



NEOM - Lining Up a New Smart City

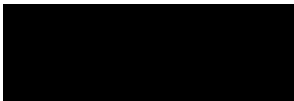
A thesis submitted to Swansea University, Geography Department in fulfilment of the requirements for the Degree of Doctor of Philosophy

By
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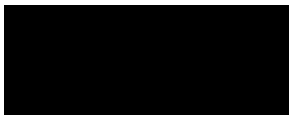
Declarations

This work has not previously been accepted in substance for any degree and is not being concurrently submitted in candidature for any degree.

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This thesis is the result of my own investigations, except where otherwise stated. Other sources are acknowledged by footnotes giving explicit references. A bibliography is appended.

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Abstract

NEOM, a US\$500 billion megaproject under development in Saudi Arabia and a flagship of the Kingdom's Vision 2030, proposes a new model of urbanism powered entirely by renewable energy, governed through AI-driven systems, and anchored by The Line, a 170-kilometre linear city designed to eliminate car dependency, reduce carbon emissions, and preserve 95% of its surrounding natural environment.

This study examines how the planning of the NEOM urban area draws upon lessons from other established smart cities worldwide, with an emphasis on NEOM's planning motivations, environmental strategies, and its distinctive linear spatial logic. Boyd Cohen's Smart City Wheel is used as a diagnostic framework to assess NEOM's alignment with established smart city dimensions, while the lens of smart and cognitive urbanism offers insight into the project's symbolic, technological, and strategic dimensions.

A qualitative interpretive case study methodology guided the research during NEOM's construction, gaining empirical insights into NEOM's formative planning and early construction stages. Primary data was collected through 39 semi-structured interviews with high-level internal stakeholders, including NEOM planners, consultants, and experts, and external participants such as urban scholars, sustainability professionals, and policy advisors. These insights are supported by documentary analysis and in-depth engagement with planning reports and media sources. The findings reveal that NEOM selectively integrates global best practices while extending them through novel frameworks, such as AI urbanism, Zero Gravity Urbanism, and cognitive dimensions. While the project introduces ambitious innovations in renewable energy systems, vertical spatial design, and AI-enhanced service delivery, it remains in an early experimental phase. At this stage, NEOM cannot yet be considered a fully replicable model, but it embodies a potential future paradigm marked by conceptual boldness and global significance. The study concludes by identifying key challenges for translating NEOM's ambitious vision into a viable and replicable model, particularly in terms of inclusive governance, environmental resilience, technological feasibility, and the uniqueness of NEOM's political and geographical context. Finally, recommendations for future research are suggested as NEOM continues to be built, specifically the need for longitudinal monitoring and comparative studies to evaluate and contextualise its evolving progress and replicability.

Abbreviations

AI	Artificial Intelligence
API	Application Programming Interface
BCSCW	Boyd Cohen's Smart City Wheel
CLC	Centre for Liveable Cities
CNBC	Consumer News and Business Channel
ESG	Environmental, Social, and Governance concerns
GDP	Gross Domestic Product
ICT	Information and Communication Technology
IoT	Internet of Things
NbS	Nature-based solutions
KAEC	King Abdullah Economic City
km	Kilometres
PIF	Public Investment Fund
PVPC	PlanIT Valley Paredes City
SEZ	Special Economic Zone
SDG	Sustainable Development Goal
SSC/SSCs	Smart Sustainable City/ Smart Sustainable Cities
SAR	Saudi Arabian Riyal
UOS	Urban Operating System

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Chapter 1: Introduction

1.1. The Context

Globalisation has intensified interconnectivity, fuelling both urbanisation and economic expansion. This dynamic has catalysed the emergence of global and smart cities; urban forms characterised by the integration of technology, sustainability, and innovation (Sankaran & Chopra, 2020; Shin, 2016; Kim, 2013). While global cities function as key economic and political hubs (Smith, 2014; Sassen, 1991; Friedmann, 1986), smart cities distinguish themselves by deploying advanced technologies to enhance urban living (Höjer & Wangel, 2014; Loo & Tang, 2019; Kim et al., 2017). As Robertson (1995) suggests, smart cities can be understood as global phenomena, as they reflect a fusion of both global and local processes and systems. Increasingly, global cities are incorporating smart features to optimise resource management, enhance service delivery, and foster innovation, thereby reinforcing their global reach and advancing urban sustainability (Dameri et al., 2019; Bhati et al., 2017; Caragliu et al., 2011; Cohen, 2013; Doherty, 2014).

The escalating demands of urban populations have intensified issues such as pollution, employment strain, energy consumption, waste, and fiscal pressures (Cohen, 2014; Nam & Pardo, 2011). Smart cities have emerged as offering crucial solutions to the challenges facing contemporary urban environments. By integrating Information and Communication Technology (ICT) with the Internet of Things (IoT), they aim to improve service efficiency, enhance quality of life, and reduce ecological impacts (Arroub et al., 2016; Albino et al., 2015; Kitchin, 2014a; Carvalho & Campos, 2013; Chen, 2010; Bronstein, 2009). For example, in terms of traffic congestion, housing shortages, and ageing infrastructure, smart technologies enable the collection and analysis of data to inform more efficient urban planning and resource allocation (Artyushina, 2020; Kitchin, 2014b). Sensors and surveillance systems can manage traffic, reduce emissions, and improve transport efficiency, while smart grids are able to support sustainable energy distribution (Elassy et al., 2024). Simultaneously, these cities foster economic growth and innovation by creating conditions conducive to entrepreneurial ecosystems (Rezk et al., 2020), where

digital infrastructure, co-working spaces, and data-driven services converge to attract startups, incubate new business models, and enhance competitiveness in knowledge-based economies. Enhanced digital connectivity also facilitates cross-sector collaboration among governments, businesses, and citizens, driving the development of services across healthcare, education, and entertainment (Capdevila & Lai et al., 2020; Zarlenga, 2015).

Smart cities also make significant contributions to environmental sustainability. Green technologies, renewable energy adoption, and waste reduction initiatives work to reduce carbon footprints and contribute to global climate goals (Bibri & Krogstie, 2017; Crot, 2013). Real-time environmental monitoring through IoT further enables rapid response to ecological challenges (Fiore et al., 2019). Another defining feature of smart cities is their emphasis on participatory governance. Digital platforms and social media facilitate two-way engagement, allowing policymakers to respond more effectively to citizens' needs (Cocchia, 2014). This inclusive model fosters a stronger sense of community and civic identity (Alamoudi et al., 2022). Finally, pioneering smart city initiatives such as those in Singapore, Barcelona, and Amsterdam demonstrate the transformative potential of integrated urban planning, advanced digital infrastructure, and sustainability-driven policies (Bakici et al., 2012; Gonzaga, 2018; Jameson et al., 2019). These examples underscore the capacity of smart cities to be not only technologically advanced but also socially resilient and ecologically responsible.

1.2. Background

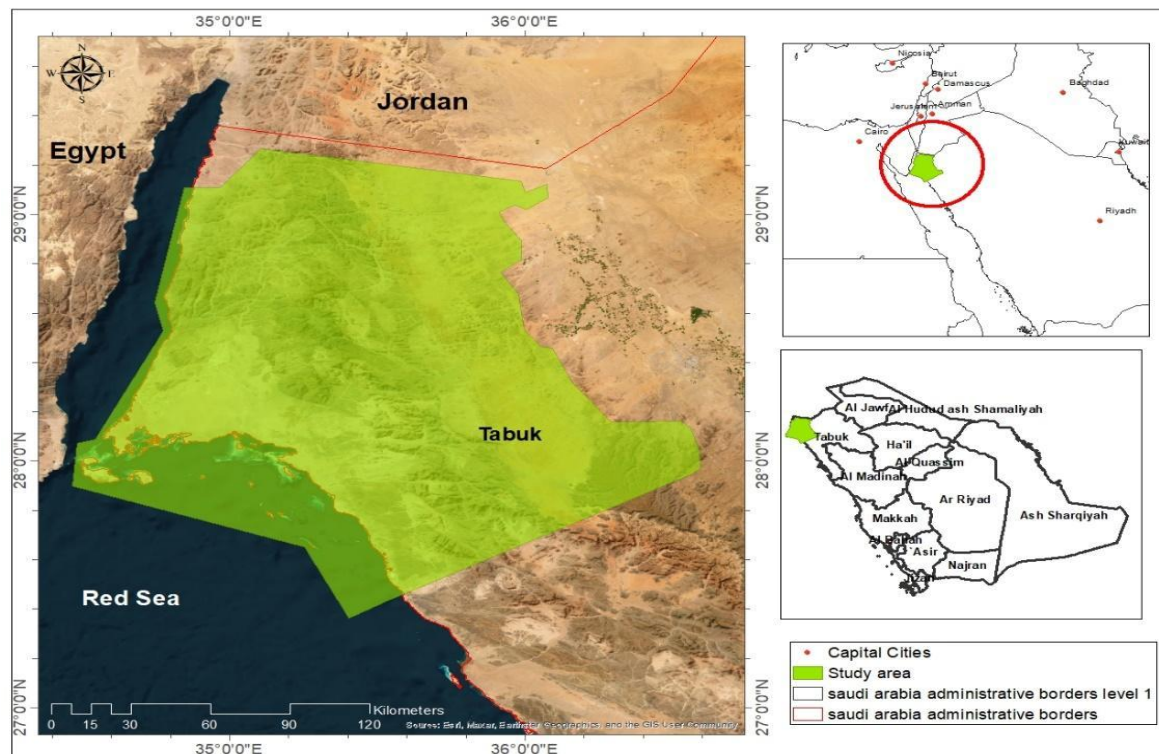
NEOM demonstrates a new way of urban development that is closely related to sustainability principles and to the era of digital technology (Rashed & Mahmoud, 2018, p.1)

NEOM represents one of Saudi Arabia's most ambitious undertakings; an initiative to build a futuristic city encompassing approximately 26,500 square kilometres in the Kingdom's north-western region, extending towards the borders of Jordan and Egypt (NEOM, n.d.; see Figure 1). Officially announced by Crown Prince Mohammad bin Salman during the 2017 Future Investment Initiative conference, NEOM is a cornerstone of Saudi Vision 2030, the nation's strategic framework for economic diversification and reducing dependency on oil

revenues (Grand & Wolff, 2020; Alomi, 2017; Bahreldin et al., 2025). The Crown Prince's declaration captured the project's imaginative ambition: "I tell people who cannot dream; [you] should not negotiate with us or come to NEOM. Welcome dreamers who can come to the new world" (Farag, 2019, p. 36). The name NEOM itself reflects the project's ethos. It is derived from the Ancient Greek prefix *neo*, meaning 'new', combined with the Arabic word *Mostaqbal*, meaning 'future' (Alam et al., 2021; Farag, 2019). It is the symbolic fusion of linguistic traditions to project a vision of forward-looking innovation.

Figure 1

Geographical Study Area



Source: Adapted by the author from SANSRS (Saudi Arabia National Spatial Reference System Implementation Guidelines, 2022).

NEOM is a pioneering urban development project designed to showcase to the world how urban development does not have to come at the expense of environment and that it is possible for principles of sustainability to seamlessly coalesce with the digital era (Farag, 2019). The cornerstone of NEOM's design revolves around the pursuit of a sustainable future where renewable energy sources, predominantly solar and wind, are harnessed to

power the entire city (Hassan, 2020). Buildings are to be designed with sustainable materials and green technology that focus on minimising waste and maximising energy efficiency. This approach challenges traditional urban planning and sets a new global standard which demonstrates that modern cities could thrive without compromising ecological integrity (Farag, 2019). Moreover, NEOM is not merely an ecological utopia; it is designed as an emblem of the digital era. It is envisioned as a smart city, with every facet of life interconnected through state-of-the-art digital infrastructure (Nuseir et al., 2020). From autonomous vehicles to advanced robotics and Artificial Intelligence (AI), digital technology is deeply rooted in the city's infrastructure (Rashed & Mahmoud, 2018). The smart grid system will manage energy usage, waste management, and water resources in real-time and optimise city-wide services based on the needs of its inhabitants. IoT devices will permeate every corner of the city which would create a hyper-connected society that merges seamlessly with the fabric of daily life (Rezk et al., 2020). It is this integration of the two guiding principles of sustainability and digital technology to create a harmonious blend that sets NEOM apart as representing a truly new way of urban development (Farag, 2019; Nuseir et al., 2020). NEOM stands as a testament to what could be achieved when innovation, sustainability and digital technology converge for the purpose of establishing a model that other cities around the world could look to as they strive to build a more sustainable and connected future. This fusion of ecology and technology holds the promise to redefine how people conceptualise, design, and live in cities (Madakam & Bhawsar, 2021). As Hassan (2020) summarises, NEOM represents a pivotal moment in the evolution of urban development, positioning itself as a potential global prototype for future cities that integrate sustainability with advanced digital innovation.

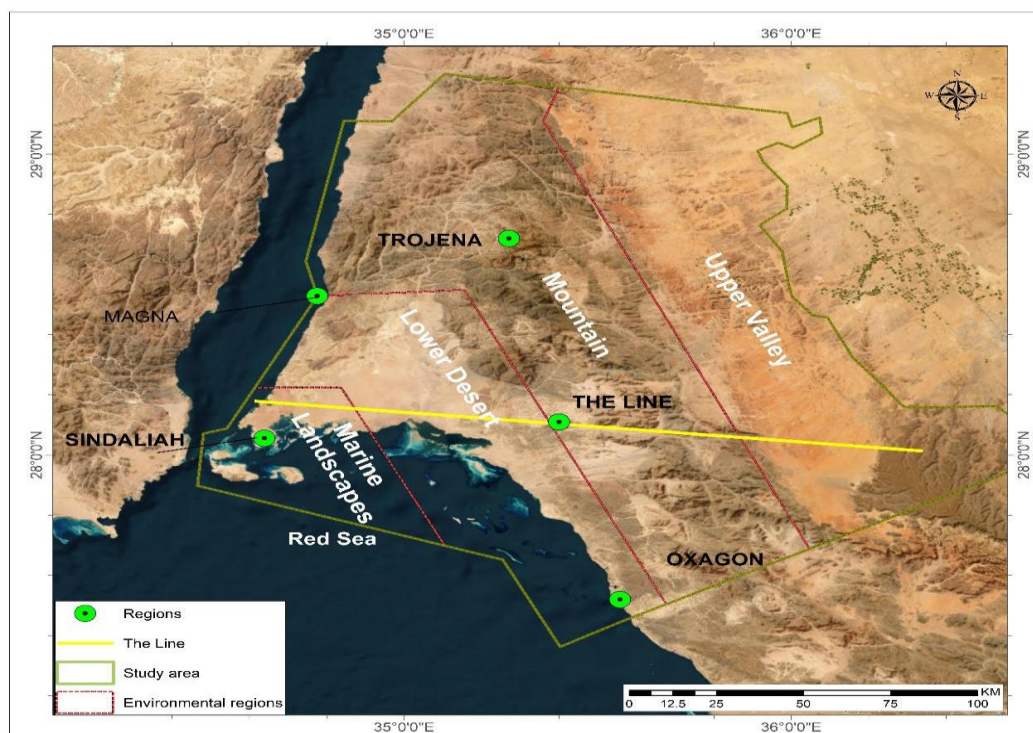
This ambitious project has additional economic goals, seeking to establish a global hub for innovation, technology, and sustainable living that will make it a transformative force in the world's economy. With an estimated investment of US\$500 billion, the Saudi Arabian government aims to attract international investors and businesses to help drive the growth of this mega-city in areas such as IoT, biotechnology, robotics, and other advanced technologies that will drive the future of human progress (Hassan, 2020; Kaluarachchi, 2022; Nuseir et al., 2020). In addition to the economic and technological aspects, NEOM also emphasises the importance of culture and entertainment, aiming to create a vibrant and diverse urban environment (Doheim et al., 2019). The city will host various cultural events,

sports competitions, and artistic performances, in addition to offering world-class educational and healthcare facilities (Saeed et al., 2022).

