban furniture	- Install historically themed benches equipped with USB charging ports. - Set up historically themed lighting poles equipped with pressure-based electricity generation systems. - Utilization of smart benches equipped with environmental sensors to monitor air quality, temperature, and humidity, contributing to the preservation of the urban heritage environment -Deployment of smart waste bins with sensors to optimize waste collection and reduce littering, while maintaining the visual integrity of the heritage streetscape - Incorporation of interactive digital information kiosks or signage, providing visitors with historical information, maps, and points of interest in the heritage urban area - Introduction of interactive art installations or heritage-themed sculptures that incorporate smart technology, fostering engagement and cultural appreciation
conference room	- Communication systems - Internet connection (Wi-Fi 6 – Ethernet) - Smart displays - Room control systems (Alixa and Google assistant) - Smart lighting - Surveillance cameras - Installing solar panels and turbines
Renovation of a museum	- Providing a Wi-Fi network - Monitoring and sensing devices - Using augmented reality (AR) - Interactive screens - Installing audio devices that provide information about the displayed pieces - Smart lighting - Using solar panels - Installing smart climate control devices
Smart mobility	- Development of mobility-as-a-service (MaaS) platforms, offering seamless integration of various transportation modes and payment options - Implementation of smart infrastructure for connected and autonomous vehicles, including vehicle-to-vehicle (V2V) and vehicle-to-infrastructure (V2I) communication

	- Establishment of car-sharing programs and carpooling incentives to reduce private vehicle usage and encourage shared transportation - Deployment of dynamic routing systems for public transit, utilizing real-time data to optimize bus routes and schedules - Integration of micro-mobility options such as electric scooters and hoverboards, with designated lanes and parking areas - Development of pedestrian-friendly zones and walkable neighborhoods with dedicated sidewalks, crosswalks, and pedestrian plazas Implementation of smart bike-sharing systems, including GPS tracking and mobile app integration for easy rental and return
Smart waste management	- Install smart bins with sensors to signal when they are full. - Smart recycling stations - Pay-As-You-Throw (PAYT) Programs - RFID-Based Collection
Data collection center	- Establish a central data collection center for monitoring and managing all smart systems - Integration of data from various sensors for real-time analytics Support decision-making processes with comprehensive data analysis

3. Project Blueprint: Designing a Smart Neighborhood for El Arsa

Designing a smart neighborhood like El Arsa requires careful planning and integration of various technologies to enhance efficiency, sustainability, and quality of life for its residents. Here's a blueprint outlining key aspects to consider:

3.1. Vision for Smart El Arsa:

Smart El Arsa aims to transform into a vibrant, sustainable, and technologically advanced neighborhood that enhances the quality of life for its residents while promoting environmental stewardship and economic growth.

3.1.1. Redevelopment into a smart heritage park

- Integration of surveillance systems to enhance park security and visitor safety
- Implementation of intelligent irrigation and air monitoring systems for efficient resource management and environmental sustainability
- Preparation of garden furniture with smart features, such as smart benches and lighting poles, designed to preserve the historic character of the park
- Use sensors to monitor air quality and noise levels within the park
- Waste bins with sensors to report fullness, helping to improve waste
- Providing smartphone applications that provide information on park

Changing the panels into smart screens that provide information about the history of the park

Figure 51: panel of the garden el arsa
Source: Photo taken by the author.

Changing the seats to solar-powered seats equipped with USB ports, in the same historical character of the park

Figure 52: the garden of el arsa
Source: Photo taken by the author.

3.1.2. Smart Market Enhancements

- Smart lighting
- Smart waste collection systems
- Improved ventilation systems
- Developing electronic payment systems
- Mobile applications that help visitors navigate within the market
- Security surveillance systems
- Smart billboards inform you of the market history

