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Human Smart City: An Integrated Vision for Al-Madinah Al-Munawwarah, KSA 2030

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Abstract

Saudi Arabia is embracing Smart Cities Initiatives to transform urban and rural areas into sustainable, citizen-centric hubs aligning with Vision 2030—a blueprint for a prosperous, inclusive, and equitable future. The research explores the potential of Al-Madinah Al-Munawwarah, one of the world's most significant religious cities, to evolve into a human smart city. Human smart cities are the new generation of smart cities, which balance the technological infrastructure with human aspects. Compared to existing literature that typically views smart and human city models as separate or even conflicting, this study promotes their integration. Previous research has largely focused on the technological aspects of smart cities, highlighting efficiency, automation, and data-based governance, but has paid less attention to incorporating human values, cultural identity, and active community engagement within these systems. This research aims to analyse the technology-based solutions and the human-centered initiatives in Al-Madinah, supported by a literature review and case studies of projects that emphasise citizen participation. The research begins with a theoretical overview of smart city concepts. Then, the research analyses both the technology-based solutions and the human-centered urban initiatives shaping Al-Madinah's development. The research concludes with an integrated framework outlining strategies to transform Al-Madinah into a human smart city, ensuring a sustainable future for both residents and visitors.

Keywords: Human Smart Cities; Madinah- KSA; Citizen Empowerment; Sustainable Urban Development; Integrated Framework

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1. Introduction

1.1 Background and Context

The Kingdom of Saudi Arabia is embracing Smart City Initiatives to transform urban and rural areas into sustainable, citizen-centric hubs, aligning with Vision 2030—a blueprint for a prosperous, inclusive, and equitable future. Cities such as Riyadh and Jeddah are at the forefront of this transformation, leveraging humanized technology to enhance quality of life, boost productivity, and foster community engagement. Likewise, Makkah and Al-Madinah Al-Munawwarah are undergoing development to become human-sustainable smart cities, equipped to serve the millions of visitors who arrive for religious rituals.

On one hand, the Kingdom of Saudi Arabia (KSA) began formulating its vision to transform Madinah (Al-Madinah Al-Munawwarah) into a smart city, as part of the broader Saudi Vision 2030 initiative. On the other hand, the initiative to make Al-Madinah Al-Munawwarah a human-centric city stands as a fundamental pillar of Vision 2030. This effort began in 2018, marked by the launch of

the Human Cities Conference by the Madinah Regional Development Authority (MRDA). The transformation focuses on sustainability, inclusivity, and an improved quality of life—values that align with both the city's spiritual importance and the evolving needs of its residents and millions of annual visitors. Despite the Madinah Regional Development Authority (MRDA) being the central body tasked with implementing both the smart city and human-centric city visions under a unified strategic framework, the transformation of Al-Madinah Al-Munawwarah has encountered significant challenges. These include institutional, technical, and operational barriers that have hindered consistent progress. While the overarching visions present a coherent and ambitious narrative, the corresponding implementation plans have often lacked the necessary depth, integration, and operational clarity. Consequently, many of the projects initiated under both visions have emerged as fragmented, stand-alone efforts rather than components of a comprehensive, integrated urban development strategy. This fragmentation has limited the city's ability to realize the full potential of its transformation goals, both in terms of technological advancement and human-centered development.

This research explores the potential of Al-Madinah Al-Munawwarah, one of the world's most significant religious cities, to evolve into a Human Smart City—a concept that integrates advanced technology with social engagement, citizen empowerment, and the interaction of people in both physical and virtual environments. The Human Smart City model envisions an ecosystem where physical and digital infrastructure coexist in a systemic relationship with the city's human capital, ensuring a holistic and sustainable urban transformation. The study analyzes technology-based solutions and human-centered initiatives in Al-Madinah, supported by a literature review. The findings indicate that while citizens play an increasing role in the ongoing transformation, there is still a need to enhance digital inclusion, community engagement strategies, and the scope of participatory urban projects.