The development plan for NEOM is centred around fifteen carefully selected key sectors comprising energy, water, mobility, entertainment and culture, food, manufacturing, media, tourism, sport, design and construction, financial services, health and wellbeing, education, research and innovation, and technology. Alongside these sectors, the project is divided into five key infrastructural regions: The Line, Industrial City ‘Oxagon’, Trojena, Magna, with 15 luxury hotels and the Luxury Island ‘Sindalah’ (see Figure 2 for the locations). While NEOM’s development was always envisioned as a phased approach, challenges have already arisen in terms of the timeline for construction. Phase One was scheduled for completion by end of 2025 and full project realisation by 2030. However, this timeline has since been revised, with current plans focusing instead on exclusively on completing just the initial phase, primarily centred on the Marina zone, by 2030 (Cameron, 2024; *Wall Street Journal*, 2024; Wallace, 2024). Bearing in mind the uncertainty over the actual construction dates for the planned phases, the following introduces five of the planned key locations and the aims set out for each within the NEOM vision.

Figure 2

Landscape of Study Area

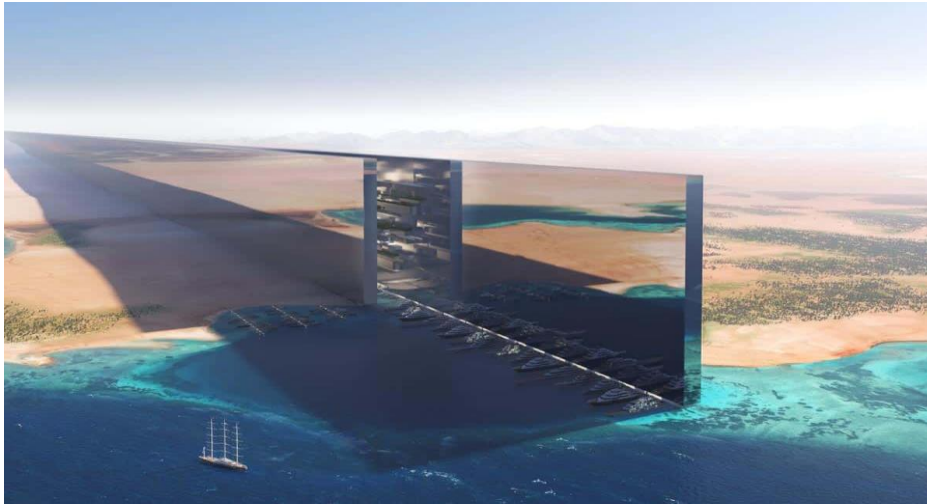


Source: Adapted by the author based on SANSRS (Saudi Arabia National Spatial Reference System Implementation Guidelines, 2022).

1.2.1. The Line – A Revolutionary Urban Model

Figure 3

The Line – a mirror-covered megacity emerging from the desert and sea



Source: NEOM.com

Positioned as a radical break from conventional urban sprawl, The Line is NEOM's flagship project and urban core. It is intended to be a linear city that is 170 kilometres (km) long, 200 metres wide, and 500 metres high. It is made up of two enormous, mirrored structures that cross a variety of ecological zones, including highlands, deserts, and coastal regions. With its compact vertical footprint and nature-centric design, this ambitious development seeks to house up to 9 million people while maintaining 95% of the surrounding natural environment. According to NEOM, the city is to be constructed “around nature, rather than over it,” with walkable areas, integrated greenery, and biodiversity corridors woven throughout the buildings (NEOM, 2024a; Bahreldin et al., 2025).

The Line is designed to eliminate the need for roads and private vehicles by ensuring that all essential services, such as housing, education, healthcare, workplaces, and leisure facilities, are accessible within a five-minute walk from any residence. A high-speed transit system spanning the entire 170-kilometre length of the city will enable end-to-end travel in just 20 minutes, offering a solution to traffic congestion and reducing long commute times (Al-Sayed et al., 2022). Additionally, The Line is designed as a model of cognitive urbanism, with AI-driven predictive systems integrated into urban infrastructure that will anticipate user needs and optimise service delivery. These cognitive communities, which

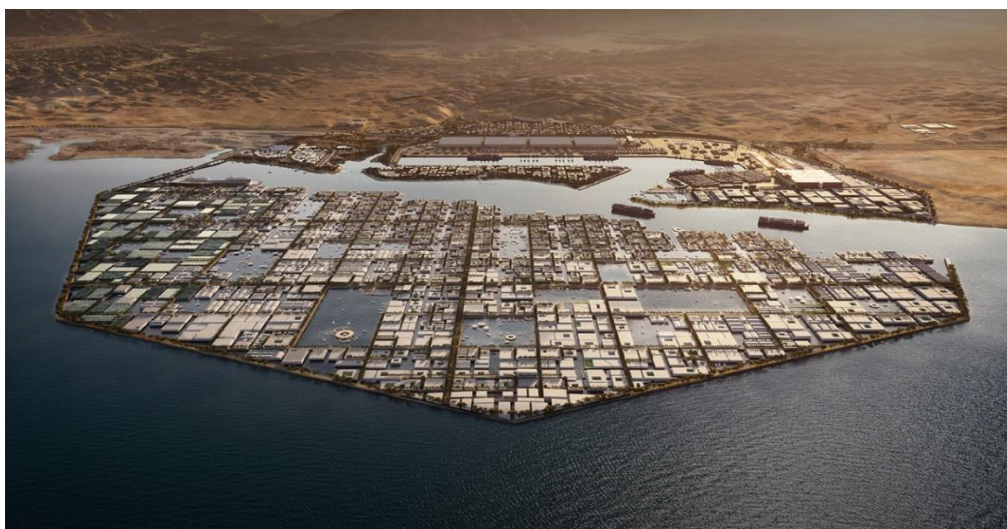
integrate data, energy, transportation, and utilities through a smooth, undetectable infrastructure spine, are regarded as the next stage of smart city development.

To move away from reliance on oil and establish Saudi Arabia as a world leader in innovation and environmental stewardship, the project also acts as a strategic rebranding initiative for the Kingdom (Touri, 2024). Saudi Arabia is indicating its intention to spearhead a new era of city-making, one based on digital transformation, green energy, and urban liveability, by referring to The Line as a “post-Dubai” city (Aly, 2019, p. 100). By 2030, it is anticipated that the Line will generate more than 380,000 jobs and add 180 billion Saudi Arabian Riyal (SAR) to the national Gross Domestic Product (GDP). This establishes The Line as a cornerstone of Saudi Arabia’s economic diversification strategy and seeking to attract talent and investment from across the world to develop the city into a living laboratory for exploring the limits of renewable infrastructure, AI, and sustainable urbanism. At such a scale, its success or failure will probably impact the way smart cities are planned and executed globally in the future (Madakam & Bhawsar, 2021).

1.2.2. Oxagon – NEOM’s Industrial City and Node of Innovation on Sustainable Terms

Figure 4

Oxagon – NEOM’s Revolutionary Floating Industrial City



Source: NEOM.com

A key component of Saudi Arabia's NEOM megaproject, Oxagon is set to become the largest floating industrial city in the world. Announced by Crown Prince Mohammed bin Salman in 2021, Oxagon aims to revolutionise industrial urbanism by a similar combination of cutting-edge technology and sustainable practices that guide the NEOM project (NEOM, 2025a). Strategically located on the Red Sea, it is designed to operate as a high-tech logistics and manufacturing hub, with an emphasis on automation, AI, and renewable energy systems (Parsons, 2023).

Oxagon's infrastructure will be powered entirely by clean energy, in line with Saudi Arabia's Vision 2030 and the broader sustainability goals of NEOM (NEOM, 2025a). Furthermore, Oxagon incorporates the principles of the circular economy and seeks to create a mixed-use environment that blends urban living spaces with industrial operations. This represents a novel approach to intelligent and integrated industrial development. Oxagon is planned to be a major departure from traditional industrial zones and to serve as a prototype for future smart city and sustainable projects (NEOM, 2025a).

1.2.3. Trojena – All-Season Mountain Destination

Figure 5

Trojena – NEOM's Futuristic Mountain Destination for Year-round Adventure and Skiing



Source: NEOM.com

Trojena, which is intended to be a year-round tourist and adventure destination, is to be in the mountainous region of NEOM at an elevation of 1,500 to 2,600 meters. In sharp contrast to NEOM's desert landscapes, seasonal activities will include mountain biking, water sports, skiing in the winter, and lavish hospitality. It exemplifies how NEOM's goal of balancing urban development and environmental preservation is achieved through the smooth integration of contemporary infrastructure into the scenic mountainous landscape (NEOM, 2022a). Trojena has also been chosen to host the 2029 Olympic Winter Games Asia, which will be held in West Asia for the first time. The region's goal to become a global centre for innovation, sports, and tourism is further highlighted by this proposed milestone (International Olympic Committee, 2024).

1.2.4. Sindalah – Luxury Island Hub

Figure 6

Sindalah: NEOM's Luxury Island Destination for an Exclusive Red Sea Experience



Source: NEOM.com

NEOM's ultra-luxurious island in the Red Sea, Sindalah, is intended to serve as a global centre for marine tourism. With its 86-berth marina, upscale resorts, and yachting amenities, Sindalah is well-positioned to draw both luxury travellers and the global yachting community. This project should further Saudi Arabia's economic diversification objectives while raising NEOM's profile within the luxury travel industry (NEOM, 2024b).

1.2.5. Magna – A Centre of Coast and Culture

Figure 7

Epicon in the Magna area – NEOM's Ultra-Luxury Coastal Resort Redefining Hospitality and Wellness



Source: NEOM.com

Magna is a significant coastal area that is part of Saudi Arabia's NEOM initiative to diversify its economy and create top-tier travel and leisure destinations. Magna, which spans 120 Kilometres along the gulf of Aqaba, seeks to combine luxury travel, ecological stewardship, and digital innovation in twelve unique locations intended to create a 'coast of the future' (NEOM, 2024c; *Arab News*, 2024). The focus is explicitly on premier resorts, with many developments targeted towards attracting high net-worth individuals.

One of Magna's flagship projects is Leyja, set to be an ecotourism valley with three architecturally unique hotels – Adventure, Oasis, and Wellness – that emphasise conservation and blend in with the untamed landscape (NEOM, 2024c). Zardun, a 4 km² nature reserve with boutique lodges and adventure tourism, will likewise focus more on engagement with the environment (NEOM, 2024c). Well-being is another area planned for, with Siranna in the coastal hills designated as a tranquil haven for wellness with private homes (NEOM, 2024c), and Elanan as a retreat centred on holistic well-being. Several locations are oriented towards leisure activities, such as Epicon, which will offer immersive

digital and leisure experiences with its two futuristic towers that house a beach villa and a luxury resort. Gidori designed to cater to the lifestyles of elite golfers (*The Sun*, 2024), and Treyam planned to have the longest infinity pool in the world, suspended over a lagoon. Clubs and marinas also feature as part of the Magna coastal resort, again explicitly aiming towards the luxury market, including Xaynor, an ultra-private coastal club, and Jaumur, an ultra-luxurious marina community for ultra-high net worth individuals that features 700 villas, 350 hotel suites, and private moorings (*The Sun*, 2025). Perhaps the most radical project within NEOM, and more specifically Magna, is Aquellum, a digital city that is upside-down and embedded inside a mountain, accessed through a hidden underwater portal (NEOM, 2024c).

In addition to these areas, NEOM Bay is a luxurious waterfront development featuring hotels, residential units, and entertainment facilities. It is expected to be the first area to be developed within NEOM (NEOM, 2022b). To facilitate easy access to the megacity from around the globe, the existing NEOM Bay Airport is set to be expanded into a world-class international airport.

In terms of underlying infrastructure to service the essential needs of power and water for all the planned aspects of the project, NEOM Smart Grid is conceived as a state-of-the-art power grid that will integrate renewable energy sources, energy storage systems, and smart grid technologies to provide reliable and sustainable electricity (Madakam & Bhawsar, 2021; Riera et al., 2022), supporting the plan to use 100% renewable energy through solar and wind, while water will be supplied through advanced desalination technologies and efficient water management systems (Rezk et al., 2020). In line with this focus on sustainable infrastructures, greener construction practices are also envisioned within NEOM (Hassan, 2020). To facilitate the efficient management of all these services, there needs to be a robust digital infrastructure and this is being designed to provide high-speed internet connectivity, advanced communication networks, seamless access to digital services (George & Paul, 2020), and to further help in creating a modern e-governance model that not only promotes streamlined public services but also transparency regarding their delivery and efficacy (Capra, 2014; Rashed & Mahmoud, 2018).

Despite facing numerous challenges, such as geopolitical risks, economic uncertainty, and the need for large-scale infrastructure development, the Saudi Arabian government remains committed to transforming NEOM into a global centre for innovation, sustainability, and economic growth (Alhefnawi, 2022). This is because careful planning, robust strategies, and strong collaboration between various stakeholders to ensure the success of this ambitious project. As a city planned from scratch, NEOM has the unique opportunity to learn from the successes and challenges of existing smart city projects around the world.

To achieve this vision, planners have drawn from the experiences and lessons learned from other paradigmatic existing smart cities around the world (Anthopoulos, 2017). By analysing the successes and challenges of these cities, NEOM's planners have been able to identify best practices and potential pitfalls, shaping the design and strategy of the project (Angelidou, 2017). However, learning from other smart cities has not solely involved emulating their successes; it has also been crucial to identify and avoid their shortcomings (Anthopoulos, 2015; Cugurullo, 2013). Some smart cities, for instance, have faced criticism for prioritising technology over the needs of their residents, resulting in sterile, impersonal urban environments.

Understanding how the planning of NEOM has involved learning from other paradigmatic smart cities is an essential research question, as it sheds light on the underlying principles and strategies that have informed NEOM's vision and development. By exploring the knowledge transfer and adaptation of best practices from established smart cities, this study seeks to uncover the intricate connections between global urban innovation trends and the specific characteristics of NEOM. This analysis contributes to the broader discourse on smart city development, offering valuable insights for planners and policymakers seeking to create sustainable, resilient, and technologically advanced urban environments (Cugurullo, 2015).

1.3. Research Problem

As a city planned from scratch on a vast greenfield site, NEOM represents one of the most ambitious contemporary attempts to systematically learn from the successes and challenges of existing smart city projects around the world.