3.1.3. Rehabilitating the forest into a sponge forest

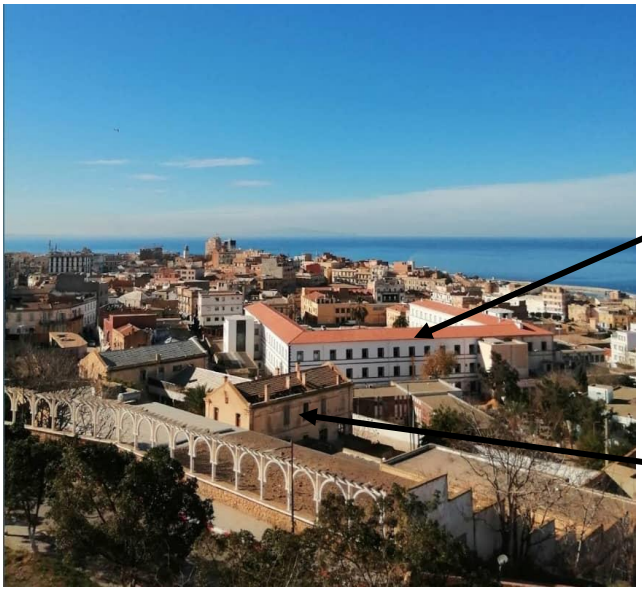
Planting trees and large plants that help absorb water and provide shade

Porous concrete pavements

Installing underground tanks to collect rainwater for later use in irrigation or other uses.

3.1.4. Heritage buildings

- ✓ Augmented Reality (AR) Tours
- ✓ Historic Building Information Modeling (HBIM)
- ✓ Instant alarm system
- ✓ Intelligent water collection system
- ✓ Installing solar panels on the roof of the building



Installing solar panels on the roof of the building

Restoration of the building

Install sensors to monitor environmental factors such as humidity and temperature

3.1.5. Redevelopment of Ayachi Belhaj Street :

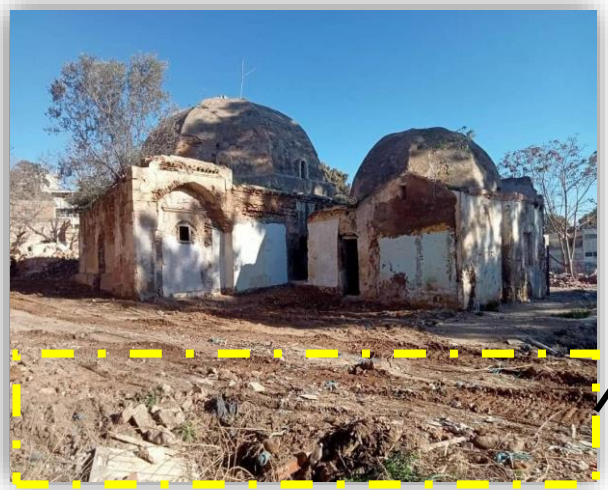
Community Gardens

Green Roofs

Installing solar panels on the roof of the building

- ✓ Sustainable Water Management Systems
- ✓ Green Corridors
- ✓ Community Gardens
- ✓ Vertical Gardens

3.1.6. Creating a cultural path :



We are going to arrange the outside area

Renovation of a museum

- Providing a Wi-Fi network
- Monitoring and sensing devices
- Using augmented reality (AR)
- Interactive screens
- Installing audio devices that provide information about the displayed pieces
- Smart lighting
- Using solar panels

Establishing a smart cultural center that combines cultural heritage and advanced technology to provide visitors with a distinctive and useful experience.

3.1.7. Preparing the way

3.1.8. Intelligent Road Rehabilitation Initiative

- Installation of smart surveillance cameras and sensors for enhanced safety and traffic monitoring
- Implementation of energy-efficient LED smart lighting