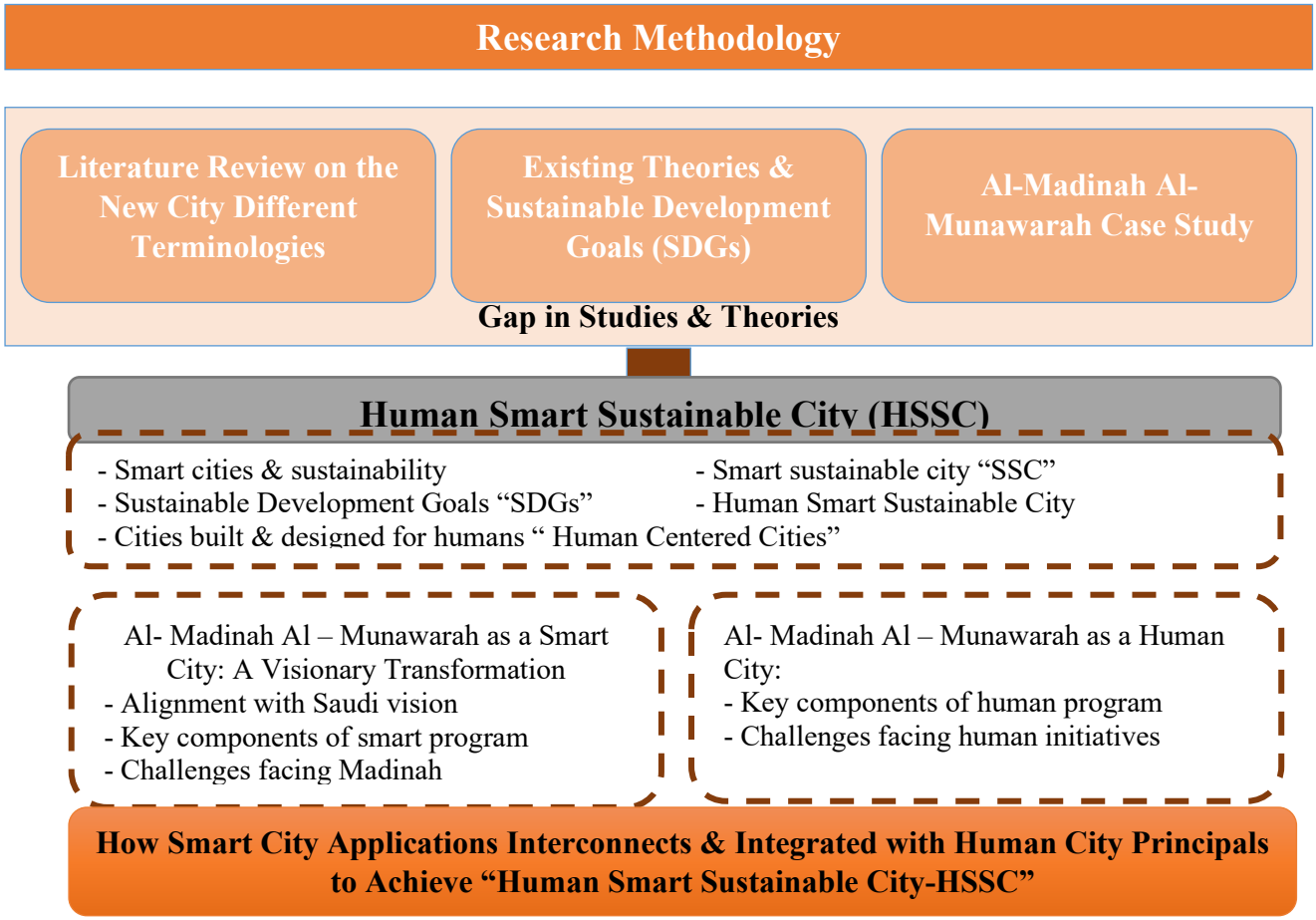

Figure 1. Methodology of the Study

1.2 Problem Statement and Research Gap

While smart city development has increasingly relied on advanced ICT tools—such as the Internet of Things (IoT), artificial intelligence (AI), and big data analytics—to enhance urban operations, this predominantly technology-driven approach has often marginalized critical human-centric considerations, including inclusivity, local context, and active citizen engagement. The overemphasis on digital infrastructure, without parallel attention to social and cultural dimensions, has contributed to implementation challenges, reduced public trust, and the deepening of urban inequalities. Despite their potential to transform urban life, smart city initiatives that lack participatory and context-aware frameworks frequently fail to deliver inclusive and sustainable outcomes. However, the integration and interrelation between smart city applications and human-centered design are not inherently conflicting; rather, they can be mutually reinforcing. When aligned, these approaches can support the emergence of a new paradigm—the "Human Smart City"—which combines technological innovation with social responsiveness to create urban environments that are not only intelligent but also inclusive, equitable, and citizen-focused. This research problem seeks to examine how the exclusion of human-centered design in ICT-led smart city strategies affects their success, equity, and public acceptance, and to identify integrated strategies for embedding social values into future smart urban planning models. The research uses the case study of Al-Madinah Al-Munwarrah, which was officially declared by the Saudi government as both a smart city and a human city. However, this dual designation was made in the absence of a clear and comprehensive strategic plan. As a result, the city's development has faced fragmented implementation, conflicting priorities, and inconsistent decision-making, reflecting a lack of integration between its technological ambitions and human-centered needs. This research problem thus seeks to examine how the exclusion-or improper integration- of human centered designed in ICT-led smart city strategies affects implementation outcomes, social equity, and public acceptance. It also aims to identify coherent and context-sensitive strategies for embedding human-centric values into future smart urban planning models, with particular attention to cities in religious, cultural, and historically sensitive contexts like Al-Madinah.

1.3 Objectives and Hypotheses

The Research Aim:

- Explaining the interconnections between the smartness application and the human city principals.
- Proposing An Integrated Framework For Al-Madina Al-Munwarah as A **Human Smart Sustainable City**, to integrate the Humanizing initiatives and the Smartness applications together in a comprehensive way.

Research Objectives:

- Analyzing the new trends of the cities from the early 1990s, from intelligent to green and resilient, etc.
- Explore the Importance of Sustainability to the Smart City.
- Highlighting the Human Smart City as new paradigm for the modern city.
- Analyzing Al-Madina Al-Munwarah initiatives and applications in both smartening and humanizing the city.

1.4 Significance and Structure of the Paper

The research begins with a theoretical overview of smart city concepts, approaches, and dimensions, leading to an exploration of the "Human Smart City" paradigm. It then examines the technological advancements and human-centered urban initiatives shaping Al-Madinah's development, emphasizing the importance of sustainable urban planning and government-led efforts to position the city as a globally recognized Islamic hub. Then, the research explains the interrelation between smart city and human city. The study concludes with an integrated framework outlining strategies to transform Al-Madinah Al-Munawwarah into a human smart city, ensuring a balanced and sustainable future for both residents and visitors. The research uses the inductive and the comparative analytical methodologies to achieve its goals.

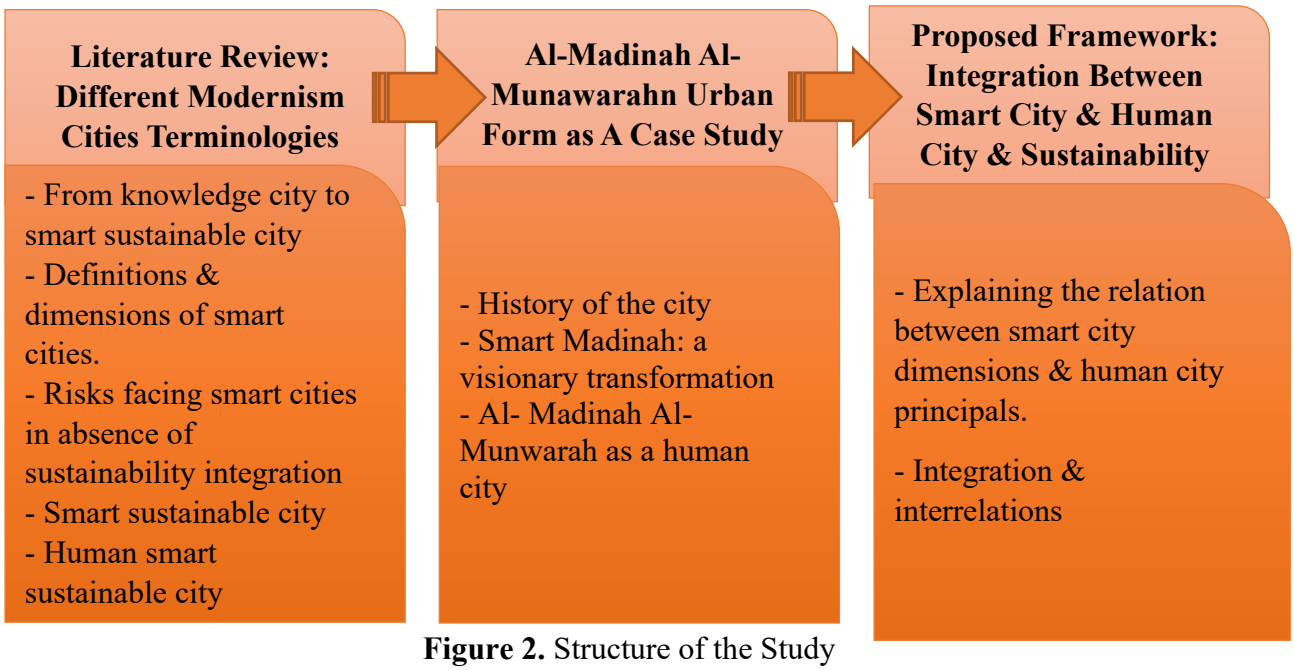

Figure 2. Structure of the Study

2. Materials and Methods

2.1. Overview & Background about Smart Cities: Different Modernism Cities Terminologies, from Knowledge City to Smart Sustainable City Nowadays

By the mid-1990s, many studies featured visions about future cities where ICTs would be the main enabler of democracy and city management (Aurigi, 2006). Theorists of the decade 1990–2000 envisaged that the Internet would allow people to access all goods and services from any location in the world. In recent years, there has been a shift in cities striving for smart city targets instead of sustainability goals (Marsal-Llacuna, 2015). However, smart cities often share similar goals as sustainable cities (Ahvenniemi, 2017). And then, there are '*sustainable cities*', '*green cities'*, '*liveable cities*', '*digital cities*', 'intelligent cities', 'smart cities', 'knowledge cities', 'information cities', 'resilient cities', 'eco cities', 'low carbon cities' proposed, and even combinations of these, such as 'low carbon eco cities' and 'ubiquitous eco cities' (Roggema, 2020).

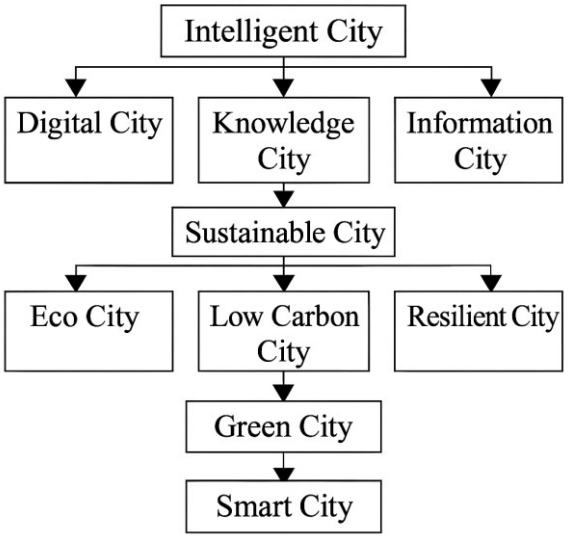

Figure 3. Developing of cities terminologies

Although terms like "sustainable," "smart," and "resilient" cities are often used interchangeably in urban policy and planning, they each originally emerged from distinct urban development concerns. Their overlapping usage suggests a shared underlying framework that emphasizes the integration of social, economic, and environmental goals in urban regeneration (De Jong, 2015). Historically, the

"digital city" concept appeared in 1998, followed by the rise of "sustainable cities" in response to sustainable development goals, and "resilient cities" in relation to climate change. While "sustainable cities" dominated discourse until 2010, the term "smart cities" surged in popularity by 2015 (Chourabi, 2012).