To achieve the NEOM vision, there has been a concerted focus on planning and strong collaboration between a range of stakeholders. Various studies (Angelidou, 2017; Anthopoulos, 2015; Cugurullo, 2013) assert that planners have drawn from the experiences and lessons learned from other paradigmatic existing smart cities around the world to identify both best practices to shape the design and strategy of the project and the potential pitfalls that need to be avoided, such as the criticism faced by some smart cities for prioritising technology over the needs of their residents, resulting in sterile, impersonal urban environments.

Understanding how the planning of NEOM has involved learning from other paradigmatic smart cities is an essential research question, as it sheds light on the underlying principles and strategies that have informed NEOM's vision and development. However, despite the initial studies mentioned above, to date there has been a dearth particularly of empirical/qualitative studies (e.g., Alhejaili, 2024; Yusuf & Abdulmohsen, 2023; Algumzi, 2022). Examining the specific role and tangible influence of policy learning from other smart cities on NEOM's planning is vital for understanding how global experiences have been selectively integrated into its urban vision. In this context, some studies highlight the benefits of adopting advanced technologies to improve efficiency and livability, portraying NEOM as a potential model of future-oriented digital urbanism (Fallatah, 2019; Hassan, 2020; Madakam & Bhawsar, 2021). Others have focused on issues of spatial form and urban morphology, which are particularly relevant to NEOM's radical design of The Line (Paszowska-Kaczmarek, 2021). Simultaneously, a growing body of scholarly literature questions whether smart city initiatives, including NEOM, can effectively address structural urban challenges related to governance, social equity, and long-term sustainability (Algumzi, 2022; Luh & Yen, 2020; Monzon, 2015).

Consequently, there is a need for a comprehensive and systematic analysis of the planning process behind NEOM, which considers the lessons learned from other smart cities and assesses their applicability to the unique Saudi Arabian context (Frag, 2019; Procter, 2022). By seeking to offer an in-depth analysis of the knowledge transfer, adaptation, and

application of best practices from established smart cities, this study seeks to uncover the intricate connections between global urban innovation trends and the specific characteristics of NEOM. By identifying the key elements that have contributed to the success or failure of existing smart cities, this research aims to provide valuable insights for evaluating the planning and implementation of NEOM and assessing or exploring what the unique characteristics of NEOM as a smart city might subsequently be. Furthermore, the research will seek to understand the potential challenges and opportunities associated with the NEOM project, as well as its implications for future smart city developments worldwide. This analysis contributes to the broader discourse on smart city development, offering valuable insights for planners and policymakers seeking to create sustainable, resilient, and technologically advanced urban environments (Cugurullo, 2015). This study addresses the lack of systematic empirical investigation into how NEOM's planning process selectively adapts global smart city experiences while developing context-specific innovations within the constraints and opportunities of the Saudi context.

1.4. Research Question, Aims and Objectives

Having identified the research problem (in Section 1.3), the research question is:

To what extent can NEOM be considered a paradigm for sustainable smart city initiatives now and in the future?

To answer the research question, 7 aims are detailed. The research aims are:

- To understand the motivations for building NEOM.
- To identify existing sustainable smart city initiatives for best practices between cities.
- To ascertain how the conception and planning of NEOM is a product of learned best practices from extant Sustainable Smart city initiatives.
- To identify the dimensions of NEOM to specify which attributes are new and perhaps future best practice.
- To determine what planning strategies and approaches have been adopted by NEOM to integrate smart technologies and sustainability.
- To understand how the linear urban form serves to animate The Line city as a sustainable smart city development.

- To clarify what lessons NEOM may offer regarding future smart city developments to enhance their planning and the design of sustainable and urban environments.

To meet these aims, the research objectives take the form of a qualitative case study, grounded in thematic analysis of 39 semi-structured interviews with key internal and external stakeholders. Using NVivo software, the study examines issues such as NEOM's vision, motivations, planning strategies, technological integration, urban form, and future implications. The research also includes documentary and discourse analysis of strategic planning materials, feasibility reports, and media sources, alongside a comparative review of best practices globally in smart city initiatives.

The specific research objectives are:

- To conduct semi-structured interviews with external stakeholders and analyse planning discourse and strategic documents (e.g., NEOM vision statements, national policy frameworks) through documentary and discourse analysis, to capture perceptions of NEOM's foundational motivations.
- To conduct a comparative literature review of internationally recognised smart cities (e.g., Singapore, Barcelona, Amsterdam), focusing on shared best practices in sustainability, governance, and technological innovation.
- To identify, through interviews with internal NEOM stakeholders, how NEOM's planners have drawn upon best practices and lessons from global smart city exemplars in the conceptualisation and planning of the project.
- Using the Boyd Cohen Wheel Smart City Model as a suitable tool to evaluate sustainable smart cities, interviews with experts in NEOM will be conducted to assess the dimensions of smart cities and ascertain NEOM's futuristic dimensions.
- To explore how smart technologies are embedded across NEOM's sectors, drawing on interviews with internal planners and technical experts, as well as analysis of sectoral documentation and feasibility reports.
- To conduct direct observation and visual analysis of The Line Exhibition and associated architectural materials, and to analyse feasibility reports to assess how The Line's linear urban morphology operationalises sustainability principles and reimagines urban form.
- To synthesise findings from internal stakeholder interviews to identify key planning insights, implementation challenges, and innovations; to triangulate these findings with

secondary data (e.g., media critiques, feasibility assessments); and to derive actionable lessons relevant to future smart sustainable city development in diverse global contexts.

1.5. Research Importance and Originality

This research offers a unique contribution to both theoretical and practical understandings of smart city development by examining NEOM as an unprecedented case of urban experimentation. As a city planned from scratch in Saudi Arabia's northwest, NEOM presents a rare opportunity to interrogate the processes of urban innovation, governance restructuring, environmental design, and technological integration at their inception. Its development intersects multiple disciplines such as urban geography, environmental studies, planning theory, and science and technology studies, thus positioning NEOM as an ideal site for progressively advancing academic theory while offering practical lessons for global urban practice.

Theoretically, the research addresses a substantive gap in the literature by examining how globally circulated frameworks of smart urbanism, such as Cohen's Smart City Wheel (Cohen, 2013), translate when applied to greenfield megaprojects in non-Western, geopolitically distinct contexts. These models, though comprehensive in their treatment of urban intelligence and sustainability, were primarily designed for mature or retrofitted cities. As such, their relevance to cities like NEOM, which are being constructed with bespoke infrastructures, autonomous governance, and novel spatial paradigms, remains untested and under-theorised (Nuseir et al., 2020; Paszkowska-Kaczmarek, 2021).

This study is original in its temporal and methodological orientation. Unlike much of the smart city literature that evaluates outcomes post-implementation, this research is embedded in NEOM's formative stages, before occupancy or full infrastructure deployment. This temporal framing allows for reflective observation of how smart city principles are not only planned and projected but actively constructed through institutional discourse, digital systems, and anticipatory governance. It also enables real-time assessment of emerging concepts such as cognitive urbanism, whose implications for urban form, governance, and social relations are still evolving (Cugurullo et al., 2023; Kim et al., 2017). NEOM's emphasis on embedded digital infrastructure and AI marks a paradigmatic departure from earlier models of smart cities primarily focused on service delivery and

operational efficiency. Its ambition to become a city powered entirely by renewable energy, integrated with closed-loop water systems, and designed to achieve ecological balance makes it a vital testbed for climate urbanism¹ (Bibri, 2021a; Govada et al., 2017). By analysing how these systems are planned and implemented within NEOM's arid and seismically active environment, this study contributes to broader debates about the material limits of sustainable urbanism and the socio-political challenges of implementing climate-resilient infrastructures in extreme geographies (Kahal, 2020).

Furthermore, the project offers valuable insight into governance and institutional design under atypical administrative conditions. As a Special Economic Zone (SEZ) with autonomous legal and regulatory frameworks, NEOM provides an experimental arena to study the interaction between urban planning, law, and transnational investment logics (Su, 2023; Algumzi, 2022). This includes understanding how institutional autonomy can enable or constrain innovation, inclusivity, and accountability within smart city regimes.

Despite its visibility in media and promotional literature, NEOM remains underexplored in empirical, fieldwork-based academic research. Much of the existing analysis either romanticises NEOM as a techno-utopia or critiques it from afar as a geopolitical spectacle (Musset, 2023). This study bridges that gap through a grounded, theory-informed approach, combining document analysis with primary data from internal and external stakeholders. It offers a rare attempt to track NEOM's alignment with, divergence from, and potential transformation of global urbanism frameworks, particularly in relation to the fifteen sectors the project claims to lead in.

By examining NEOM not only as a spatial project but also as a socio-technical and economic imaginary, this research contributes to rethinking how cities are conceptualised, constructed, and evaluated in the 21st century. It challenges prevailing assumptions in smart city assessment by probing the adaptability of existing tools to novel urban forms, and by foregrounding dimensions often marginalised in technocratic discourses such as cultural identity, community well-being, and institutional legitimacy (Farag, 2019; Aseere, 2020).

¹ Climate urbanism frames cities as experimental sites for climate governance, low-carbon infrastructure, and ecological innovation. Rooted in critical urban sustainability debates, it emphasises transformative interventions over incremental mitigation, while also raising concerns about inclusivity, justice, and resilience (Hodson et al., 2013; Long & Rice, 2019).

In sum, this research positions NEOM as both a subject and generator of knowledge. It advances scholarly discussions in urban geography and planning theory by proposing a context-sensitive framework for evaluating emergent cities. It also contributes to the ongoing evolution of smart city assessment methodologies by emphasising the need for hybrid tools that account for the complexity of greenfield megaprojects in socio-politically distinct settings. As cities across the Middle East pursue increasingly ambitious urban futures, the findings from this study offer timely insights with broad relevance to policy, practice, and academic theory.

1.6. Synopsis of the Chapters

To provide a coherent narrative consistent with the nature of the research, this thesis is structured into seven chapters, covering the main parts of the research, namely, introduction, literature review, methodology, three empirically driven findings & discussion chapters, and conclusions.

This opening chapter establishes the research context, outlining the background of smart city development and the emergence of NEOM within the broader landscape of Saudi Arabia's Vision 2030. The chapter continues to set the stage by articulating the research problem, aims, and guiding questions, while also highlighting the importance of the study in relation to global debates on urban futures, sustainability, and digital infrastructure. Emphasis is placed on the theoretical and empirical gaps that this study addresses, particularly in relation to how smart city models are conceptualised and applied in non-Western, pre-implementation contexts.

Following this, the second chapter is an in-depth literature review that examines the evolution of smart cities as a planning paradigm. The chapter unpacks various theoretical frameworks and typologies, such as Boyd Cohen's Smart City Wheel (BCSCW), evaluating their relevance for understanding large-scale planned cities. Case studies, including but not limited to Songdo, Singapore, Masdar, and Barcelona, are analysed to situate NEOM within a global field of smart city experimentation. The review then turns towards the existing documentation and scholarly commentary on NEOM, clarifying its fifteen sectoral pillars and overarching urban philosophy, and identifying how its goals intersect with debates on

sustainability, governance, and technological integration. In doing so, the chapter outlines the conceptual terrain upon which this research builds.

The third chapter details the methodological approach underpinning the study. Grounded in an interpretivist epistemology, the research adopts a qualitative case study design, allowing for an in-depth exploration of NEOM as a dynamic and evolving project. Data is drawn from semi-structured elite interviews with high-level internal and external stakeholders involved in planning, policymaking, and critical analysis, supported by a review of secondary materials including planning reports, media coverage, and official documentation. Thematic analysis, following the six-phase approach developed by Braun and Clarke (2014), is used to identify and interpret key patterns within the data. Considerations of ethics, positionality, and limitations are also addressed to ensure transparency and academic rigour.

The fourth chapter presents findings from interviews with external stakeholders, including academics, policy advisors, and urban experts. It explores how NEOM is understood from outside the organisation, focusing on its strategic national motivations, geopolitical positioning, and sustainability ambitions. The analysis identifies key themes related to national development, global leadership, and geo-strategic significance, situating NEOM within broader narratives of state-led urban transformation. An interim synthesis draws together these perspectives to highlight how external actors frame NEOM less as a technical planning project and more as a symbolic and strategic intervention in global urbanism.

The fifth chapter shifts the focus to internal NEOM stakeholders and examines how planners and decision-makers conceptualise NEOM's smart and sustainable city agenda. The chapter addresses two key themes: the role of global best practices in shaping NEOM's planning, and the project's conceptual alignment with Boyd Cohen's Smart City Wheel. Drawing on interview data, the chapter demonstrates how NEOM selectively adopts and adapts lessons from cities such as Singapore, Barcelona, and Amsterdam, while extending existing frameworks through context-specific innovations. An integrated discussion synthesises these themes, highlighting NEOM's hybrid approach to smart sustainable urbanism.

The sixth Chapter continues the analysis of internal stakeholder perspectives, focusing on NEOM's most distinctive and experimental dimensions. It explores two further themes: NEOM's unique and innovative planning strategies, including cognitive urbanism, AI-driven governance, and revolutionary urban form, and the tensions between utopian ambition and practical implementation. The chapter critically examines issues such as feasibility, governance opacity, technological risk, and environmental contradiction. By integrating empirical findings with critical urban theory, this chapter assesses the extent to which NEOM can be understood as a genuinely new urban paradigm rather than a conventional smart city scaled up.

The seventh and final chapter draws together the main conclusions of the research, offering a synthesis of how NEOM contributes to and challenges established thinking in smart city development and urban geography. It reflects on the study's contributions to theory, methodology, and practice, and considers the broader implications for planning in transitional economies and climate-vulnerable regions. Limitations of the study are acknowledged, particularly regarding the evolving nature of the project and the constraints of accessing a still-developing urban site. The chapter concludes with recommendations for future research, including longitudinal follow-up studies and comparative analyses with other emergent smart city initiatives, highlighting the importance of ongoing engagement with cities in formation.

Chapter 2: Literature Review

2.1. Introduction

Governments across the globe are facing the unavoidable challenge of transforming urban areas into sustainable, liveable, and prosperous settlements to enhance the quality of life for their citizens (Neirotti et al., 2014; Yigitcanlar et al., 2019). Enhanced urbanisation and the need to address the problems facing conventional cities, such as overpopulation and limited resources, necessitate the need for governments to provide new and innovative services; hence, the idea behind the inception of smart cities can withstand the challenges currently faced by urban areas across the globe (Matsumoto et al., 2019). According to Hollands (2015) and Kitchin (2014b), the concept of smart cities is premised on the application of ICT Systems to augment urban management by embedding software-enabled technologies into various facets of cities. Considering the unprecedented nature of the issues presented by rapid urbanisation, the concept of smart cities offers countries the opportunity to find new avenues to address the various challenges and achieve better living conditions for residents (Yin et al., 2015).

Populations are increasingly becoming concentrated in cities. In the 1950s, only about 30% of the world's population lived in urban areas (Yin et al., 2015; Albino et al., 2015). Today, this share exceeds 55%, and the United Nations projects it will reach approximately 68% by 2050 (United Nations, 2019; Tonne et al., 2021). This unprecedented pace of urbanisation places mounting pressure on existing urban systems. Scholars note that many modern cities and emerging megacities are ill-equipped to manage the consequences of rapidly expanding populations, including inadequate mobility infrastructure, rising congestion, housing shortages, resource constraints, and the intensifying impacts of climate change (Angel, 2023; Yin et al., 2015). The need for a more sustainable way of life includes diversifying the economy and reducing dependency on limited natural resources while ensuring the quality of life (Komninos et al., 2019; Persaud et al., 2020). Looking towards the welfare of future generations makes the implementation of smart cities even more important. Many countries around the globe have directed attention to smart sustainable

initiatives aimed at attaining smart city standards and sustainable knowledge-based economies, such as Saudi Arabia, which has implemented a strategic vision called Saudi Vision 2030 (Nurunnabi, 2017).