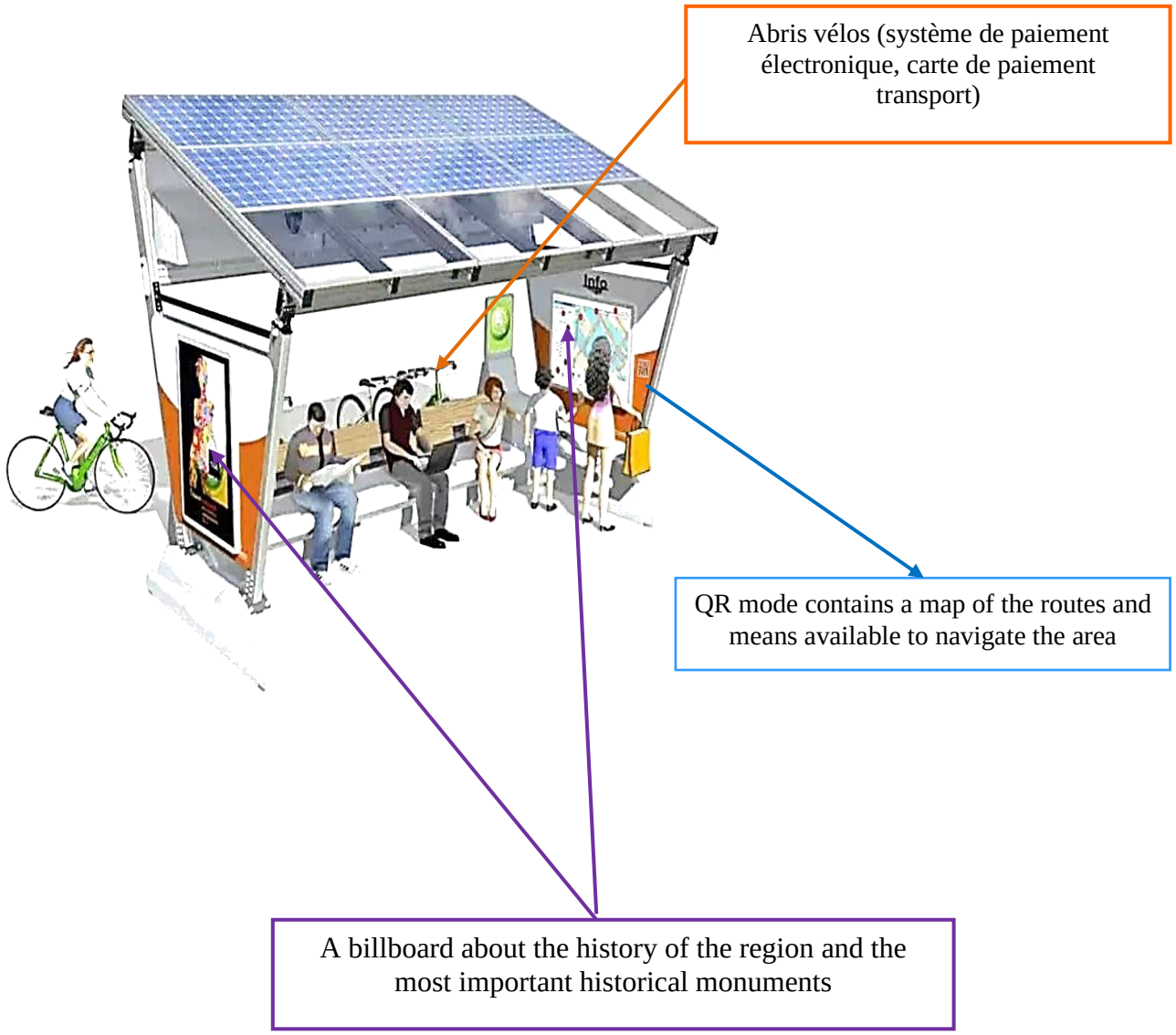
Provision of interactive digital information panels showcasing the region's heritage and providing valuable local information

Improvement of pedestrian infrastructure for increased accessibility and safety

Designing sidewalk areas in the form of temporary water tanks and using them for

Converting daily pedestrian traffic into a renewable and sustainable energy source

3.1.9. bus stop :



4. Urban Development Plan for Smart El Arsa

The development plan for Smart El Arsa with consideration for urban heritage aims to create a harmonious balance between technological advancement, sustainability, and cultural preservation. By integrating smart technologies and sustainable practices while respecting and celebrating its urban heritage, Smart El Arsa will become a model for smart city development that honors its past while embracing its future. This holistic approach ensures that future generations can enjoy a vibrant, resilient, and culturally rich neighborhood that reflects the values and identity of El Arsa's heritage.

Figure 53: urban development plan for smart el arsa 3D
Source: by the author.

Chapter Conclusion

This chapter has provided a comprehensive understanding of El Arsa, shedding light on its rich historical, cultural, and geographical context. By exploring its past, we have appreciated the depth of its heritage and the factors that have shaped its development. Our examination of the present state of El Arsa has revealed both the strengths and challenges that define the neighborhood today.