2.1.1. Definition of the smart city

The concept of the smart city remains inconsistently defined among scholars and practitioners, though it generally refers to urban environments enhanced by digital, information, and telecommunication technologies to improve services, resource efficiency, and residents' quality of life. (Mohanty, 2016). At its core, a smart city integrates fragmented urban subsystems—such as energy, mobility, water, and the built environment—through technology, aiming to foster economic growth, innovation, and employment (Roggema, 2020).

One widely accepted perspective views smart cities as systems where human interaction with urban flows (energy, services, materials, and finances) is optimized through strategic ICT use, enabling transparent and responsive urban management (Mohanty, 2016). The term "smart" also reflects the shift toward knowledge-based economies, where ICT plays a pivotal role in driving innovation (Kourtit, 2012). Governments, academia, and industry have increasingly adopted the smart city framework, often emphasizing infrastructure integration, sustainability, efficiency, livability, and technological enhancement of urban systems (Kitchin, 2014).

Table: Different definitions for smart cities.

No.	Definition	Scope / key words
1	A city "linking the IT physical infrastructure, the social infrastructure, and the business infrastructure to take advantage of the collective intelligence of the city (Mohanty, 2016)	Integration of infrastructures, collective intelligence
2	A city that is doing well in an economically forward-looking way in economy, people, governance, mobility, environment, and living, founded upon the smart combination of endowments and activities of self-decisive, autonomous and well-informed citizens (Giffinger, 2007)	Economy, people, governance, mobility, environment, living
3	The Smart City is a sustainable and efficient city with high 'Quality of Life' that attempts to address urban challenges through the deployment of ICT in its infrastructure and services, collaboration between its key stakeholders, integration of its main domains, and investment in social capital (Mosannenzadeh, 2014)	Quality of life, ICT, social capital, stakeholder collaboration
4	A city that monitors and integrates conditions of all its critical infrastructures like roads, bridges, tunnels, rails, subways, airports, seaports, communications, water, power, even big buildings, can allocate optimally more of its resources, plan more efficiently its preventive maintenance operations, and monitor security aspects while optimizing its services to citizens (Hall, 2000)	Infrastructure monitoring, resource optimization, security
5	A city "integrating the physical infrastructure, the IT infrastructure, the social infrastructure, and the business infrastructure to leverage the city-wide collective intelligence (Albino, 2015)	Integration of infrastructures, collective intelligence
6	An urban area endeavoring to enhance its intelligence by becoming more efficient, sustainable, equitable, and livable (Roggema, 2020)	Efficiency, sustainability, equity, livability
7	"The use of Smart Computing technologies to make the critical infrastructure components and services of a city—city government, education, healthcare, public safety, real estate, transportation, and utilities—smarter, more interconnected, and more efficient (Washburn, 2010)	Smart computing, interconnected infrastructure, efficiency
8	"A well-performing city in a forward-looking way in economy,	Economy, people,

	people, governance, mobility, environment, and living, based on the intelligent combination of endowments and activities of self-determined, independent, and conscious citizens (Giffinger, 2007)	governance, mobility, environment
9	"A city is smart when investments in human and social capital and traditional (transport) and modern (ICT) communication infrastructure fuel sustainable economic growth and a high quality of life, with a wise management of natural resources, through participatory governance. (Caragliu, 2009)	Human, social capital, transportation, , ICT, economic growth, Qol
10	"Any adequate model of the smart city must prioritize the intelligence of its citizens and promote the processes that render cities important: those that underpin different—often contradictory—activities (Haque, 2012)	Smart citizen, sustainable activities
11	"A smart city is a clearly delineated geographical area, whereby high technologies like ICT, logistic, energy production, etc. work together to produce advantages for citizens in terms of well-being, inclusion, and participation, environmental quality, intelligent development; it is ruled by a clearly defined pool of subjects, capable of expressing the rules and policy for the city government and development (Dameri, 2013)	ICT, logistics, energy production, citizen, well being, participation, environmental quality, intelligent development, governance, policy

2.1.2. Dimensions of the smart city

The key smart applications enabled by big data analytics and context-aware computing include smart transport, smart energy, smart environment, smart planning, smart design, smart grid, smart traffic, smart education, smart healthcare, and smart safety (Roggema, 2020). In further specifying the concept, these most adopted and well-known sets of six dimensions or types of action form the pillars of Smart City development. In fact, they have sets of well-established indicators that can be used to measure the 'smartness' of the city and hence be able to rank it or assess its success in the transformation process (Piro, 2014). These are the following dimensions & sub-dimensions as shown in Table (2).

Table 2: The smart city dimensions.

Smart Economy	**Smart People**
Innovative Spirit	Level of qualification
Entrepreneurship	Affinity to life long learning
Economic image & trademarks	Social & ethical plurality
Productivity	Flexibility and creativity
Flexibility of labour market	Cosmopolitanism / open-mindedness
International embeddedness	Participation in public life
Ability to transform	
Smart Mobility	**Smart Living**
Local and inter-national accessibility	Cultural and educational facilities
Availability of ICT-infrastructure	Health conditions
Sustainable, innovative and safe transport systems	Individual safety
	Housing quality
	Touristic attractively
	Social cohesion
Smart Governance	**Smart environment**
Participation in decision-making	Attractively of natural conditions
Public and social services	Pollution
Transparent governance	Environmental protection
Political strategies & perspectives	Sustainable resource management

2.1.3. Risks facing smart cities in the absence of sustainability integration

Although many definitions of smart cities contain the meanings of sustainability, resilience, quality of life, well-being, economic development, governance, citizen engagement, and social inclusiveness, many applications of smart cities have lost their main aim and become cities with advanced technology but lacking a strong sustainability focus, which we could call it "icy" tech cities: efficient and data-driven but not green or socially inclusive. Adding sustainability to smart city definitions is important because it ensures that technological advancement aligns with long-term environmental, social, and economic health. Here is why it's crucial:

Environmental Risks **(Johnsen, 2017)**	Resource Depletion: Without sustainable planning, smart cities may overuse energy, water, and land resources. - Pollution and Emissions: High-tech infrastructure without green practices can increase air and water pollution and greenhouse gas emissions. - Climate Vulnerability: Unsustainable cities are less resilient to climate change impacts like floods, heat waves, or sea-level rise.
Economic Risks **(Clark, 2020)** **(Al Sharif, 2021)**	High Operational Costs: Inefficient energy use and infrastructure maintenance can escalate costs over time. - Investment Instability: Investors may avoid cities that don't align with global sustainability standards. - Technology Obsolescence: Infrastructure built without long-term environmental consideration may quickly become out-dated or non-compliant with future regulations.
Social Risks **(Baig, 2017)**	Inequality and Exclusion: Smart technologies without inclusive planning may benefit only affluent populations, widening socio-economic divides. - Public Health Issues: Pollution and lack of green spaces can negatively impact mental and physical health. - Loss of Trust: Citizens may distrust governance if smart systems seem to prioritize efficiency over well-being and equity.
Governance and Resilience Risks **(Tan, 2020)** **(Ullah, 2021)**	Poor Crisis Response: Unsustainable cities may lack systems to handle emergencies (e.g., energy outages, natural disasters). - Regulatory Backlash: Governments may impose fines or constraints if sustainability targets are unmet. - Reduced Citizen Engagement: People may disengage from civic processes if technology replaces rather than empowers them.

2.1.4. Smart sustainable city "SSC"

The sustainability of urban areas in the future to a great extent relies on successfully addressing the issues of growing urbanization (Ali, 2019). Nevertheless, due to the diversified state of cities based on their size, level of development, and population composition, smart city initiatives have embarked on different strategies and competencies.

Hence, it is important to evaluate the capacity of a city to successfully combat urbanization problems using "smartness". A smart sustainable city is characterized by its capacity to satisfy the present needs of its citizens without compromising its ability to satisfy future generations' needs. It conforms to local or planetary environmental boundaries, wherein Information and Communication Technologies (ICTs) are essential tools in pursuing sustainability.