This chapter reviews the pertinent literature that deals with the definitions, domains, and characteristics of a smart city. The chapter then examines the literature on how other smart cities work and interact and the kind of environments they create, against which the available material on the proposed NEOM smart city in Saudi Arabia is introduced. The chapter concludes by bringing the material together to highlight the similarities and differences between typical cities and NEOM.

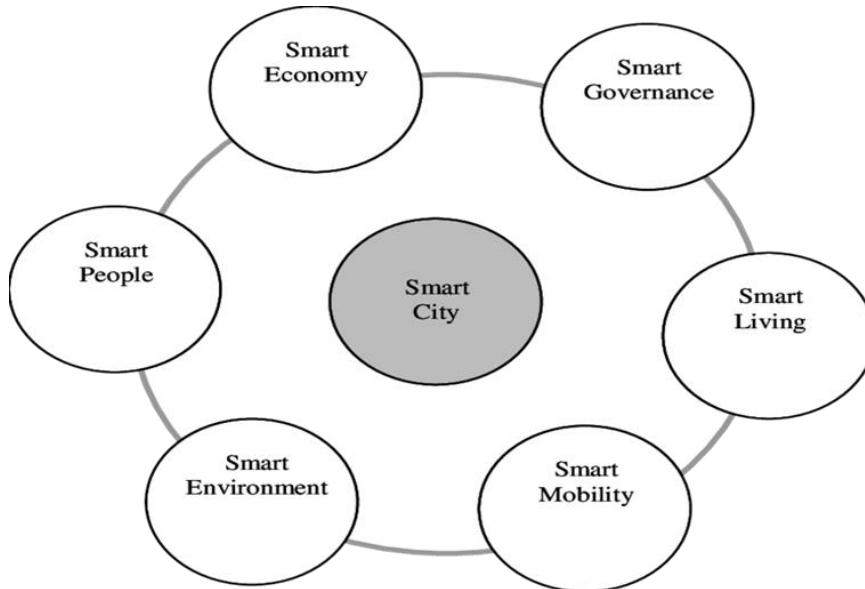
2.2. Smart City Definitions, Domains, and Characteristics

The term ‘Smart Cities’ emerged in the 1990s and to date has seen various definitions applied to it (Hollands, 2008). According to Caragliu et al. (2011) one of the definitions of a smart city is a city where its ICT, mobility, and human and social capital foster a high-quality of life and sustainable economic growth through the management of scarce natural resources, by means of participatory governance. Chen (2010) adds that a smart city exploits the IoT technology integrated into its infrastructure to optimise logistics and improve quality of life. Overall, it can be said based on a range of studies that smart cities are technologically modern urban areas that incorporate ICT, including sensors, electronics, and networks, to collect data and enhance operational efficiency by developing, deploying, and promoting sustainable development (e.g., Hall et al., 2000; Cocchia, 2014; Bibri & Krogstie, 2017), (Table 1) provides a summary of widely cited definitions in the academic literature, illustrating the conceptual evolution of the term ‘smart city’ over the past two decades.

Table 1*Literature Review of Definitions of Smart Cities*

No.	Author(s)	Year	Definition
1	Giffinger et al.	2007	A smart city is a city performing well in economy, people, governance, mobility, environment, and living.
2	Hollands	2008	A smart city uses digital technologies to enhance performance and well-being.
3	Caragliu et al.	2011	A city is smart when investments in human and social capital fuel sustainable development.
4	Nam & Pardo	2011	Smart cities integrate technology and human capital to address urban challenges.
5	Batty et al.	2012	Smart cities use digital technologies to create sustainable and efficient systems.
6	Chourabi et al.	2012	Smart cities are characterised by technological, institutional, and human dimensions working in harmony.
9	Cohen	2013	Smart cities utilise digital innovation to make cities more liveable, sustainable, and productive.
10	Albino et al.	2015	Smart cities combine human, collective, and AI to create sustainable urban environments.

Komninos et al. (2019) highlight how smart cities are developed using top-down and bottom-up models, which then leverage market forces and strategic planning to build the digital infrastructure necessary to ‘smarten’ cities and make them more intelligent and sustainable. The smart city paradigm arises due to the need to not only provide better living conditions for smart citizens but also to assess urban planning and industry from an environmental and sustainable perspective (Sánchez-Corcuera et al., 2019; Yin et al., 2015; Khan, 2020). A model (see Figure 8) can be utilised to further clarify what exactly is predefined in the concept of ‘smart’. The approach is based on Giffinger’s concept of “smart degree,” which focuses on six dimensions, including smart mobility, smart environment, smart governance, smart economy, smart people, and smart living (Giffinger et al., 2007).

Figure 8*Six Components of a Smart City*

Source: Androniceanu & Ivan (2012, p. 337).

As such, unique characteristics define smart cities from other cities, and these include eco-friendly infrastructure, sustainable production, distribution and consumption of resources, and the use of digital technology to ensure efficiency and sustainability in the various domains such as assured energy, waste management, affordable housing, and efficient mobility and public transportation (Kitchin, 2014a; Arroub et al., 2016). Angelidou (2017) highlights a smart city as characterised by its application of advanced technology, the development of social and human capital, networking, and pro-business environments that are manifested in various domains, while Yin et al. (2015) and Sánchez-Corcuera et al. (2019) cite domain application, technical infrastructure, system integration, and data processing as the core characteristics of smart cities. Overall, even though the features, models, and approaches to smart cities may differ depending on the strategic implementation plan, smart cities can always be defined as comprising elements that seek to integrate institutional, human, and technological dimensions (Sánchez-Corcuera et al., 2019).

In view of the many aspects identified as being part of a smart city, Cohen (2013) developed what he termed the smart cities wheel (Figure 9) as a tool to more clearly and concisely bring together the major defining marks of a smart city in a way that then can be used to both measure the ‘smartness’ of a city and as a guide to help incorporate technology and innovation in every domain to make cities smarter. Using Griffinger et al.’s six core aspects of a smart city, smart economy, smart government, smart environment, smart mobility, smart living, and smart people (see Figure 9), as the central starting place, each of these areas is then identified with three key aspects or indicators that need to be considered, or developed and fostered, as part of any smart project. For example, according to Cohen’s wheel, smart economies should promote entrepreneurship, innovation, and productivity at a local and international level; smart governance is achieved via ICT and e-government integration that enhances open data, transparency, and public participation; and a smart environment focuses on sustainable infrastructure, building materials, and renewable energy. Smart people are encouraged through city designs that foster creativity, inclusivity, quality education, while smart living focuses on good health, safety and cultural vibrance (Loo & Tang, 2019; Cohen, 2013).

Figure 9

Boyd Cohen Smart City Wheel



Source: Petrova-Antonova & Ilieva (2019, p.2).

This model is deemed a significant tool and valuable guide (Qonita & Giyarsih, 2022; Brutti et al., 2020; Yadav & Patel, 2016), particularly in helping stakeholders, architects, and city and urban planners expedite the designing and planning of any form of smart project in each of the smart city dimensions (Petrova-Antonova & Ilieva, 2019).

While sustainability is often interwoven in the aspects and characteristics outlined in the sections above, it cannot be assumed that a smart city necessarily indicates an intention towards sustainability, and the following section thus turns to examining what further distinguishes a smart city as a sustainable smart city.

2.2.1. Smart Sustainable Cities

The concept of the Smart Sustainable City (SSC) has emerged at the intersection of two previously distinct urban paradigms: the sustainable city, which prioritises social justice, economic resilience, and environmental integrity; and the smart city, which is centred on technological innovation and data-driven governance (Höjer & Wangel, 2014). While long-term ecological and socioeconomic well-being has been given priority in the sustainable city agenda, the smart city paradigm has historically placed more emphasis on real-time monitoring, ICT infrastructure, and service optimisation (Caragliu et al., 2011; Bibri & Krogstie, 2017).

A wider trend in urban theory towards comprehensive, systems-based methods of urban transformation is reflected in the integration of these two paradigms. According to Ahvenniemi et al. (2017), this convergence has resulted in a hybrid urban model that aims to incorporate digital intelligence into sustainability planning. According to this model, cities are ‘green’ in their efforts to lower emissions, support circular economies, and improve urban resilience in addition to being ‘wired’ with smart infrastructure (Bibri & Krogstie, 2020). Global frameworks like the Sustainable Development Goals (SDGs) of the United Nations (UN), especially Goal 11, which advocates for “inclusive, safe, resilient, and sustainable cities,” are in line with this dual agenda (United Nations, 2015a; Kutty et al., 2020).

It is important to note that the SSC calls for integration and synergy between ecological logics and technological systems, rather than just being an additive framework (De Jong et al., 2015). For instance, real-time AI-based control and renewable energy generation are now combined in urban energy grids, and low-emission objectives are combined with smart mobility apps in transportation systems. These integrations seek to address infrastructure stress, climate change, and quality of life all at once, problems that neither sustainable nor intelligent approaches could adequately resolve on their own (Persaud et al., 2020).

2.2.2. AI Urbanism and the Rise of Cognitive Cities

To effectively manage urban complexity and provide adaptive responses, smart and sustainable cities (SSCs) are increasingly utilising advanced digital technologies, particularly AI. This shift has given rise to the concept of AI urbanism, also known as cognitive urbanism, which views urban environments as self-regulating learning systems (Batty, 2018a; Cugurullo et al., 2023). By leveraging data analytics, machine learning, and digital twins², cities can anticipate demand, model urban dynamics, and customise services, ranging from traffic management to energy consumption and emergency response (Townsend, 2013; Kitchin, 2014a).

AI urbanism enhances the anticipatory governance of cities, allowing planners to move from reactive to proactive urban management approaches (Cugurullo & Xu, 2025). This includes optimising public services through algorithms, automating environmental monitoring, and facilitating predictive infrastructure maintenance. Cities capable of ‘thinking’ and ‘learning’ in real-time hold significant promise for improving operational efficiency and sustainability outcomes.

However, the use of AI in urban areas raises serious political and ethical concerns. Scholars like Kitchin (2016) and Datta (2020) argue that these technologies could

² Digital twins are virtual replicas of physical systems that enable real-time data analysis and simulation, offering significant potential in various fields, including healthcare and urban planning. However, their implementation raises critical privacy and consent concerns due to the extensive and dynamic nature of data collection involved. Addressing these challenges necessitates robust ethical frameworks and real-time consent mechanisms to ensure transparency and accountability (Bäumer et al., 2024).

exacerbate existing disparities, reduce transparency, and replace human-led governance with machine-driven systems. Recently, Feitsma and Whitehead (2025) demonstrated how governance of AI futures can become “flattened,” where uncertainty is managed through narrow political and institutional framings, raising further concerns about democratic oversight and inclusivity. As urban life becomes increasingly mediated by opaque decision-making processes, issues such as algorithmic bias, data ownership, surveillance, and democratic oversight emerge as pressing areas of concern. These challenges are heightened when corporate platforms or government-led digitalisation initiatives significantly influence urban development.

Moreover, critics caution against an overemphasis on technology in city planning. While AI and smart technologies can aid in achieving sustainability, they must be integrated into inclusive governance frameworks that uphold civic rights, ensure accountability, and emphasise the human aspect of urban life (Bibri & Krogstie, 2017; Cugurullo & Xu, 2025).

2.2.3. Urban Form and Morphological Innovation

All cities, of course, have a physical shape and the spatial and morphological arrangement of cities, known as urban form, has long been a central focus in urban theory, planning, and design (Hall, 2002; Marshall, 2004). And due to the very distinct form planned for The Line as a new city, it is important at this juncture to briefly address some of the main concepts at play in the debate over urban form to situate The Line in terms of its potential innovative challenge to the more traditional understandings of the shaping of cities. Early 20th-century urban growth patterns, rooted in industrial economies and increasing motorisation, were explained by classic models of urban structure, such as the multiple nuclei model (Harris & Ullman, 1945), sector theory (Hoyt, 1939), and the concentric zone model (Burgess, 1925). However, these classic models have many inefficiencies, not least reliance on cars, and negative environmental impacts. Consequently, contemporary planners and urban theorists have advocated for more compact, transit-oriented, and sustainable urban forms that align with mixed-use density, low-carbon mobility, and human-scaled public spaces (Burton et al., 1996).

The Line, a project by NEOM, offers a thought-provoking re-examination of urban morphology. The design intends to vertically layer urban functions, eliminate private vehicles, and operate entirely on renewable energy (NEOM, 2024a). The project claims to reconcile ecological urbanism with digital hyper-efficiency by proposing an unprecedented integration of infrastructure and spatial compression.

The Line's form is not without historical antecedents. It draws conceptual lineage from Arturo Soria y Mata's Ciudad Lineal (1882), which proposed a transit-oriented linear city to decentralise and democratise urban living. It also echoes the verticality and functional separation of Le Corbusier's Ville Radieuse and the ecological-technological utopianism of Paolo Soleri's Arcology (Fishman, 1977; Koolhaas, 2014). However, the Line is presented as a state-backed, AI-managed infrastructure megaproject rather than merely a conceptual exercise like its predecessors. Contemporary urban theorists, such as Gandy (2022) and Datta (2020), classify such interventions as speculative urbanism, viewing them as ambitious yet often authoritarian design visions that blend digital innovation with geopolitical goals. These politically motivated and techno-utopian projects raise significant questions about public participation, governance, and spatial justice.