El Arsa's central location, historical landmarks, and cultural vibrancy present significant opportunities for sustainable development and technological integration. However, issues such as infrastructural deficiencies, limited accessibility, and the need for modernization pose substantial challenges. Addressing these challenges requires a balanced approach that respects the neighborhood's historical and cultural essence while embracing innovative solutions.

The potential for El Arsa to transform into a smart and sustainable urban environment is immense. By integrating modern technologies and smart city principles, El Arsa can enhance its livability, foster economic growth, and preserve its unique character. The strategic implementation of these technologies, combined with careful planning and community involvement, will be crucial in achieving this vision.

In conclusion, El Arsa stands at the threshold of a transformative journey. The insights gained from this chapter provide a solid foundation for developing a smart urban development plan that harmonizes heritage preservation with technological advancement. By embracing this dual approach, El Arsa can become a model for smart urban development, ensuring a vibrant and sustainable future for its residents and visitors alike.

General Conclusion

General Conclusion

In conclusion, this study has illuminated the transformative impact of integrating advanced technologies in Mostaganem El Arsa to enrich the accessibility, appreciation, and understanding of its unique historical and cultural heritage. Through empirical investigation and active community engagement, it has been demonstrated that technologies such as augmented reality applications for heritage sites, interactive digital platforms, and online interactive maps have played a critical role in revitalizing historical narratives, enhancing visitor experiences, and raising cultural awareness among both residents and visitors.

For instance, initiatives like the augmented reality tour of Mostaganem's historical landmarks, which allows visitors to explore history in an interactive and immersive way, and the digital archive project, which provides easy access to historical information, have not only preserved the city's rich heritage but also brought it to life in innovative ways. These efforts have fostered a deeper connection to local traditions and history, encouraging active participation from the community in heritage preservation.

The findings underscore the synergistic relationship between technological innovation and community involvement in shaping Mostaganem El Arsa's evolution into a smart city. Collaborative efforts, such as community-led heritage conservation projects and digital storytelling workshops that bring together community members and technology experts, exemplify how stakeholders can work together to amplify the preservation and appreciation of urban heritage, paving the way for sustainable urban development.

However, challenges such as funding constraints for technology implementation, the need for digital literacy among residents, and concerns about maintaining cultural identity amidst technological modernization highlight the importance of strategic planning and public-private partnerships to overcome obstacles. Addressing these challenges presents opportunities for innovative solutions, fostering inclusivity, and adopting sustainable development practices, which are crucial for Mostaganem El Arsa's continued growth as a culturally vibrant and technologically advanced urban center.

In conclusion, by harnessing technology alongside community-driven initiatives, such as those documented in this study, Mostaganem El Arsa can effectively navigate the complexities of urban development while preserving its rich historical legacy. This research provides actionable insights and a model for other municipalities seeking to integrate modernization with cultural heritage preservation, offering a guiding framework for sustainable urban planning and development. Thus, Mostaganem El Arsa can become a leading example of how to achieve a balance between modernization and the preservation of cultural identity and historical heritage.

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ANNEX

إستبيان

يسعدني دعوتكم للمشاركة في استبياننا الذي يتعلق بمذكرة ماستر تحت عنوان "نحو مدينة ذكية: استخدام التقنيات الجديدة لتعزيز التراث الحضري في مدينة مستغانم". يهدف هذا الاستبيان إلى جمع آراءكم وتصوراتكم حول كيفية استخدام التقنيات الحديثة للمساهمة في الحفاظ على التراث الحضري في مستغانم وتعزيزه، وذلك في إطار دراسة الماستر المذكورة. شكرًا جزيلاً على وقتكم وتعاونكم.