The idea is to solve social, economic, and environmental issues at both the local and global levels, thus enhancing citizens' standard of life (Höjer, 2015), (Martin, C.J., J. Evans, and A. Karvonen,2018).

Associated with **Sustainable Development Goal 11**, it is necessary to collaboratively build the world's smart sustainable cities.

2.1.5. Human smart sustainable city (HSSC): towards a new paradigm of the modern city

Humanizing smart cities involves designing urban environments that prioritize the well-being, dignity, and participation of all residents. This approach ensures that technological advancements serve people, fostering inclusive, sustainable, and resilient communities.

The phrase “human city” can have a few different meanings depending on the context.

Human-centered design is important in smart cities because it ensures that technology and infrastructure are built to meet the real needs of the people who live, work, and move through them. Here are the principles of a human city:

1. **Improve Quality of Life:** Designing with people in mind ensures that services - like transportation, healthcare, and energy - are accessible, efficient, and truly helpful.
2. **Promotes Inclusivity:** it accounts for diverse populations, including the elderly, disabled, and low-income communities, preventing technological or social exclusion.
3. **Encourage Adoption:** when systems are intuitive and aligned with daily human behaviour, people are more likely to use and benefit from smart city technologies.
4. **Participatory Governance & Builds Trust:** Transparent, user-friendly design fosters trust in how data is collected and used, which is critical in tech-heavy environments.
5. **Enhances Sustainability:** By prioritizing real human needs and behaviour, resources like energy, water, and transport can be managed more efficiently and responsibly.

2.2. AL-Madinah AL-Munawarah Urban Form as A Case Study

Al-Madinah Almunawarah’s population recently crossed the 1 million mark. It is considered the fourth-largest city in Saudi Arabia, ahead of the national average growth at around 3.4 per cent per year and expected to increase in the next two decades. On the other hand, around 6–8 million Muslims visit Madinah every year, and this number is projected to reach 34 million by 2024. The continuous expansion of Al-Masjid an-Nabawi (the Haram) and the substantial annual increase in the number of visitors underscore the urgent need for comprehensive urban development strategies in Al-Madinah. In alignment with the objectives of Saudi Arabia’s Vision 2030—particularly the emphasis on enhancing the quality of urban life through human-centered design and smart city initiatives—Al-Madinah presents a significant opportunity for transformation into a smart and human-centric city. By adopting the core dimensions of smart cities, adhering to sustainability frameworks, and integrating principles of human urbanism, the city can evolve into a globally recognized model that harmonizes spiritual heritage with technological advancement. This integrative approach not only supports the city’s cultural and religious significance but also positions it as an international destination for innovation, sustainability, and inclusive urban development.

2.2.1. History of the city

Al-Madinah Almunawarah started to take its unique urban form between 1850 and 1950; before then, it lacked urban documentation, and the only data were a few old pictures. The Prophet’s Mosque was the node of the old urban form. Its surroundings comprised mixed residential and commercial uses, which took the old Islamic city form, with narrow streets and no special urban pattern. Figure (4) shows the study model for the old urban form of the city, derived from old maps and urban documentation. The Prophet’s Mosque was in the middle of an area of houses with no clear vision for future expansion (Nassar, 2017)

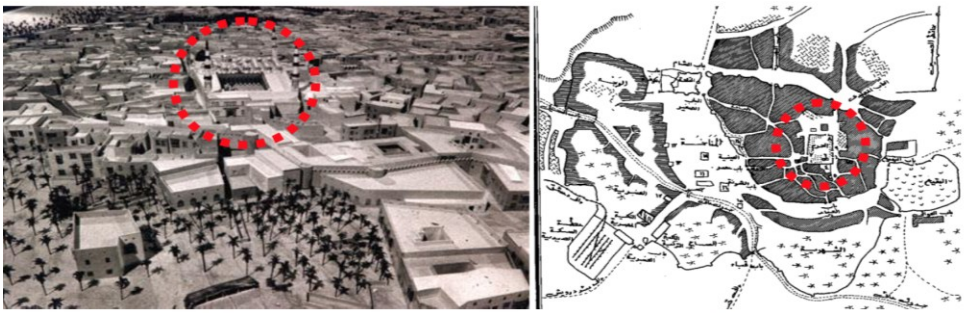

Figure 4. Old urban form of Al-Madinah Almunawarah.
(a) The Prophet Mosque before the expansion (b) Street urban form, 1925
Source: Nassar (2017).

2.2.2. Smart Madinah: a visionary transformation

The Kingdom of Saudi Arabia (KSA) is seeking to establish five smart cities during the next ten years. One of these cities is Madinah, which is one of the most crowded cities in the KSA, as it is a holy city that Muslims from everywhere visit, especially at the time of Pilgrimage (Hajj). The Madinah Region Development Authority (MRDA) is spearheading the transformation of Madinah into a smart city, aligning with Saudi Arabia's Vision 2030. This initiative focuses on enhancing urban living through technological integration, sustainability, and cultural preservation. The Madinah Smart City Programme (MSCP), led by the MRDA, is a comprehensive initiative aimed at integrating advanced technologies to improve the quality of life for residents and visitors. The program emphasizes "Connectivity as a Lever of Change", ensuring that technological advancements complement the city's rich cultural heritage.

Figure 5. Sectors implemented smart city in Al-Madinah

2.2.2.1. Key components of the Madinah smart city program (MSCP)

Table 3: Key features of Al-Madinah smart city program as below:
Source: MSCP https://www.mda.gov.sa/, developed by the author

1. Al-Madinah Al-Munawarah as a smart city	**City's central digital infrastructure, integrating various sectors and services to enhance urban living.**
2. Smart healthcare & emergency services:	- Remote Health Monitoring - Smart Emergency Response
3. Enhancing pilgrim & tourist experience:	- Multilingual Smart Cards - Digital Guides and Virtual Tours
4. Enhancing pilgrim & tourist experience:	- Smart Tree Mapping - Smart Street Lighting - Rainwater Drainge Monitoring
5. Urban planning & digital twins	- Urban Simulation - Predictive Maintenance - Pilgrimage Management - Environmental Monitoring
6. Innovation labs & human centric design	- Innovation Labs - Persona-Based Planning
7. Data governance & AI integration	- Manarah Data Platform. - AI Scenario Modeling
8. Transportation & mobility	- Digital Advertising on Public Transport - Smart Traffic Management

2.2.2.2. Challenges facing smartness applications in Al-Madina Al-Munwarah

Al-Madinah Al-Munawwarah, one of the holiest cities in Islam and a prominent destination for millions of pilgrims annually, presents unique opportunities and challenges in this transformation. While its cultural and religious significance makes it a focal point for innovation and sustainable development, the city also faces a complex set of challenges.

1. Infrastructure limitations:

Here may still be gaps in Internet connectivity and the capacity of existing infrastructure to support a large-scale implementation of smart technologies.

2. Data security and privacy:

As with any smart city initiative, data privacy and security are major concerns. The large amounts of personal data collected through smart applications (e.g., location tracking, payment data) need to be securely stored and managed to avoid breaches or misuse.

3. Integration across systems: Many smart applications in Madinah operate in silos, which make it difficult to integrate them into a unified platform.

4. Adoption resistance:

Some segments of the population may be resistant to adopting new technologies, especially if they are not familiar with them. This could be due to lack of awareness, limited access to devices, or concerns about the impact of these technologies on daily life.

5. Cultural and religious sensitivity:

Madinah is a city with significant religious importance, and the use of smart applications may raise concerns regarding privacy, surveillance, and the impact on the experience of worshippers and pilgrims. Balancing technological advancement with cultural and religious values is crucial.

6. Maintenance and updates:

Smart applications require ongoing maintenance, updates, and support.

7. Environmental factors:

Madinah's harsh climate, especially the high temperatures, can impact the functioning of certain smart infrastructure components. For instance, outdoor sensors, solar panels, or communication towers may need to be designed to withstand extreme heat and dust storms.