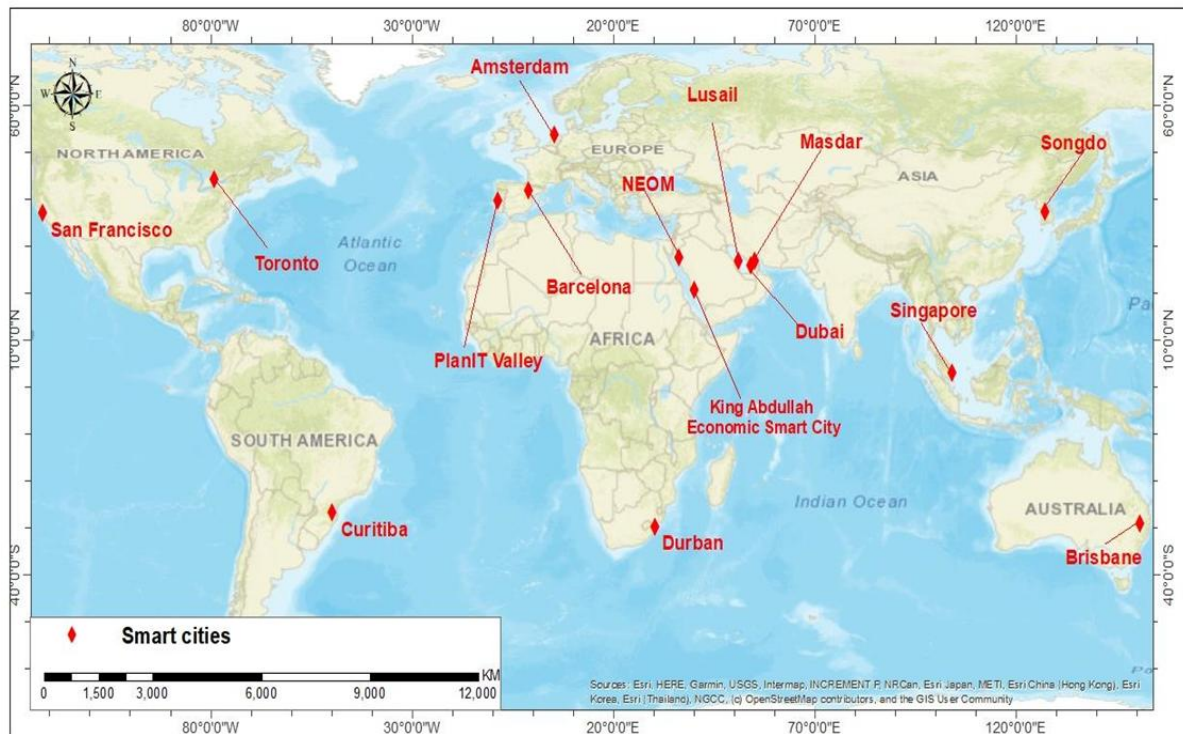
Despite aiming to depart from traditional urban forms by rejecting sprawl, minimising ecological footprints, and integrating vertical zoning within a high-speed transit corridor, The Line's design has sparked considerable scepticism. Academics and media outlets have raised concerns about its social viability, accessibility, ecological trade-offs, and lack of human-scale design (Musset, 2023; Fast Company, 2024; *The Wall Street Journal*, 2024). Critiques include the effects of high-density confinement, the psychological and spatial implications of mirrored facades, and the practical difficulties of constructing in a remote, arid environment.

Ultimately, The Line challenges established theories of urban morphology by proposing a post-spatial city that is automated, compressed, and vertically layered. However, it remains uncertain whether this vision will be realised. As this thesis examines, The Line offers a compelling case study of how urban form is being reimagined in the context of technological advancement and the climate crisis, and as overtly instigated by government as a display of political action.

2.3. The World's Leading Smart City Initiatives

Figure 10

Smart City Initiatives Around the World



Source: Adapted by the author using ArcMap 10.8.

Having established the main contours of the current literature on the paradigm of smart cities and the attendant issues of what constitutes a sustainable smart city or a cognitive city, the next key issue to examine is the work done on analysing the cities that are currently deemed to be smart cities to situate NEOM within the global field of smart city innovation. The aim of this section is not to cover all smart cities, but to focus on those that the literature has highlighted as notable examples of smart cities to establish what has been determined as ‘best practice’ in their planning and implementation.

The identified cities are as follows: Songdo (South Korea), Singapore (Singapore), Barcelona (Spain), Amsterdam (The Netherlands), PlanIT Valley Paredes (Portugal), Toronto (Canada), San Francisco (USA), Curitiba (Brazil), Durban (South Africa), Brisbane (Australia), Masdar City, Abu Dhabi (United Arab Emirates), Dubai (United Arab Emirates), Lusail (Qatar), King Abdullah Economic City (KAEC) (Saudi Arabia), and

NEOM (Saudi Arabia) (Figure 10). As noted above, critical review of the literature regarding the development of these cities, their unique initiatives, novel innovations, and utilisation of state-of-the-art technologies draws attention to these cities as standing out as examples of best ‘smart practices’ (Albino et al., 2015; Angelidou, 2017; Yigitcanlar & Kamruzzaman, 2018). The selection of these 14 cases was therefore literature-led, intended to synthesise internationally recognised best-practice approaches that were most pertinent to NEOM’s conception as a flagship smart-sustainable city; importantly, this choice was later partially corroborated by the empirical findings, as several of the same “headline” benchmark cities (e.g., Barcelona, Amsterdam and Singapore) were independently referenced by interviewees as relevant comparators for NEOM.. For ease of discussion, the cities have been grouped by continent, which also serves to highlight the various contextual issues also in play in their development.

While smart city initiatives often circulate through global policy networks as models of best practice, their implementation is rarely uniform or universally applicable. Rather, smart urbanism is best understood as a situated socio-technical process, shaped by the political economy, governance structures, institutional capacities, civic cultures, and spatial conditions of individual cities (Luque-Ayala & Marvin, 2015; McCann & Ward, 2011; Söderström et al., 2014). As such, the cases examined in this section are not presented as replicable blueprints, but as contextually embedded experiments that highlight both the possibilities and limits of smart-sustainable urban development. This comparative lens foregrounds the question of transferability; namely, what elements of smart-city practice can travel across contexts, and which remain place-bound. Addressing this issue is crucial for projects like NEOM, where global urban models are frequently invoked, yet must be critically adapted to radically different governance logics, environmental conditions, and socio-political realities.

2.3.1. Smart City Initiatives in Asia

2.3.1.1 Songdo, South Korea

Songdo City is a futuristic city and private town located in Southwest Seoul, South Korea, conceptualised at the beginning of the 21st century as a technological urban district aimed

at solving problems afflicting modern cities, including pollution and overcrowding (Kim, 2022; Peyrard & Gelézeau, 2020; Mullins, 2017). The city acts as a model of how people could live in the future, offering valuable insights into how technology could be incorporated into urban planning to enhance sustainability, and not only places South Korea at the forefront of the global innovation race but also avails a model that could be exported to other smart cities globally such as NEOM (Shwayri, 2013; Carvalho, 2014).

The city is hailed as the world's first eco-friendly smart city, developed with, an unusual planning pattern coupled with an ambitious urban design aspect and strong shaping narrative (Shin, 2016; Kim, 2013). Songdo adopts boulevards from Paris, canals from Venice, and Central Park from New York City in its recombinant urbanism that combines and reconfigures these urban elements in a dynamic way (Picon, 2015). At its core, Songdo encapsulates the characteristics of a sustainable futuristic smart city, evidenced by its use of high-level technology that includes sensors that monitor temperature and capture data, the use of green energy, the elimination of cars and agents of pollution, amongst other elements of sustainability (Kim, 2010; Shwayri, 2013).

One unique feature aimed at ensuring economic sustainability includes the concept of a multicentred metropolitan region with a spatial structure that includes various economic nodes which connect and compete to bolster economic growth and development (Eireiner, 2021). Halpern et al. (2013) reiterate that, unlike other megacities across the world that claim a cosmopolitan vibe typically associated with major cities such as New York, Songdo's design renders the city logically feasible, including its transportation system, communication network, political structure, and a spatial infrastructure specifically designed to house and encourage economic activity.

A key aspect of Songdo City emphasised in the literature (e.g., Kshetri et al., 2014) is its status as a ubiquitous or U-city that seeks to address the many challenges faced in urbanisation by providing a range of inexpensive IoT, such as modern amenities and LEED-certified buildings (Madakam & Holmukhe, 2019). A notable feature of this drive towards Songdo being a U-city is the intention of South Korea to have a smart city as part of its entrepreneurialism agenda, which, according to Joo and Tan (2020) serves as a milestone for competitiveness in the current tech-driven global environment. The initial findings of

Strickland (2011) support the statement in noting that Cisco had invested US\$47 million in its initiative to bring interconnectivity to Songdo City. Many studies, such as George and Paul (2020) and Madakam and Holmukhe (2019), observe that Songdo City reflects the demand for and rise of smart cities globally as an effective strategy to achieve business-led technological innovations that address the modern demands of urban populations. As argued by Shin (2016), this is not just an increased application of technology, but, as witnessed in Songdo, a paradigm shift to develop intelligent infrastructure away from conventional models with a clever combination of interconnected things. This should not be at the expense of the environment, and according to George and Paul (2020), through the implementation of a U-city policy by the central government of South Korea, Songdo Smart City acts as a symbol of both economic growth and enhanced protection of the environment by integrating green building codes, utilising pneumatic waste collection systems to reduce landfill dependency, promoting mixed-use walkable neighbourhoods to reduce vehicle emissions, and incorporating extensive green spaces and stormwater management features such as rainwater harvesting and permeable pavements (Kim & Han, 2021; Yigitcanlar & Cugurullo, 2020). These environmental interventions demonstrate that Songdo's U-city vision represents a dual commitment to technological advancement and ecological resilience, reinforcing its reputation as a global model for sustainable urban innovation.

In examining Songdo, it is crucial to note that its development is heavily shaped by South Korea's unique governance structures and ambitious state-driven innovation agenda (Joo & Tan, 2020). The city's success as a smart city is intertwined with the national government's ability to coordinate large-scale urban projects, leverage public-private partnerships, and integrate cutting-edge technology within a controlled urban environment (Kim, 2022; Shin, 2016). Thus, while Songdo's urban technologies, such as its integrated sensor networks and green infrastructure, are technically transferable, the broader socio-political and institutional conditions that enabled their success may not be easily replicated elsewhere (Kshetri et al., 2014).

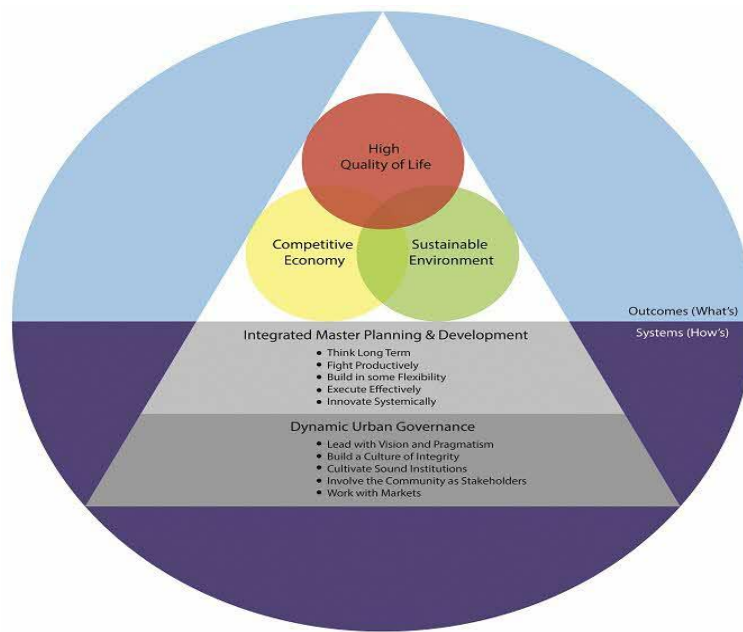
In this context, Songdo serves as a powerful illustration of how smart city models must be viewed as both globally influenced and locally situated. The city's unique blend of global urban design elements and Korean planning culture demonstrates that while certain smart city tools can be exported, the deeper integration of these tools into the social fabric

and governance framework of a city is inherently context-dependent (McCann & Ward, 2011; Söderström et al., 2014). For NEOM, this means that while Songdo provides a compelling reference for technological and ecological innovation, it must adapt these lessons to its own distinctive political, economic, and cultural environment. In this thesis, the findings reflect that NEOM considers global models like Songdo as inspirations that must be translated into NEOM's own context rather than directly replicated.

2.3.1.2 Singapore City, Singapore

Singapore is among the top smart cities in the world, designed around the principles of sustainability and innovation by embracing societal, ecological, and health issues as well as technology (Maye, 2019; Yeo, 2022; Choi, 2021). Against the Boyd Cohen Smart City Wheel, many studies judge Singapore to excel in all domains of a smart city, including smart economy, governance, environment, and mobility, thanks to a centralised model that allows for a flexible regulatory system that fast-tracks the appropriation of innovative technology.

Central to Singapore's smart city model is its emphasis on long-term urban planning and institutional integration, traits that differentiate it from many fragmented smart city initiatives globally (Chourabi et al., 2012). A key institutional player in this regard is the Centre for Liveable Cities (CLC), established in 2008 as a joint initiative between Singapore's Ministry of National Development and the Ministry of the Environment and Water Resources. The CLC's framework (Figure 11) for a liveable and sustainable city is organised around three key outcomes: a competitive economy, a sustainable environment, and a high quality of life, all underpinned by principles of integrated planning and dynamic urban governance (Tan & Taeihagh, 2020). This model reflects the city's commitment to holistic urban management, where land use, transportation, housing, and environmental strategies are aligned through robust inter-agency coordination and digital platforms.

Figure 11*Singapore Liveability Framework*

Source: Centre for Liveable Cities & Civil Service College (2014, p. 7)

Ho (2016) likewise attributes the success of Singapore City to willingness to take a long-term perspective, rooted in its Smart Nation agenda that was birthed in 2014, which has enabled the city-state to look ahead and prepare the government and citizens to embrace change and support initiatives for change aimed at ensuring sustainability in the capital city. A proactive government and the existence of a guiding long-term vision or plan like the Smart Nation initiative is the primary lesson that can be drawn from the example of Singapore City according to both Yeo (2022) and Choi (2021), while Kong and Woods (2018) emphasise the significance of an agenda that names a Smart Nation rather than just a particular smart city. They comment that the Smart Nation agenda signifies the intent of the government to bring about a new vision that can appeal to the whole population of Singaporeans, an approach that other countries can imitate. This chimes with an earlier assertion by Mahizhnan (1999) that smart governance through progressive policies plays a significant role in enhancing smart interventions citing the stunting effect of the neoliberal-development logic of the state.

In assessing Singapore City's success as a smart city, Taylor (2017) and Glass (2018) highlight that overall, incorporating smart technologies in people's daily lives has

reconfigured urban socio-spatial relations that have improved the quality of life for many in the city. For example, on a daily level, the city leverages technology to achieve sustainable mobility through infrastructure and AI to reduce traffic congestion and enhance road safety (Joo, 2023; Ang-Tan & Ang, 2021), while smart technology has been explored to enhance energy conservation by borrowing concepts highlighted by Mangla et al. (2019) and Mital et al. (2019) who promote context-aware smart devices as a technique to enhance energy-saving. It needs to be noted that there has been some disquiet from a sizeable proportion of the population about having sensors and other data mining technologies operational at every moment of their lives (Ho, 2016). However, the weight of opinion, as reflected in Bhati et al. (2017), Shamsuzzoha et al. (2021), and Gonzaga (2018) agrees that there is significant proof of the ability of smart urbanism to foster various and lasting forms of betterment.

Singapore's initiatives in developing a smart city have addressed the primary components of smart cities as set out by Calder (2016), including environmental concerns, sustainable transportation, and energy efficiency, and the dimensions of Singapore as a city and state thus identified have strengthened international support for the ability to thrive in a sustainable smart city. Within this, Singapore's smart city has demonstrated the importance of policies that are not only pursued in the city but also at the national level (Mahizhnan, 1999; Choi, 2021; Ho, 2016).

Singapore's emergence as a global smart city exemplar is deeply tied to its unique geographical and political conditions. As a compact, high-density city-state, it has long practiced integrated urban planning and infrastructure development, supported by strong centralised governance and a high degree of institutional coherence (Chourabi et al., 2012; Tan & Taeihagh, 2020). Its Smart Nation initiative exemplifies this, mobilising state resources to synchronise long-term urban, economic, and technological planning under a unified vision. Agencies such as the Centre for Liveable Cities have enabled cross-sectoral coordination, fostering an environment where innovation can be deployed systematically and iteratively across domains like housing, transport, environment, and energy (Ho, 2016; Maye, 2019). The city's ability to deploy pervasive sensing, data analytics, and AI-driven services is underpinned not only by its technological capacity, but by a political culture of trust in government, high compliance, and a generally technocratic governance model.