1. الإدراك العام:

- ما هو تصورك عن التراث الحضري في مستغانم؟

أ) غني ومهم ☐
ب) غير مقدر ☐
ج) في تدهور مع مرور الوقت ☐
د) غير متأكد ☐

- هل تؤيد فكرة تطوير مدينة مستغانم لتصبح مدينة ذكية؟

✓ نعم ☐
✓ لا ☐

- هل تعلم بوجود جهود جارية للحفاظ على وتعزيز التراث الحضري في مستغانم؟

أ) نعم ☐
ب) لا ☐

2. استخدام التكنولوجيا:

السؤال	نعم	لا
• هل تستخدم الهواتف الذكية والأجهزة الرقمية بشكل منتظم في حياتك؟		
• هل استخدمت تطبيقات الهواتف الذكية أو الأدوات الرقمية لاستكشاف التراث الحضري في مدينة مستغانم؟		
هل لديك الوعي بالتقنيات الجديدة التي يمكن استخدامها لتعزيز التراث الحضري في مستغانم ؟		

3. تعزيز التراث الحضري:

- ما هي التحديات التي تواجه التراث الحضري في مدينة مستغانم من وجهة نظرك؟

✓ نقص التمويل والموارد ☐
✓ تدهور و سوء البنية التحتية ☐
✓ التلوث و التصحر ☐
✓ عدم التوعية و التثقيف ☐
✓ التحديات التنظيمية و القانونية ☐

- هل لاحظت جهودًا لتعزيز التراث الحضري في المدينة مؤخرًا؟

✓ نعم ☐
✓ لا ☐

- هل تعتقد أن تكنولوجيا التراث الحضري يمكن أن تلعب دورًا هامًا في حماية وتعزيز التراث في مدينة مستغانم؟

✓ نعم

✓ لا

4. التقنيات الجديدة والتراث الحضري:

- هل تعتقد أن استخدام التقنيات الجديدة يمكن أن يعزز التفاعل مع المواقع التراثية في المدينة؟
- نعم
- لا
- كيف تعتقد أن التقنيات الجديدة يمكن أن تساهم في الحفاظ على وتعزيز التراث الحضري في مستغانم؟

أ) عن طريق توفير أساليب أفضل للتوثيق والحفظ

ب) من خلال تجارب الواقع المعزز للسياح

ج) عن طريق تحسين مرونة البنية التحتية

د) الجميع مما سبق

هـ) غير متأكد

- أي التقنيات المحددة تعتقد أنها ستكون الأكثر فائدة للحفاظ على التراث الحضري في مستغانم؟
- أ) المسح والنمذجة ثلاثية الأبعاد
- ب) أنظمة الإضاءة الذكية
- ج) تطبيقات الهاتف المحمول لتفسير التراث
- د) الحساسات لمراقبة البيئة
- هـ) الجميع مما سبق
- و) غير متأكد
- ما مدى أهمية تحويل مستغانم إلى مدينة ذكية من حيث الحفاظ على التراث الحضري؟

أ) مهم جداً

ب) مهم إلى حد ما

ج) غير مهم

د) غير متأكد

5. التحديات والفرص:

- ما هي التحديات أو العوائق المحتملة لتنفيذ التقنيات الجديدة لتعزيز التراث الحضري في مستغانم؟

أ) نقص التمويل

ب) قيود البنية التحتية التكنولوجية

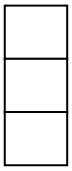
ج) المقاومة للتغيير

د) الجميع مما سبق

هـ) غير متأكد

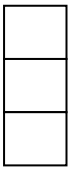
- هل تعتقد أن إشراك المجتمع في جهود الحفاظ على التراث ضروري؟ إذا كان الجواب نعم، كيف يمكن تحسين مشاركة المجتمع؟

أ) نعم، من خلال البرامج التعليمية وحملات التوعية
ب) لا، ليس من الضروري
ج) غير متأكد



- هل تكون على استعداد للمشاركة في المبادرات الهادفة إلى الحفاظ على التراث الحضري في مستغانم من خلال استخدام التقنيات الجديدة؟

أ) نعم
ب) لا
ج) غير متأكد



6. التطور المستقبلي

- كيف تتصور تراث مستغانم الحضري في المستقبل، بالنظر إلى دمج التقنيات الجديدة؟

أ) محفوظ جيدًا ومتاح للجميع
ب) مهمل ومتدهور
ج) غير متأكد

7. تعليقات إضافية:

- هل لديك أي تعليقات أو اقتراحات إضافية بشأن استخدام التقنيات الجديدة لتعزيز التراث الحضري في مستغانم؟

شكرًا على وقتك وتعاونك في هذا الاستبيان، سيساهم إجاباتك في فهم أفضل لمدى استعداد مدينة مستغانم للتحول إلى مدينة ذكية وتأثير ذلك على تعزيز التراث الحضري.