8. Funding and budget allocation:

Implementing smart applications at scale requires significant investment. Securing consistent funding for these technologies and ensuring that the budget is allocated effectively to both initial development and long-term maintenance can be a challenge.

9. Legal and regulatory hurdles:

As smart technologies evolve rapidly, local laws and regulations may struggle to keep pace.

10. Pilgrim-centric needs:

Madinah sees millions of pilgrims every year, and managing their needs through smart applications can be a logistical challenge.

2.2.3. AL-Madinah Al-Munawarah as a human city

The Humanizing Al-Madinah Al-Munawwarah initiative officially began in 2018 under the leadership of His Royal Highness Prince Faisal bin Salman bin Abdulaziz, Governor of the Madinah Region and Chairman of the Madinah Region Development Authority. The initiative aims to promote the human dimension in urban planning, enhance quality of life, and preserve the historical and architectural identity of the city, in alignment with the goals of Saudi Vision 2030.

2.2.3.1. Key components of the Madinah human city include

In May 2018, the Development Authority organized the first International Conference on Humanizing Cities in Madinah, bringing together local and international experts in urban development and planning. The conference explored global best practices in creating more liveable, inclusive and people-friendly urban environments. The initiative includes a number of redevelopment projects such as the rehabilitation of the Hamra Al-Asad neighborhood and Quba Avenue, both of which have received international awards for enhancing the urban environment and

reinforcing the city's cultural identity. The overarching goal is to transform Madinah into a human-friendly city by improving public spaces, encouraging pedestrian mobility, enhancing infrastructure, and maintaining the city's spiritual and historical character.

Figure 6. The Sayed Al-shohada area before & after development
Source: Humanizing Medina book

The Sayed Al-shohada area, which was developed as one of the projects aimed at humanizing Medina, did not actually implement the principles of urban humanization. Instead, the development was limited to façade enhancements, road paving, and road widening works.

Table 4: Key features of Al-Madinah Human City.

1. Pedestrian friendly areas:	**- Expansion of pedestrian zones around the prophet Mosque** **- Development of shaded walkways is important in Al-Madina hot climate**
2. Green Spaces & Landscaping	- Expansion of pedestrian zones around the prophet Mosque - Development of shaded walkways is important in Al-Madina hot climate
3. Public Transportation & Accessibility	- Al Haramain high speed railway - Smart bus network
4. Cultural & Heritage Preservation	- Revitalizing of historic neighborhood like Al-Masani' and Quba
5. Inclusive Urban Design	- Universal Design Principles - Human-scaled architecture

Figure 7. Development of Qubaa district
Source: Humanizing Medina book

The project didn't align with the aspirations of the residents of the Quba area, as it failed to ensure easy access to residential units by car and did not provide permanent, affordable public transportation. Consequently, visitors were discouraged from shopping in one of the area's ost important commercial streets, leading to social and economic imbalance after development.

2.2.3.2. Challenges facing humanizing initiatives in Al-Madina Al-Munwarah

Transforming a historically significant and rapidly growing urban center like Al-Madinah Al-Munawwarah into a human-centered city presents a unique set of challenges.

1. Over-commercialization of sacred areas

- Urban beautification and infrastructure upgrades near the Prophet's Mosque can lead to commercialization that may diminish the city's spiritual atmosphere.
- Development may prioritize tourists and visitors over the needs and traditions of residents.

2. Displacement of local Communities

- Humanization projects (e.g., green spaces, walkways, transport corridors) may require demolishing old neighborhoods, leading to the displacement of long-time residents.
- Cultural and social fabric can be disrupted when communities are relocated.

3. Loss of historical and architectural heritage

- Modern urban design and smart applications can lead to the erasure of historical structures or traditional urban patterns.
- Replacing older buildings with modern developments may reduce the city's historical identity.

4. Traffic and accessibility challenges

- Pedestrianizing streets and reducing vehicle access to "humanize" certain areas may unintentionally reduce accessibility for the elderly, disabled, or service vehicles.
- During peak pilgrimage seasons, such changes can create bottlenecks.

5. Socioeconomic imbalance

- Gentrification can occur as upgraded areas become more attractive to wealthier visitors and investors, raising property prices and living costs.
- Local, lower-income residents may find it harder to afford housing or services in improved areas.

6. Environmental stress

- Increased green spaces and urban landscaping in a desert environment require substantial water and maintenance, putting stress on local resources.
- If not sustainably designed, "humanized" infrastructure can worsen ecological impact.

7. Cultural Tensions

- Some modernization efforts might clash with conservative cultural norms, such as open mixed-gender public spaces, liberal use of public art, or untraditional design elements.

8. Short-term disruptions

- Construction, rerouting, and redevelopment efforts can temporarily inconvenience residents and visitors, impacting religious rituals and business activity.

3. Results

3.1. Proposed Framework: Design Framework For Al-Madinah Al-Munawarah: Integration Between Smart City Dimensions and Human City + Sustainability

The relationship between a smart city and a human city lies in their complementary goals: while a smart city focuses on using technology to optimize urban systems, a human city centers on the well-being, inclusivity, and needs of its residents.

- Smart city initiatives involve the use of data, sensors, and digital tools to improve efficiency in areas like transportation, energy, water, and governance.
- Human city principles prioritize livability, community engagement, equity, and human-centric.

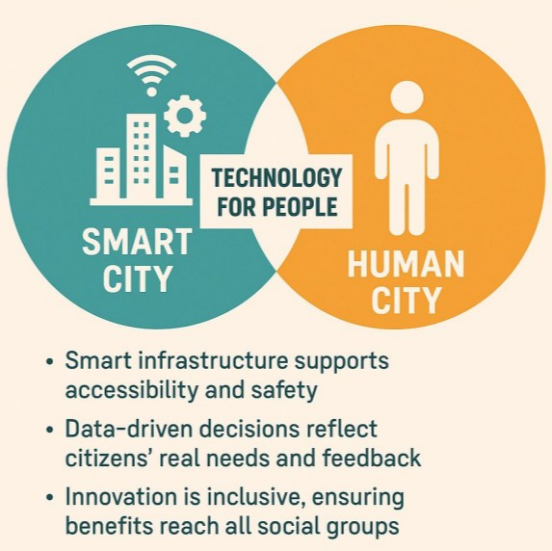

Figure 8. Integration between Smart & Human City principles

Matrix: Interrelation Between Human City Principles and Smart City Dimensions
This matrix visually demonstrated how each human-centered principle aligns with one or more smart city dimensions, showing their complementary roles in shaping livable, inclusive, and sustainable urban environments.

Table 5: shows the Matrix between smart city dimensions and human city principals.

	Smart Living	Smart Economy	Smart Mobility	Smart Environment	Smart People	Smart Governance
Improve Quality of Life	■		■	■	■	
Promote Inclusivity					■	■
Encourage Adaption	■	■	■			
Participatory Governance						■
Enhance Sustainability			■	■		

This part shows how the Smart City dimensions relate to the Human City principles, showing that the two approaches are deeply interconnected and complementary. While Smart Cities often emphasize technological solutions, and Human Cities emphasize people-first values, the two are not at odds. Instead, smart technologies can enable human-centered outcomes—making cities not only more efficient but also more equitable, inclusive, and livable, as shows in table (5), (6).

1. Smart Living ↔ Improve Quality of Life
- Smart Living focuses on enhancing urban life through technology in areas like health, safety, education, and culture.
- This directly improves quality of life, a key principle of Human Cities, by ensuring that people's daily experiences are more convenient, healthy, and fulfilling.
2. Smart Economy ↔ Encourage Adoption
- A Smart Economy leverages innovation, entrepreneurship, and digital services to boost productivity and employment.
- For Human Cities, encouraging adoption means fostering environments where people can participate in and benefit from these innovations, leading to inclusive economic growth.
3. Smart Mobility ↔ Promote Inclusivity
- Smart Mobility provides accessible, efficient, and sustainable transport options.

- This promotes inclusivity by ensuring all citizens—regardless of income or ability—can move freely and access services and opportunities.