While many of Singapore's smart-city principles, such as anticipatory planning, digital infrastructure integration, and sustainability-oriented governance, are transferable at the level of ideas or frameworks, their operational success relies on deeply embedded local conditions. These include an agile civil service, stable political leadership, and a populace accustomed to top-down planning processes. In contrast, features such as extensive sensor networks, real-time surveillance, and the state's role in managing data are far less portable, especially in societies where privacy, civil liberties, or decentralised governance models complicate such approaches (Kitchin, 2014; Cardullo & Kitchin, 2019; Kong & Woods, 2018). Additionally, Singapore's ability to implement and scale urban innovations rapidly is bolstered by its status as a city-state, where urban and national governance are functionally inseparable, a structural condition that few cities elsewhere can replicate.

For NEOM, Singapore offers a compelling reference for how state capacity, regulatory integration, and long-term visioning can underpin smart and sustainable urban development. Lessons around institutional coordination, digital governance architecture, and adaptive infrastructure are particularly relevant. However, Singapore's model also highlights the limits of policy transfer: the civic trust, regulatory cultures, and political structures that make Singapore's smart city model successful are context specific. The results chapters show that NEOM is adopting a similar principle of concentrating development within a defined footprint while preserving large areas as natural reserve, demonstrating that NEOM is selectively interpreting Singapore's approach to fit its own environmental and governance context. NEOM must therefore approach Singapore not as a blueprint to emulate wholesale, but as a model to selectively interpret; adapting relevant practices while remaining critically aware of the profound differences in governance, public expectations, and cultural context that shape what can and cannot be reproduced.

2.3.2. Smart City Initiatives in Europe

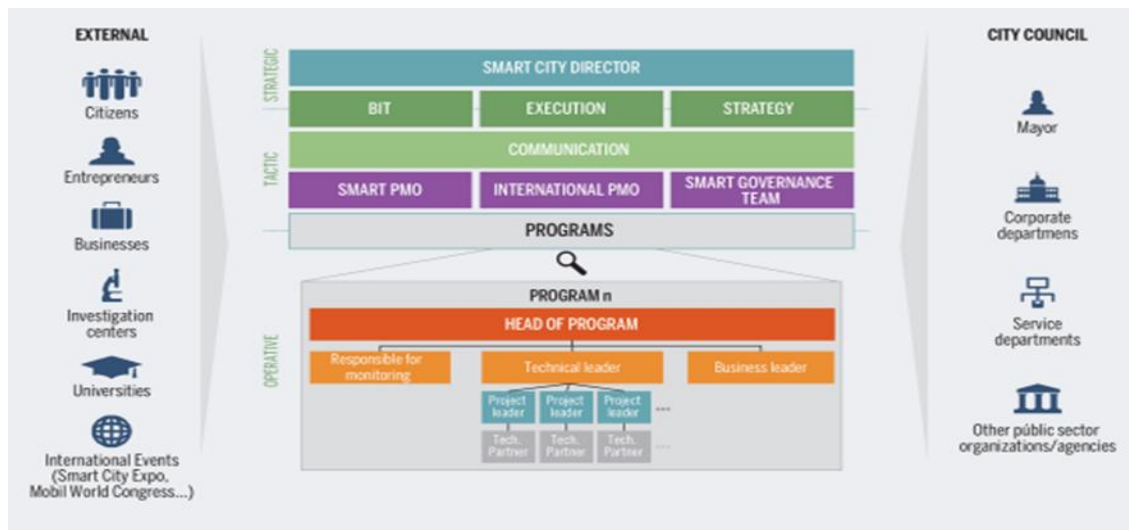
2.3.2.1 *Barcelona, Spain*

As one of the earliest smart cities in Europe, Barcelona incorporated digital technologies in its infrastructure, including sensor networks aimed at collecting data for informed decision-making by the government and private sector regarding transportation, energy usage, and levels of pollution (Calzada, 2018; Capdevila & Zarlenga, 2015; Ranchordas, 2018) as early

as 2011, when the city launched its Smart City Strategy (Bakici et al., 2012). As characteristic of other smart cities, Barcelona implemented IoT devices to streamline decision-making, service delivery, and ultimately the lives of citizens by effectively achieving smart transportation, smart living, smart people, and a smart economy (Bakici et al., 2012; Capdevila & Zarlenga, 2015).

The example of Barcelona gives insight into the way existing metropolises might be transformed into smart cities through smart local programmes (Lynch, 2019). The city's twofold model includes using new technologies to improve the living experience of its inhabitants and foster economic growth. As Capdevila & Zarlenga (2015) highlight, Barcelona brought IoT into daily life by leveraging technology to enhance efficiency in governance and service delivery to its citizens through kiosks that disseminated information, enhanced access to services, and allowed them to make requests directly to the government. Charnock et al. (2019) add that Barcelona's smart city has shown how significant a role the political ecology of urban transformation plays in implementing projects and strategies that seek to incorporate information and communication technologies in cities to enhance sustainability based on a knowledge economy.

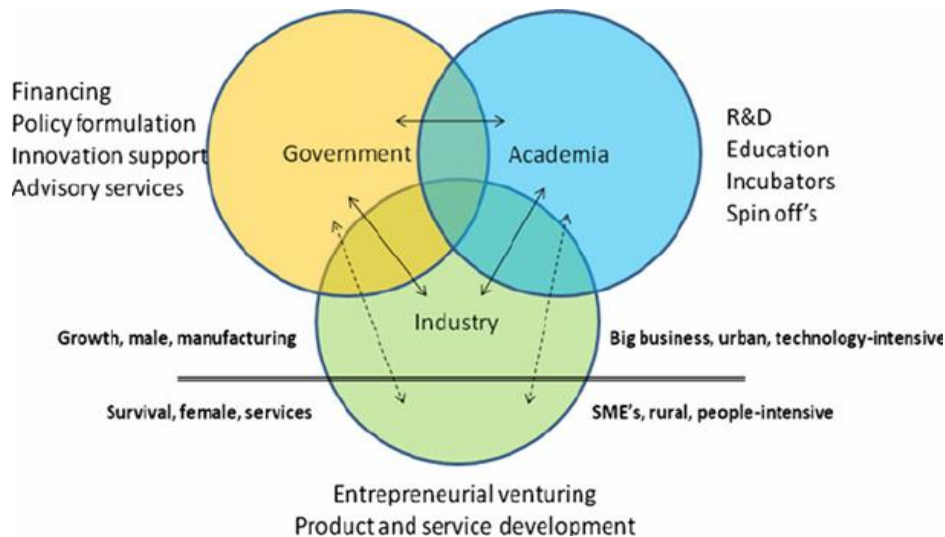
Ranchordas (2018) notes that smart city frameworks typically follow the top-down technology diffusion process, with some advocates perceiving top-down and bottom-up initiatives as opposing forces. However, according to several studies, Barcelona's model is an excellent example of the way smart city approaches can incorporate both top-down and bottom-up dynamics as complementary perspectives that can synergistically affect the city's capacity for innovation (March & Ribera-Fumaz, 2016; Lynch, 2019; and Calzada, 2018).

Figure 12*Barcelona Governance Model*

Source: Noori et al. (2020, p. 13).

The Barcelona model enhances participative democracy by offering digital rights to its citizens and engendering radical forms of subjectivity among the inhabitants (Figure 12) (Bakici et al., 2012). The resulting technological sovereignty allows the bottom-up model to work in conjunction with government initiatives, enhancing the consumption of digital technology, incentivising citizens to embrace smart change and fast-tracking the whole process of transformation (Bakici et al., 2012; Calzada, 2018; Capdevila & Zarlenga, 2015).

A further robust approach by Barcelona is the initiative for an industrial area called 22@Barcelona district, which is a model of a knowledge-intensive city (Bakici et al., 2012) and a significant economic driver that acts as a gateway for the globalisation of business in Barcelona. Bakici et al. (2012) identified the most integral aspects of smart city development that led to the development of 22@Barcelona as coming within the domains of Smart Governance, Smart Economy, Smart Living and Smart People. An iconic feature of 22@Barcelona is the establishment of an innovation cluster based on a triple helix concept (Figure 13) that allows “companies, faculties and citizens ...[to] interact and collaborate” (Bakici et al., 2012, p.139).

Figure 13*The Triple Helix model*

Source: Lindberg et al. (2014, p. 101).

One of the main projects supported by the 22@Barcelona district is the Barcelona Urban Innovation Lab & Dev (BUILD) programme, which promotes the involvement of the private sector in developing smart and innovative products to foster urban development. Another notable contribution by the 22@Barcelona BUILD programme, as stated by Bakici et al. (2012), is that “living labs are used as tools and processes for the creation of user innovation cooperatively in real-life environments. It is employed for learning, conducting tests and research to implement recent technologies and services of organisations in large-scale real-life environments” (p. 142).

Barcelona’s smart city journey offers a compelling example of how a historic and densely built European city can retrofit smart technologies into its existing urban fabric. Unlike cities that implement smart technologies from the ground up, Barcelona has had to integrate these innovations into a complex pre-existing metropolitan structure. This makes Barcelona an instructive case of how smart urbanism can be layered onto traditional urban infrastructure (Capdevila & Zarlenga, 2015; Lynch, 2019).

What sets Barcelona apart is its hybrid governance model, which blends top-down policy initiatives with strong bottom-up civic participation. This unique combination has

allowed Barcelona to foster a culture of technological sovereignty, where citizens are granted digital rights and invited to co-create urban solutions (Calzada, 2018; March & Ribera-Fumaz, 2016). While certain technical elements, like the use of open data platforms, IoT infrastructure, and innovation districts, can be transferred to other cities, the underlying reliance on a politically engaged citizenry and local participatory governance is less easily replicated. These aspects are deeply rooted in Barcelona's own political ecology and traditions of municipal autonomy (Ranchordas, 2018; Charnock et al., 2019).

For NEOM and comparable smart city projects in the Middle East (e.g., Masdar and Lusail), Barcelona provides a useful reference point for how technological innovation can be coupled with citizen-oriented urban governance and public engagement. However, Barcelona also demonstrates that participatory practices are deeply embedded in specific institutional histories and local governance cultures, which may limit straightforward transferability. The findings of this thesis show that NEOM has therefore had to translate rather than replicate such lessons, developing context-specific mechanisms for public engagement and legitimacy aligned with its distinctive governance arrangements and socio-political environment.

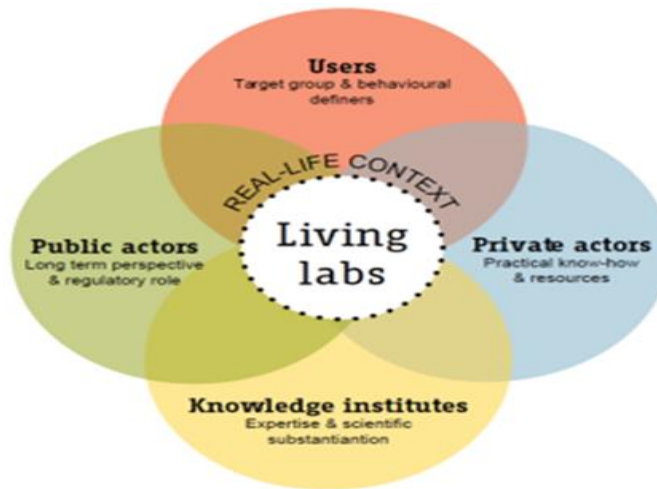
2.3.2.2 Amsterdam, The Netherlands

Like Barcelona, Amsterdam, the capital of the Netherlands, was among one of the first cities in Europe to adopt smart city concepts, including the adoption of ICT to enhance efficiency and achieve the various domains of a smart city within its bounds (Willis & Aurigi, 2020; Ampatzidou et al., 2015; Aurigi & Odendaal, 2020). Aurigi and Odendaal (2020) describe the smart aspect of the city as being an open innovation platform covering the Amsterdam metropolitan region that was started in 2009 to ensure sustainability and enhance the lives of the capital's citizens. It has since facilitated over 80 pilot projects toward making itself smarter. One of Amsterdam's unique smart city features is its City Data Open Source, which enables all city citizens to access information and upload their own data sets online (Jameson et al., 2019). The city successfully uses technology to collect data and control pollution, enhance peer-to-peer communication, streamline services, and generally improve the living standards of its citizens (van Winden et al., 2016; Nelson, 2021; Zandbergen, 2020). A collaborative development model also marks a significant aspect of Amsterdam as a smart

city. Fitzgerald (2016) points out the need for a concerted effort from private and public players through collaboration, which Amsterdam's various smart city projects demonstrate (Figure 14).

Figure 14

Collaboration Model Used in Amsterdam City Development



Source: Noori et al (2020, p.12).

According to the report by Noori et al. (2020) the development of smart cities not only depends on developing and applying technology but also on new networking and management competencies. Through open data access and other initiatives that bring citizens on board with smart city projects, Amsterdam has demonstrated the role of the government in driving citizen participation in projects where they then have a stronger role in the development of smart cities (Willis & Aurigi, 2020; Aurigi & Odendaal, 2020; Capra, 2014). The model of incorporating citizens in projects aimed at smart living, smart governance, and other smart initiatives helps to educate and receive feedback from residents to improve the decision-making process and service delivery (van Winden et al., 2016).

Amsterdam's administration even challenges mobile application developers to use publicly available data to customise their applications to improve service delivery and the lives of residents and visitors (Nelson, 2021; Zandbergen, 2020). Overall, Amsterdam emphasises the importance of taking into account the interests and moral orientations of all

stakeholders within the city to ensure the final smart products serve the needs of residents to effectively enhance the quality of their lives and livelihoods (Ampatzidou et al., 2015).

Amsterdam's smart city approach is deeply embedded in the Netherlands' political culture of decentralised governance, open innovation, and strong traditions of civic participation. Unlike more technocratic or state-driven models, Amsterdam has adopted a collaborative and experimental model, positioning the city as a testbed for citizen-led innovation and digital democracy (Ampatzidou et al., 2015; Aurigi & Odendaal, 2020). The city's open-source data platforms, participatory pilot projects, and collaborative governance frameworks reflect an urban culture that prioritises inclusion, co-creation, and responsiveness. These features are underpinned by a mature regulatory environment and a high-trust relationship between government, civil society, and the private sector (Willis & Aurigi, 2020; Noori et al., 2020).