4. Smart Environment ↔ Enhance Sustainability

- The Smart Environment dimension deals with reducing pollution, optimizing resource use, and protecting natural ecosystems.
- This clearly aligns with the Human City goal to enhance sustainability, ensuring that urban development supports both present and future generations.

5. Smart People ↔ Promote Inclusivity & Encourage Adoption

- Smart People refer to education, and digital literacy, enabling citizens to engage with smart solutions.
- This supports inclusivity by empowering all social groups and encourages adoption by building the skills needed to participate in smart initiatives.

6. Smart Governance ↔ Participatory Governance

- Smart Governance includes transparency, e-governance, and digital tools to improve decision-making and service delivery.
- It is closely linked to participatory governance, a Human City principle, by enabling citizens to co-create policies and influence how cities are managed.

Table (6), shows the relation and interconnection between smart city principals and human city dimensions - Source: the author

		1-Smart living						2-Smart economy							3-Smart mobility			4- Smart environment				5-Smart people						6-Smart governance			
		1	2	3	4	5	6	1	2	3	4	5	6	7	1	2	3	1	2	3	4	1	2	3	4	5	6	1	2	3	4
Improve Quality of Life	Accessible efficient transportation																														
	Accessible efficient healthcare																														
	Accessible efficient energy																														
Promote Inclusivity	Support elderly																														
	Support disabled																														
	Support low income communities																														
	No technological or social exclusion																														
Encourage Adoption	Systems intuitive																														
	Systems aligned with daily human behavior																														
Participatory Governance	Transparent																														
	User friendly system design																														
	People role in decision making																														
Enhance Sustainability	Economic																														
	Social																														
	Urban																														
	Environmental																														

1-Smart living						2-Smart economy						3-Smart mobility			4- Smart environment				5-Smart people						6-Smart governance			
Cultural and educational facilities	Health Conditions	Individual Safety	Housing Quality	Touristic Attractively	Social Cohesion	Innovative Spirit	Entrepreneurship	Economic Image	Productivity	Flexibility of Labor Market	International Embeddedness	Ability to Transform	Availability of ICT infrastructure	Local & International Acess	Sustainable safe transport	Attractively Natural Conditions	Pollution	Environmental Protection	Sustainable Resource Management	Level of Qualifications	Affinity to Lifelong learning	Social & Ethical Purity	Flexibility & Creativity	Cosmopolitanism / open-mindedness	Participation in Public life	Participation in Decision Making	Public & Social Servicess	Transparent Governance	Political strategies & Perspectives

4. Discussion

While a smart city is typically defined as an urban area that leverages digital technologies, data analytics, and automation to enhance the efficiency of city services, infrastructure, and governance, a human city focuses on creating inclusive, livable, and socially responsive spaces that prioritize the well-being and participation of its residents. Recognizing the limitations of purely technology-driven approaches, a new paradigm has emerged in urban development: the human smart city. This concept seeks to harmonize technological advancement with human-centric design, ensuring that innovation is used not just for efficiency, but also to enhance the quality of life, social equity, and cultural identity of urban communities. A practical example of this paradigm can be developed in Al Madinah Al Munawwarah, where smart technologies are being thoughtfully integrated with the city's rich spiritual, cultural and historical context. One notable initiative is the smart transportation system around the Prophet's Mosque area, which uses real-time data to manage traffic flow and improve the experience of millions of pilgrims and residents. At the same time, urban planners could preserve walkable spaces, green areas, and culturally significant architecture to maintain the human and spiritual character of the city. This balanced approach exemplifies how Al Madinah could be evolved into a human smart city—leveraging innovation while remaining deeply rooted in its social and cultural fabric.

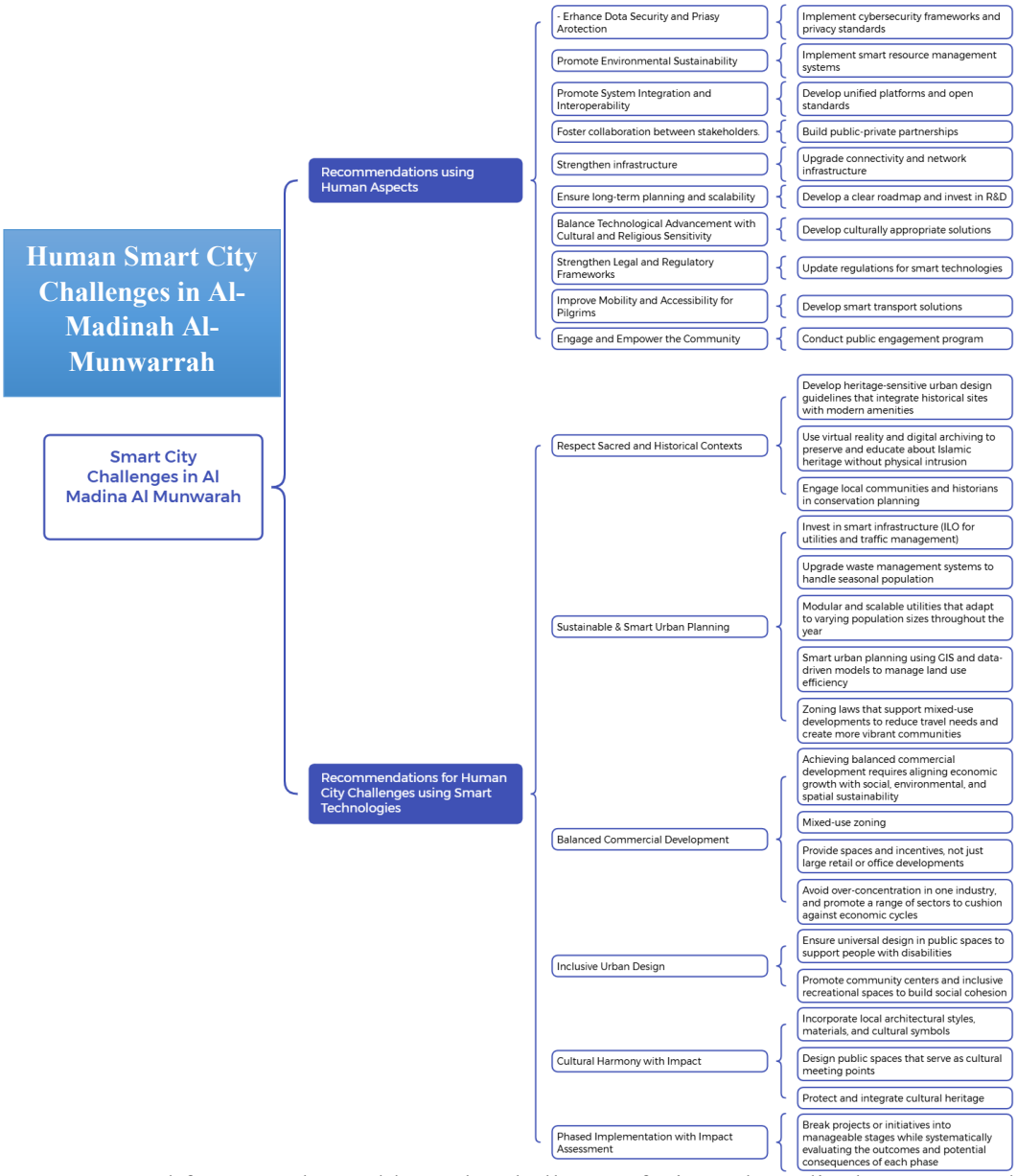

Figure 9. A proposed framework to address the challenges facing Al Madinah as a smart human city

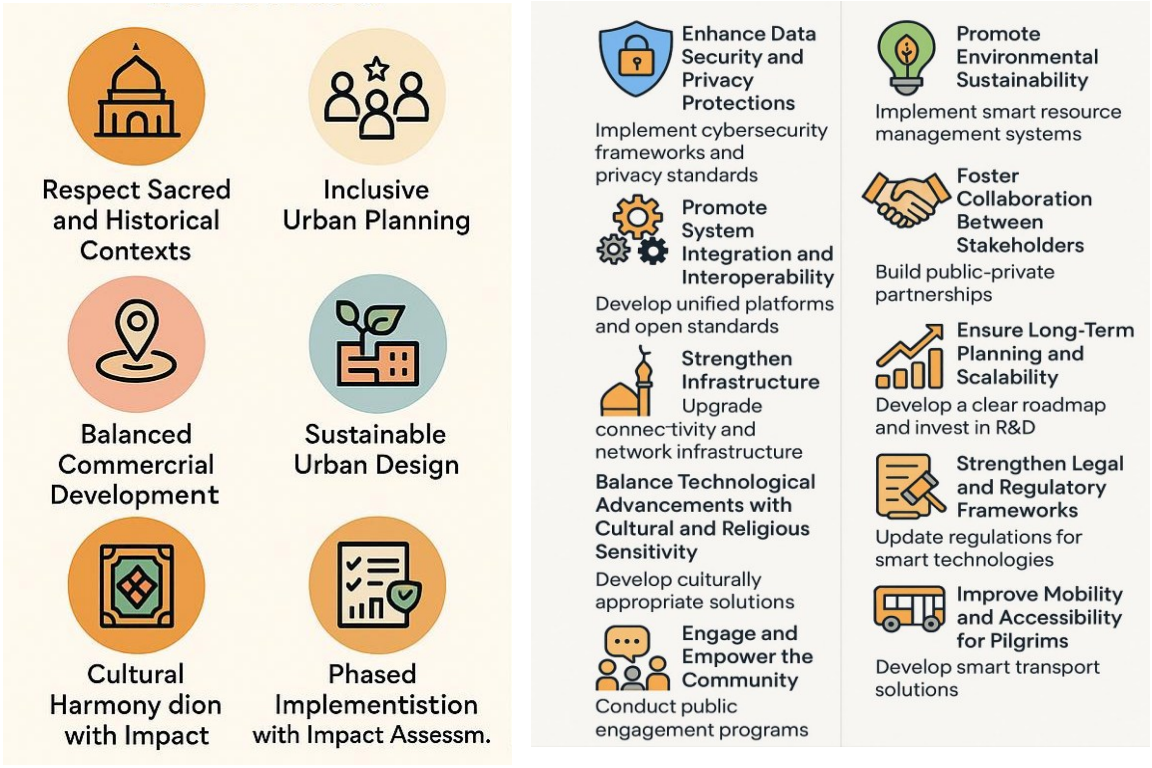

Figure 10. Recommendation for Medina as A Human Smart City
Source: The Author

5. Conclusion

- The integration of ICT tools and infrastructure is fundamental to the development of smart cities; however, their effectiveness ultimately depends on alignment with human needs. A smart city, in its fullest expression, cannot exist independently of sustainability—these two paradigms are inherently intertwined. Both aim to enhance the quality of urban life through efficient, inclusive, and environmentally responsible practices. As such, the evolving concepts of smart, sustainable, and resilient cities represent a unified vision of urban development that integrates social equity, economic vitality, and environmental stewardship.

- This study emphasizes that smart cities are more than technological upgrades—they represent a transformative model grounded in sustainable development, citizen participation, and human-centered design. To achieve meaningful progress, smart city initiatives must embed sustainability principles throughout planning and implementation processes, ensuring that digital innovation serves broader societal goals. Inclusivity, equity, and community engagement are not peripheral concerns but essential components in shaping livable and just urban environments.

- Within the context of Saudi Arabia's Vision 2030, Al-Madinah offers a unique opportunity to become a leading example of a human-smart city. Despite a current lack of coherence between its designation as both a "Smart City" and a "Human City" Madinah's strategic position as a global religious hub with a diverse demographic composition presents a powerful platform for inclusive and culturally sensitive urban transformation. Challenges related to infrastructure modernization, cyber security, digital literacy, and cross-sectoral collaboration remain; however, they can be addressed through integrated, long-term planning that respects the city's historical and spiritual identity.
- To support this vision, a matrix was developed illustrating the interrelationship between smart city dimensions and human-centric urban principles:
• Smart living enhances comfort, safety, and health but requires ethical data use and equitable

access.
- Smart economy promotes inclusive, transparent, and efficient ecosystems for growth and innovation.
- Smart mobility reduces social and physical barriers, improving access to urban opportunities.
- Smart environment supports sustainability through responsive and integrated resource management.
- Smart people foster a culture of openness, inclusivity, and adaptive innovation.
- Smart governance merges technological capabilities with participatory mechanisms to empower communities.

- In comparison to existing literature, which often treats smart and human city paradigms as parallel or even competing approaches, this study advocates for their convergence. While prior research has extensively discussed the technological dimensions of smart cities—emphasizing efficiency, automation, and data-driven governance—there has been relatively less emphasis on embedding human values, cultural identity, and community participation into these frameworks. Conversely, human city models tend to prioritize livability, equity, and social inclusion but often lack integration with advanced technological infrastructure. This research bridges that gap by proposing a synthesized model—the human-smart city—that balances innovation with empathy, planning with participation, and performance with purpose. It reinforces the emerging scholarly perspective that future urbanism must be both digitally intelligent and deeply humane to be truly sustainable and resilient.

- The findings of this study strongly support the hypothesis that there is significant potential to establish a dual model that integrates both smart and human city frameworks. By mapping the interdependencies between technological advancement and human-centric values, the research demonstrates that these models are not mutually exclusive but rather complementary. The matrix developed in this study provides a practical foundation for operationalizing this dual approach, showing how elements such as smart governance, mobility, and economy can align with inclusivity, cultural sensitivity, and social equity. The case of Al-Madinah exemplifies how a city can leverage digital tools to address urban challenges while simultaneously preserving its historical and religious identity. This dual model offers a scalable and adaptable blueprint for cities aiming to foster both innovation and livability, affirming that a balanced integration of smart and human-centric principles is not only feasible but essential for sustainable urban transformation.

A key contribution of this research lies in its novelty and originality—specifically, in its conceptualization of a dual framework that integrates smart city technologies with human-centered urbanism within a real-world case. While much of the existing literature tends to explore either the technological optimization of urban systems or the social and cultural dimensions of urban life in isolation, this study uniquely bridges both domains. It goes beyond theoretical abstraction by applying its integrated model to the context of Al-Madinah, a city with distinctive religious, cultural, and demographic dynamics. The research not only identifies gaps in existing policy and planning approaches but also introduces a practical analytical matrix that links smart city pillars (such as digital governance, smart mobility, and smart economy) with human-centric values (such as inclusivity, equity, and cultural identity). This multidimensional approach challenges the prevailing linear models of urban innovation and positions the human-smart city as an emergent paradigm—especially relevant for cities in the Global South or those with complex socio-religious fabrics. As such, the study makes a significant theoretical and methodological contribution to urban studies, offering a new lens through which cities can be both technologically advanced and deeply human in character.
- As urban areas worldwide respond to technological shifts and global challenges, the convergence of smart and sustainable models becomes imperative. Moving beyond fragmented approaches, cities

must adopt a holistic, adaptable framework—one that places people at the center while harnessing digital tools for equity, resilience, and long-term livability. Al-Madinah, if guided by such a vision, has the potential to lead as a pioneering human-smart city in the global urban landscape.

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The author declares no conflicts of interest.

Data availability statement
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Institutional Review Board Statement
Not applicable.

CRediT author statement
Not applicable, the whole research is an individual contribution from one author.