Transferable aspects of Amsterdam's model include its digital infrastructures, open data ecosystems, and modular, pilot-based urban experimentation. Its strategy of inviting developers and citizens to innovate using real-time city data is particularly replicable where legal, technical, and cultural frameworks permit bottom-up engagement (van Winden et al., 2016; Zandbergen, 2020). However, the success of this model is contingent on political decentralisation, digital literacy, and civic empowerment; conditions not universally present. Amsterdam's emphasis on co-governance and ethical tech development is strongly shaped by European norms of privacy, transparency, and citizen rights, which may not align easily with contexts marked by centralised authority or top-down planning logics (Fitzgerald, 2016; Capra, 2014).

or NEOM, Amsterdam offers valuable insights into how smart governance can foster legitimacy, innovation, and responsiveness by involving citizens as active agents in urban transformation. However, transferring these participatory dynamics into the NEOM context will require careful adaptation, particularly in light of different governance models, regulatory frameworks, and civic cultures. NEOM may draw inspiration from Amsterdam's technical systems and collaborative ethos, but will need to develop context-specific mechanisms for fostering inclusion, digital trust, and local innovation. However, as highlighted in the results chapter, NEOM is not simply replicating Amsterdam's model. For

example, while Amsterdam's approach relies heavily on a long-standing culture of civic engagement and decentralised governance, NEOM is adapting these lessons through a context-specific governance framework that aims to create its own pathways. In other words, NEOM draws inspiration from Amsterdam's collaborative ethos but is crafting its own mechanisms suited to its unique socio-political environment. As discussed in Chapter 5, the findings show that NEOM draws inspiration from Amsterdam's collaborative ethos but is developing its own context-specific mechanisms to foster inclusion and digital trust. In other words, (see the findings in Chapter 5) for how NEOM selectively adapts global models like Amsterdam's within its unique socio-political landscape.

2.3.2.3 PlanIT Valley Paredes, Portugal

Unlike the previous two cases of Barcelona and Amsterdam, PlanIT Valley Paredes City (PVPC) is a prototype smart city to be developed on the eastern side of Porto in Portugal. The futuristic city is centred on a model following software developed by Living PlanIT company known as the Urban Operating System (UOS) (Angelidou, 2017; Carvalho & Campos, 2013; Sweet, 2011). The platform will be used to gather data via the IoT, which will then be fed to the application that monitors and controls the city's system (Alusi et al., 2011). The city is expected to have a hosting capacity of 225,000 inhabitants and incorporate smart infrastructure right from its foundation. The foundations and buildings will be constructed in phases using prefabricated construction material fitted with and furnished with the necessary smart infrastructure (Alusi et al., 2011).

Like the other smart cities, PVPC would use autonomous vehicles for sustainable traffic, a controlled sensor network for communication and data collection, and carbon-neutral buildings that not only cut down pollution significantly but also reduce the cost of construction, making way for affordable housing (Carvalho, 2015). However, as reported by Madakam & Ramaswamy (2015) and Angelidou (2017), the project, which is still in its infancy, is already showing significant challenges related to resource access, operational licenses, and the development of a socially rich innovation ecosystem. According to the studies, the primary lesson is that planning frameworks for futuristic cities should look beyond governance, societal dimensions, and technological challenges (Madakam & Ramaswamy, 2015; Angelidou, 2017). This is because overemphasising smart technologies or top-down governance models, without adequately considering ecological limits, cultural

context, spatial justice, and long-term resilience, often leads to exclusionary urbanism, environmental degradation, and technological obsolescence (Datta, 2020; Marvin & Luque-Ayala, 2017). Nonetheless, PVPC is still designed on the dimensions of smart cities aimed at balancing ecologies, bolstering economic progress, and offering a better quality of life to city dwellers (Angelidou, 2017; Alusi et al., 2011; Carvalho, 2015). Other future smart city projects may likewise still benefit from modelling their smart city projects on an urban operating system such as the one used by PVPC, as well as embracing public-private partnerships in the development of such megaprojects to lower the cost, enhance the quality of research, and generally get more stakeholders involved in the process to help capture their interests better and enhance innovation (Madakam & Ramaswamy, 2015). Additionally, collaboration can help solve the problem of resource access and compliance issues when private developers work with policymakers on issues of national interest, such as erecting a futuristic smart city (Madakam & Ramaswamy, 2015; Angelidou, 2017).

Crucially, the stalling of PlanIT Valley underscores the limits of the ‘tabula rasa’ approach to urbanism, where the city is conceptualised primarily as a computational platform, or Urban Operating System (UOS), rather than a socio-political entity. From a geographical perspective, this case illustrates the friction inherent in ‘policy mobility,’ a concept in critical urban geography describing how best-practice models travel between jurisdictions (McCann & Ward, 2011; Peck, 2011). While the technological blueprint of the UOS is theoretically placeless and easily transferable, its implementation is deeply situated, or dependent on local institutional frameworks and economic realities. PlanIT Valley’s struggle highlights that smart city models cannot simply be dropped into a new location without contending with the specificities of the local political economy; in this case, Portugal’s financial crisis and the subsequent lack of capital liquidity (Kitchin, 2015). The failure here was not technological but contextual; the model assumed a level of seamless public-private integration and capital flow that the host geography could not sustain, revealing the fragility of corporate-led urban utopias when detached from state capacity.

For NEOM, the lessons of PlanIT Valley are transferable but must be read through the lens of Middle East exceptionalism; a framing in urban studies that acknowledges the distinct developmental capacity of gulf states (Koch, 2025). Unlike the market-dependent/austerity-constrained context of Portugal, NEOM operates within a rentier state

framework characterised by high capital liquidity (via the Public Investment Fund) and centralised authoritarian decision-making (Cugurullo, 2016). Consequently, the transferability of the UOS model to NEOM is arguably higher solely because the Saudi state possesses the financial and regulatory power to force the model into existence, bypassing the friction that stalled PlanIT Valley. However, this ease of transfer brings its own risks. While the gulf context allows for the rapid deployment of such computerised urbanism, it may exacerbate the issues of social sterility and surveillance identified in PlanIT's critique. If the UOS is transferred to NEOM without modification, it risks creating a hyper-efficient but socially brittle enclave, governed by algorithmic logic rather than civic engagement, potentially replicating the splintering urbanism often critiqued in gulf megaprojects (Graham & Marvin, 2001). Importantly, as discussed in Chapter 5, the findings indicate that NEOM stakeholders do not frame digital operating systems as neutral "plug-in" solutions; rather, they repeatedly stress the need to rework global models to fit NEOM's governance logics, legitimacy strategies, and socio-cultural context. This empirical emphasis helps position PlanIT Valley not as a roadmap to be implemented, but as a cautionary comparator that clarifies what must be redesigned, politically and socially, if intensive urban automation is to avoid reproducing the very critiques levelled at earlier smart-city experiments.

2.3.3. Smart City Initiatives in North America

2.3.3.1 Toronto, Canada

Toronto is leveraging more ingenious ways of doing things through technologies and data that optimise resources while enhancing quality and performance across the various smart city dimensions, including governance, the environment, and the economy (Artyushina, 2020; Mann et al., 2020; Tenney et al., 2020). The city has developed and implemented innovative policies and technologies to harness the various smart city benefits, including the proliferation of digital platforms and using big data and smart technology to address the difficulties of civic engagement (Valverde & Flynn, 2020; Goodman & Powles, 2019).

Toronto's smart city initiatives can be encapsulated, in both a positive and challenging sense, in its Sidewalk development project which aimed to advance a new model of inclusive urban development for sustainable transportation, living, economy,

housing and so forth (Mann et al., 2020; Leszczynski & Kong, 2022; Carr & Hesse, 2020). Although Toronto has made significant strides towards developing the smart nature of the city, the Sidewalk Labs project looked to incorporate heated pavements and autonomous vehicles, among other exclusive features, and this has generated controversy regarding privacy and governance (Carr & Hesse, 2020; Robinson & Coutts, 2019; Artyushina, 2020). The controversy over the Sidewalks Lab serves as a reminder to government bodies of the importance of public participation when seeking to launch smart city projects. Tenney et al. (2020) reiterate this point and the need to encourage citizen access to open data through various mediums to enhance participatory governance and bring all stakeholders on board to realise smart city initiatives smoothly, further recommending engaging citizens at all levels of planning and execution, including co-designing for inclusive, modern and open smart cities.

The collapse of the Sidewalk Labs project in Toronto offers a critical lesson on the situatedness of smart city policies. While the technologies of sensors and autonomous transit are theoretically mobile and can move between cities, the governance structures required to manage them are deeply embedded in local political culture. Toronto's experience demonstrates that a smart intervention is never spatially neutral but must negotiate with existing local geographies of data privacy and civic rights. Scholars argue that policy mobility is not a smooth transfer but a mutation that changes as it lands in different institutional environments (Peck & Theodore, 2015). Consequently, the failure in Toronto was not a technical malfunction but a geographical mismatch between the corporate desire for data extraction and a local populace empowered to demand digital sovereignty.

This friction has profound implications for transferring best practices to NEOM. The resistance encountered in Toronto arose from a liberal-democratic context where public consultation is a prerequisite for urban planning. In contrast, NEOM retains absolute centralized state control over development (Koch, 2025) which suggests that the specific blockers that stopped Sidewalk Labs, such as data privacy activism or prolonged regulatory debates, may simply not exist in the Saudi context. The transferability of a data-driven urban model is therefore more likely for NEOM not because the technology is better, but because the governance model strips away the friction of public dissent.

However, this streamlined transferability presents its own risks for NEOM. While the gulf context allows for the rapid implementation of high-tech infrastructure without the delays seen in Toronto, it removes the safeguards that protect residents from digital overreach. The absence of the civic friction seen in Canada could lead to a form of splintering urbanism where efficiency is prioritized over social inclusion (Graham & Marvin, 2001). Therefore, while the hardware of Toronto's vision can be effortlessly moved to the desert, the software of civic accountability cannot. NEOM's challenge will be to prevent its highly efficient data systems from creating a sterile environment that lacks the social vitality often preserved by the democratic processes seen in western contexts. As the findings discussed in Chapter 5 indicate, NEOM's governance challenge is therefore not simply technical implementation, but the construction of credible legitimacy arrangements, developing context-specific forms of oversight, trust, and inclusion capable of preventing highly efficient data systems from producing socially sterile or exclusionary urban environments.

2.3.3.2 San Francisco, USA

The city of San Francisco has long been perceived as a leading centre for innovation and enjoys a strong reputation as a smart city, with a vibrant and thriving entrepreneurial community (Bronstein, 2009; Ching, 2013; Yigitcanlar et al., 2019). The city has incorporated aspects of smartness across various dimensions, including smart living, smart people, smart governance, smart economy, and a smart environment. According to Shmelev and Shmeleva (2018), what distinguishes San Francisco is its outstanding commitment to environmental leadership through its sustainable management of waste, air quality, energy, and buildings.

Another distinguishing feature is the way San Francisco has implemented smart governance through technologies that enhance transparency by allowing public participation. Lee et al. (2014), show how San Francisco uses open data technologies, including Application Programming Interface platforms across governmental departments, to demonstrate a commitment to transparency. By adopting San Francisco's model, which has increased citizen involvement and quality of life, other cities can imitate the use of such open data technologies (Lee et al., 2014). Bronstein's (2009) study not only advocates for the employment of information to increase the quality of life but also to help streamline

governance and improve other characteristics of smart cities and attributes the rise of San Francisco as a smart city to the presence of numerous technology corporations that drive innovation of smart city technologies, where the requisite knowledge and networks necessary to inspire innovative thinking spills over into the city itself (Bronstein, 2009; also Yigitcanlar et al., 2019). Prospective smart cities might replicate this dynamic by attracting investment from technology corporations through favourable policies and other strategies, where their presence can help spearhead smart innovation in the city (Yigitcanlar et al., 2019).

From a geographical perspective, San Francisco's smart city profile is shaped by its location at the heart of a globally significant technological and entrepreneurial ecosystem, which influences both its innovation dynamics and governance culture (McCann, 2011; Yigitcanlar et al., 2019). The city's sustained commitment to environmental leadership, including sustainable waste management, air quality initiatives, energy performance programs, and green building efforts, reflects its embeddedness in a socio-political context that prioritises environmental sustainability alongside economic dynamism (Bronstein, 2009; Ching, 2013). This orientation is reinforced by local institutional capacities and civic expectations for public accountability and environmental stewardship, which together shape the city's distinctive smart governance culture.

San Francisco's use of open data technologies and platforms to enhance government transparency and citizen participation demonstrates how digital tools can be used to strengthen urban governance and civic engagement (Lee et al., 2014). Open data initiatives, such as exposing government data through Application Programming Interfaces (APIs) across departments, facilitate public access to information, foster collaborative problem-solving, and support evidence-based policy making, thereby improving quality of life and cross-sectoral service effectiveness (Paskaleva, 2017; UNESCO, 2023). These practices are transferable to other cities seeking to build data-driven governance frameworks, particularly where there is institutional support for transparency and stakeholder participation. Yet the transferability is conditioned by local cultural and institutional norms: the high level of civic digital literacy and strong civil society engagement seen in San Francisco may not be present in cities with different political cultures or lower levels of public trust in government, which can constrain the adoption of

open data practices (Yigitcanlar et al., 2018; Valverde & Flynn, 2020). Furthermore, San Francisco's innovation ecosystem benefits from proximity to Silicon Valley, creating spillover effects that are geographically specific and unlikely to be replicated in contexts lacking similar industrial agglomerations.

For projects like NEOM, San Francisco's experience offers valuable lessons in embedding open governance and environmental monitoring within smart urban strategies, illustrating how digital transparency can support civic involvement and sustainability outcomes. However, these lessons are not directly transferable because they are enabled by San Francisco's particular governance culture, regulatory environment, and innovation ecosystem. This thesis evidence in its results that NEOM has therefore had to translate rather than replicate these ideas, developing context-specific approaches to data accessibility, environmental stewardship, and public legitimacy that align with its own institutional and socio-cultural setting (see the chapter 5 where these tailored governance and policy mechanisms are discussed).

2.3.4. Smart City Initiatives in Latin America

2.3.4.1 Curitiba, Brazil

Curitiba has ranked among the smartest cities in the world on the basis of technological innovation and infrastructure that has improved urban liveability, workability, and sustainability throughout the various dimensions of smart cities, including people, environment, economy, and mobility (Macke et al., 2018; Macadar et al., 2016). De Oliveira et al. (2021), in a study that examines such characteristics as water consumption, access to basic health, water losses, and air quality index, among others, point out that Curitiba scores highly in dimensions such as smart living, smart people, smart governance, and smart environment, evidenced by a 70% performance in the person, planning, and governance dimensions. One outstanding feature of Curitiba is its call and information centre 156, which makes information available to citizens within the city via telephone calls and serves as a platform for addressing citizens' demands as a way of enhancing effectiveness, transparency, convenience, and sustainability (Macadar et al., 2016).

The city follows the contemporary smart city development model in which the government includes the private sector, public-sector institutions, and citizens in smart city

project planning and implementation to ensure the needs of all stakeholders are accounted for, an approach that has considerable success and which can be emulated by other cities looking to ‘smarten’ their cities (Macke et al., 2018; Macadar et al., 2016). Curitiba has also used technology to its advantage to manage and improve its transportation system. The City Administration Dashboard, for instance, is an analytics app for public transport that offers real-time data helpful for easing traffic and averting potential accidents (Fiore et al., 2019; Dreier & Silveira, 2016). According to de Carvalho et al. (2021) Curitiba, like many conventional cities, grappled with mobility issues until it leveraged technology and achieved one of the world’s best quality public transport systems.