References

2030, S. V. (n.d.). *Saudi Vision 2030*. https://www.vision2030.gov.sa

Ahvenniemi, H., Huovila, A., Pinto-Seppä, I., & Airaksinen, M. (2017). What are the differences between sustainable and smart cities? *Cities, 60*, 234–245. https://doi.org/10.1016/j.cities.2016.09.009

Al Sharif, R. A., & Aina, Y. A. (2021). Smart city dimensions and associated risks: Review of literature. *Sustainable Cities and Society, 77*, 103542. https://doi.org/10.1016/j.scs.2021.103542

Albino, V., Berardi, U., & Dangelico, R. M. (2015). Smart cities: Definitions, dimensions, performance, and initiatives. *Journal of Urban Technology, 22*(1), 3–21. https://doi.org/10.1080/10630732.2014.942092

Ali, F. (2019). *Characterising cities: Form, function, and features* (Doctoral dissertation, University of Delaware). University of Delaware Institutional Repository. https://udspace.udel.edu/items/2b969b63-6f23-4a2c-9cb8-f7d04145ef67

Alrefaei, R. (2023). *Urban growth pattern: The impact of the number of religious visitors on urban development in Al Madinah, Saudi Arabia* (Master's thesis). https://hdl.handle.net/20.500.14154/69245

Angelidou, M., Psaltoglou, A., Komninos, N., Kakderi, C., Tsarchopoulos, P., & Panori, A. (2018). Enhancing sustainable urban development through smart city applications. *Journal of Science and Technology Policy Management, 9*(2), 146–169. https://doi.org/10.1108/JSTPM-05-2018-0058

Aurigi, A. (2006). New technologies, same dilemmas: Policy and design issues for the augmented city. *Journal of Urban Technology, 13*(3), 5–28. https://doi.org/10.1080/10630730601145989

Madinah Development Authority. (n.d.). *Madinah Development Authority*. https://www.mda.gov.sa

Baig, Z. A., Shuib, L., Yadegaridehkordi, E., Mahmud, R., Al-Nafjan, A., & Al-Sharif, Z. A. (2017). Security, privacy and risks within smart cities: A literature review and development of a smart city interaction framework. *Information Systems Frontiers, 21*(3), 495–517. https://doi.org/10.1007/s10796-017-9782-0

Bait, Z. I., Kamal, M. A., & Khan, M. M. (2020). Security, privacy, and risks within smart cities: Literature review and development of a smart city interaction framework. *Information Systems Frontiers, 22*(2), 421–437. https://doi.org/10.1007/s10796-020-10044-1

Caragliu, A., Del Bo, C., & Nijkamp, P. (2009). *Smart cities in Europe* (Research Memoranda No. 2009-48). VU University Amsterdam. https://research.vu.nl/en/publications/smart-cities-in-europe

Chourabi, H., Nam, T., Walker, S., Gil-Garcia, J. R., Mellouli, S., Nahon, K., Pardo, T. A., & Scholl, H. J. (2012). Understanding smart cities: An integrative framework. In *Proceedings of the 45th Hawaii International Conference on System Sciences (HICSS)* (pp. 2289–2297). IEEE. https://doi.org/10.1109/HICSS.2012.615

Clark, J. (2020). *Uneven innovation: The work of smart cities*. Columbia University Press.

Dameri, R. P. (2013). Searching for smart city definition: A comprehensive proposal. *International Journal of Computers & Technology, 11*(5), 2544–2551. https://doi.org/10.24297/ijct.v11i5.1142

De Jong, M., Joss, S., Schraven, D., Zhan, C., & Weijnen, M. (2015). Sustainable–smart–resilient–low carbon–eco–knowledge cities: Making sense of a multitude of concepts promoting sustainable urbanization. *Journal of Cleaner Production, 109*, 25–38. https://doi.org/10.1016/j.jclepro.2015.02.004

Giffinger, R., Fertner, C., Kramar, H., Kalasek, R., Pichler-Milanović, N., & Meijers, E. (2007). *Smart cities: Ranking of European medium-sized cities* (Final report). Centre of Regional Science, Vienna University of Technology. https://doi.org/10.34726/3565

Höjer, M., & Wangel, J. (2015). Smart sustainable cities: Definition and challenges. In L. M. Hilty & B. Aebischer (Eds.), *ICT innovations for sustainability* (pp. 333–349). Springer. https://doi.org/10.1007/978-3-319-09228-7_20

Hall, R. E. (2000). *The vision of a smart city* (Report No. BNL 67902; 04042). Brookhaven National Laboratory.

Haque, U. (2012, April). Surely there's a smarter approach to smart cities? *Wired*. https://www.wired.com/story/potential-of-smarter-cities-beyond-ibm-and-cisco

Johnsen, S. O., Skjølsvold, T. M., & Foulds, C. (2017). Risks, safety and security in the ecosystem of smart cities. In M. Y. Khan (Ed.), *Risk assessment*. IntechOpen. https://doi.org/10.5772/intechopen.70740

Kitchin, R. (2014). The real-time city? Big data and smart urbanism. *GeoJournal, 79*(1), 1–14. https://doi.org/10.1007/s10708-013-9516-8

Kourtit, K., Nijkamp, P., & Arribas, D. (2012). Smart cities in perspective—A comparative European study by means of self-organizing maps. *Innovation: The European Journal of Social Science Research, 25*(2), 229–246. https://doi.org/10.1080/13511610.2012.660330

Marsal-Llacuna, M.-L., Colomer-Llinàs, J., & Meléndez-Frigola, J. (2015). Measuring the standardized definition of "smart city": A proposal on global metrics to set the terms of reference for urban "smartness." In B. Murgante et al. (Eds.), *Computational science and its applications – ICCSA 2015: Lecture Notes in Computer Science* (Vol. 9156, pp. 40–55). Springer. https://doi.org/10.1007/978-3-319-21407-8_42

Martin, C. J., Evans, J., & Karvonen, A. (2018). Smart and sustainable? Five tensions in the visions and practices of the smart-sustainable city in Europe and North America. *Technological Forecasting and Social Change, 133*, 269–278. https://doi.org/10.1016/j.techfore.2018.01.005

Moafa, M. M. (2024). *Humanising Cities Initiative: Evaluating social sustainability with a focus on well-being through Quality of Life Programme efforts – A case study of Madinah, Saudi Arabia: A comprehensive analysis* (Master's thesis). https://hdl.handle.net/20.500.14154/74081

Mohanty, S. P., Choppali, U., & Kougianos, E. (2016). Everything you wanted to know about smart cities: The Internet of Things is the backbone. *IEEE Consumer Electronics Magazine, 5*(3), 60–70. https://doi.org/10.1109/MCE.2016.2556879

Mosannenzadeh, F., & Vettorato, D. (2014). Defining smart city: A conceptual framework based on keyword analysis. *TeMA – Journal of Land Use, Mobility and Environment*. https://doi.org/10.6092/1970-9870/2523

Nassar, U. A. (2017). Expansion of the Prophet Mosque as a catalyst for sustainable urban development in Al-Madinah Almunawarah in Saudi Arabia. *UPLanD – Journal of Urban Planning, Landscape & Environmental Design, 2*(1), 99–115.

Piro, G., Cianci, I., Grieco, L. A., Boggia, G., & Camarda, P. (2014). Information-centric services in smart cities. *Journal of Systems and Software, 88*, 169–188. https://doi.org/10.1016/j.jss.2013.10.029

Roggema, R. (2020). The convenient city: Smart urbanism for a resilient city. In N. Biloria (Ed.), *Data-driven multivalence in the built environment* (pp. 37–55). Springer. https://doi.org/10.1007/978-3-030-12180-8_2

Tan, S. Y., & Taeihagh, A. (2020). Smart city governance in developing countries: A systematic literature review. *Sustainability, 12*(3), 899. https://doi.org/10.3390/su12030899

Ullah, F., Sepasgozar, S., & Wang, C. (2021). Risk management in sustainable smart cities governance: A TOE framework. *Technological Forecasting and Social Change, 167*, 120743. https://doi.org/10.1016/j.techfore.2021.120743

Waheeb, S., AlShammari, A., & Al-Harbi, M. (2025). Evaluation of the basic urban aspects in the sustainable urban development and improvement of Quba Road in Medina (Darb Al Sunna). *Journal of King Abdulaziz University: Environmental Design Sciences, 16*(1). https://doi.org/10.4197/Env.16-1.5

Washburn, D., & Sindhu, U. (2010, February). *Helping CIOs understand "Smart City" initiatives: Defining the smart city, its drivers, and the role of the CIO*. Forrester Research. http://public.dhe.ibm.com/partnerworld/pub/smb/smarterplanet/forr_help_cios_und_smart_city_initiatives.pdf