Curitiba represents a distinct ‘Southern’ trajectory of smart urbanism, often termed frugal innovation, where limited budgets necessitate creative institutional solutions rather than just high-tech hardware. Curitiba’s success is deeply situated in a specific history of participatory urban planning that predates the digital era. Consequently, the transferability of this model is constrained; the technology (the app or dashboard) is mobile, but the civic culture that drives the 156 information centre is not. Policy mobility literature suggests that attempting to move these feedback mechanisms without the underlying social trust often results in zombie infrastructures that citizens simply ignore (Söderström et al., 2014).

For NEOM, the Curitiba case offers a warning about the limits of top-down smart governance. While the Saudi context provides the capital that Curitiba lacked, it operates without the tradition of bottom-up civic engagement that made Curitiba’s system effective. The danger for NEOM is assuming that a digital interface alone can generate a vibrant urban community. If NEOM imports the monitoring tools without the participatory mechanisms, it risks reinforcing the critique of gulf cities as efficient but sterile spaces (Koch, 2025). Success in NEOM will require engineering a digital proxy for the organic civic trust that Curitiba took decades to build. In the case of NEOM, interviews show that it is trying to “engineer” civic trust through a custom governance ecosystem and AI-enabled engagement, but the findings also indicate that participatory frameworks are still underdeveloped, meaning that Curitiba-style trust is not automatically guaranteed.

2.3.5. Smart City Initiatives in Africa

2.3.5.1 *Durban, South Africa*

From the early 2000s, the Durban Aerotropolis began to restructure itself as a smart city by incorporating information technology and other digital technologies into its processes and infrastructure to achieve smart city status by reinforcing its various smart city dimensions (Odendaal, 2011). The particular factor emphasised within the literature that considers the city of Durban is what might be termed its 'local' nature, building from modest beginnings. Durban is highlighted as an example of the way local governments can make a significant difference in the management and functioning of their cities if they leverage information technology (Odendaal, 2003; Odendaal, 2011; Roberts, 2010). Researchers have noted that Durban has applied a sector model for urban development, which they have commended particularly regarding climate change adaptation strategies where the local government supported various pilot sectors of the city to develop their plans independently (Odendaal, 2011; Roberts, 2010). According to Roberts (2010), the sector model actually enhanced interactions across sectors and allowed each sector to understand its needs and roles from an adaptive point of view. Roberts (2010) further suggests that the sectoral approach to implementing smart initiatives in cities can serve to eradicate possible issues such as limited human and financial resources and ensure that sectors deal with their own most urgent developmental needs. The city's Municipal Climate Protection programme is one of the most conspicuous features that demonstrate the importance of developing locally focused response strategies in smart climate change initiatives across cities, as well as assessing local-level impacts. Tourism is another specific area where Durban is cited as an example of the benefits of leveraging digital technology in bolstering the economy by enhancing the efficiency and visibility of whole industries (Gretzel et al., 2023). According to Pai et al. (2020), technology is a key driving force for tourist cities such as Durban, as it helps enhance awareness of tourist attractions across the globe, enabling smart cities to make maximum use of tourist attractions.

Durban exemplifies actually existing smart urbanism in the Global South, distinguishing itself from the glossy, master-planned models of the Global North. Critical geographers argue that Durban's sectoral approach is a necessary response to institutional splintering and resource scarcity, rather than a mere design choice (Datta, 2015). This

situatedness reveals that smart city interventions in the Global South are often driven by survival and specific problem-solving (e.g., climate resilience) rather than a universal technological upgrade. Consequently, the transferability of this model is complex, while the logic of modular, sector-specific adaptation is resilient, it is born of constraints that wealthy rentier states do not face.

For NEOM, the contrast is stark. NEOM operates under a paradigm of Middle East exceptionalism, characterised by centralised master planning and immense capital liquidity, negating the need for the piecemeal approach seen in Durban (Koch, 2025). However, dismissing the Durban model would be a mistake. The totalising vision of NEOM, where a single operating system runs the city, creates a high-risk, single point of failure. Durban's lesson on modularity offers a pathway for resilience; allowing specific sectors (like tourism or energy) to adapt independently can prevent the rigidity often found in top-down gulf megaprojects. Thus, while NEOM need not replicate Durban's financial constraints, it should consider replicating its sectoral flexibility to avoid the brittleness of over-centralisation. And this idea is discussed in several of the interviews as detailed in the results (Chapter 6).

2.3.6. Smart City Initiatives in Australia

2.3.6.1 *Brisbane, Australia*

Brisbane is a smart city that is primarily characterised by knowledge-based urban development, an approach that, according to the literature, has proved to be quite effective and could be replicated by prospective smart cities across the globe (Yigitcanlar & Velibeyoglu, 2008; Yigitcanlar, 2011; Raynor et al., 2017; Tariq et al., 2020). According to Yigitcanlar and Velibeyoglu (2008), such strategies significantly support economic growth by attracting and retaining global investment, skilled professionals, and high-value industries. Brisbane has operationalised these strategies through several initiatives, including the establishment of the Knowledge Corridor, linking major research universities and innovation districts, as well as Smart City Brisbane, a program integrating digital infrastructure, participatory planning, and sustainability initiatives. Projects like The Capital innovation hub and the Fortitude Valley Creative Precinct further demonstrate Brisbane's

commitment to fostering a local innovation economy (Raynor et al., 2017; Yigitcanlar et al., 2020).

Yigitcanlar et al. (2020) and Raynor et al. (2017) highlight how Knowledge-Based Urban Development can also facilitate urban consolidation, making more efficient use of space and infrastructure, particularly in high-growth urban regions. This makes Brisbane's model highly relevant for replication in other cities transitioning toward smart and sustainable futures (Yigitcanlar, 2018; Tariq et al., 2020). Ultimately, policies that support technological innovation, inclusive digital governance, and capacity-building lay the foundation for transforming traditional cities into resilient, knowledge-driven smart cities (Field & Jon, 2021; Yigitcanlar, 2011; Yigitcanlar, 2018)

The concept of connection is a key aspect of Brisbane's smart city model, whether that to keep working with stakeholders to explore how innovations can usher in its new world city agenda while enhancing and preserving its liveability and prosperity (Yigitcanlar, 2018; Khanjanasthiti et al., 2021; Tariq et al., 2020). The smart city agenda seeks to make activities efficient and effective by employing digital technology, enhancing the quality of life via personalised human experiences, including citizens in major decisions, enhancing prosperity through digitisation, technology, and connection, using analytics to decipher data for insight, and enhancing transparency through openly shared data (Yigitcanlar, 2018; Yigitcanlar, 2011; Partridge, 2004). Like other smart cities worldwide, Brisbane's goals are anchored along the different smart city dimensions, where it achieves positive scores particularly regarding the nature of its smartness as efficient, transparent, insightful, personalised, inclusive, and prosperous (Yigitcanlar et al., 2022).

Brisbane's trajectory illustrates the knowledge-based urban development model, where the city acts as a spatial container for clustering universities, industry, and creative talent. From a geographical perspective, this highlights that smart cities are not just technological constructs but rely heavily on agglomeration economies; the benefits that firms obtain by locating near each other (Moulaert & Sekia, 2003). The success of Brisbane is deeply situated in its existing spatial assets, specifically the physical proximity of established universities and research hubs. Therefore, the transferability of this model is

limited; a city cannot simply legislate a knowledge economy into existence without the pre-existing soft infrastructure of educational institutions and social networks.

This presents a distinct challenge for NEOM, which is developing as a ‘greenfield’ site without a legacy of established institutions. While Brisbane retrofitted existing urban fabric to foster connection, NEOM attempts to build a knowledge economy from a blank slate. The risk here is the cold start problem: physical infrastructure (hardware) can be built quickly, but the social and intellectual networks (software) that drive innovation typically evolve slowly over decades. If NEOM relies solely on the physical design of spaces to generate innovation, it may struggle to replicate the organic synergies found in historically embedded cities like Brisbane.

Unlike Brisbane, where the state acts as a facilitator for private actors, the Saudi state acts as the primary creator of the market, using massive financial incentives to import human capital overnight (Ponzini, 2011). While this creates rapid scale, it risks producing a transient knowledge economy, where talent is mercenary rather than rooted. For NEOM to succeed where other planned cities have struggled, it must transition from state-sponsored agglomeration to a self-sustaining ecosystem, moving beyond imported expertise to genuine local knowledge production. As the Chapter 5 findings indicate, internal accounts repeatedly recognise that building an innovation ecosystem is not reducible to attracting global talent or constructing “smart” districts; rather, NEOM’s long-term viability depends on institutionalising local knowledge production, anchoring networks beyond incentive cycles, and cultivating durable communities of practice. On this basis, NEOM’s critical transition is from state-orchestrated agglomeration to a self-sustaining ecosystem, one in which innovation is reproduced locally through rooted institutions, not merely imported capacity.

2.3.7. Smart City Initiatives in the Middle East

2.3.7.1 Masdar City (Abu Dhabi), United Arab Emirates

Abu Dhabi’s planned smart city project, known as Masdar city, is among the most sustainable cities in the world today (Yigitcanlar et al., 2019). Batty et al. (2012, p. 505) similarly describe Masdar as follows: “Masdar outside of Abu Dhabi is being developed by General Electric Company as the world’s first carbon-neutral city.”. The city focuses on three aspects underlying the dimensions of a typical smart city: environmental, social, and

economic sustainability (Yigitcanlar et al., 2019; Crot, 2013; Reiche, 2010). Identical to all other smart cities, Shelton et al. (2014) highlight that Masdar employs ICT to overcome the challenges faced by conventional cities and enhance the liveability and operationalisation of urban areas across the six dimensions of smart cities: smart living, mobility, economy, governance, society, and environment to ensure they meet the needs of present and future generations.

At its inception, Masdar's master plan aimed at forging a path towards sustainability by transforming oil wealth into renewable energy leadership by optimising sources of green energy such as solar, significantly reducing the need for personal cars and transportation by integrating all aspects of city life and providing a high quality of life (Randeree & Ahmed, 2019; Madakam & Ramaswamy, 2016). According to several researchers, Masdar is the first genuine attempt for the oil and gas-reliant Middle East to embrace sustainability by combining technology and models to develop a smart city (Sankaran & Chopra, 2020; Elchalakani et al., 2014). For instance, energy shortages and issues of sourcing continue to afflict some of the world's major cities, with blackouts and power surges being a common occurrence. However, Masdar demonstrates it is possible to reduce energy use not only through the reduction of wastage but also through architectural designs and adoption of technology designed to use as little energy as possible (Kolotouchkina & Seisdodos, 2017; Elchalakani et al., 2014). As Cugurullo (2013) emphasises, the city's architecture is designed in such a way that allows streets and houses to remain cooler than they would be otherwise. Furthermore, the city encourages using innovative technologies in household appliances that conserve power, such as low-flow showers and smart water meters (Crot, 2013; Randeree & Ahmed, 2019). Although these are slight differences, they can act as the starting point for conventional cities that aspire to develop as smart cities and become more sustainable.

One of Masdar's outstanding features is its sole reliance on solar energy to power the city. Cugurullo (2015) further describes Masdar as the 'green print' for developing sustainable smart urban metropolises globally by applying real-world remedies to manage waste, improve mobility, and enhance water and energy efficiency. For example, Masdar specifies the type of electricity meters for every house to maintain a continuous focus on efficiency and optimisation (Kolotouchkina & Seisdodos, 2017; Sankaran & Chopra, 2020).

Additionally, buildings are equipped with motion-sensor lighting and smart ventilation systems to minimise unnecessary energy consumption. Carvalho (2015) acknowledges that using ICT to address challenges that affect modern cities is particularly effective when building new smart cities from scratch, such as Masdar, however, administrations seeking to transition from traditional to smart cities can still model their frameworks on various aspects of Masdar city, considering its developers have blended high-tech design with ancient construction practices such as narrow, shaded streets and wind towers (Geray, 2019). Alongside the institutional/governmental leadership in such development, Lau (2012) also insists on the importance of encouraging private technological investments in the strategic development and sustainability of smart cities, attributing part of Masdar's success to companies within the cities' borders that keep innovating green solutions technologies and urban solutions whenever a problem arises. This allows the city to become a living urban laboratory to ensure sustainability across all the dimensions of smart cities going forward (Karvonen et al., 2014).

From a critical geographical perspective, Masdar City exemplifies the paradox of eco-modernisation, where sustainability is pursued through high-tech master planning rather than social or behavioural change. Scholars argue that Masdar functions less as a reproducible urban model and more as a spaceship in the desert; a hermetic, technical enclosure designed to survive despite its environment rather than with it (Günel, 2019). This highlights a crisis of transferability: the city's success is predicated on the rentier economic model where the state acts as the primary developer, landlord, and regulator, insulating the project from the market pressures that shape ordinary cities (Cugurullo, 2016). Consequently, while specific technologies (like the wind towers or smart meters) are mobile, the urban model itself is deeply situated in the unique political economy of Abu Dhabi, making it difficult to replicate in democratic or austerity-constrained contexts.

For NEOM, Masdar serves as the critical prototype of the Saudi gigaproject vision. Both projects rely on Middle East exceptionalism, utilising hydrocarbon wealth to finance post-carbon futures, yet Masdar's trajectory offers a cautionary tale regarding the limits of build-it-and-they-will-come urbanism. Masdar significantly missed its original population and zero-carbon targets, evolving into a commuter suburb rather than a self-sustaining city, revealing the friction between rigid master plans and the fluid reality of human habitation

(Cugurullo, 2013). The lesson for NEOM is that while state capacity can force the construction of a smart city, it cannot easily manufacture the social vibrancy required to sustain it. If NEOM replicates Masdar's technocratic governance without allowing for organic urban growth, it risks becoming another spectacular but socially hollow enclave. This thesis's interview findings reinforce this caution, with internal stakeholders explicitly echoing critiques of master-planned smart cities as lacking spontaneity and social vibrancy, while also framing NEOM's smart-living agenda around community-building and fostering an inclusive, vibrant cultural scene to avoid a socially hollow outcome.

2.3.7.2 Dubai, United Arab Emirates

Dubai city launched an ambitious initiative Dubai Plan 2021, aiming to transform the desert city into a wholly smart and sustainable city (Gugler et al., 2021). Although Dubai is an impressive city, housing millions of people looking for the better life promised in the glittering metropolis, perhaps surprisingly, it is yet to join the ranks of most modern smart cities and only launched its eight-year plan in 2021 (Gugler et al., 2021; Khan et al., 2017). According to Gugler et al. (2021), the strategy for a smart Dubai focuses on six key areas: economy, urban planning, energy, communications, mobility, and infrastructure. The plan looks to implement various projects across a broad range of government services to address the issues arising from the exponential growth the city has experienced in recent years. The development follows a Smart City Lifecycle-based Modelling, which supports the evolutionary path of smart city development by a process where smart city service systems can be consistently designed, built, and operated in phases and in a modular way (Gugler et al., 2021).

As with other cities discussed above, Dubai offers the opportunity for other cities to observe and follow a plan on transitioning a conventional city into a smart city as it unfolds (Khan et al., 2017; Noori et al., 2020), particularly as Dubai city is leveraging emerging technologies and initiatives to improve the infrastructure, enhance experiences, and streamline governance by making service delivery and liveability in the city more seamless, personalised, efficient and impactful (Gugler et al., 2021). The various technologies include AI and Blockchain and data science to ensure improvements along the six dimensions of

smart cities. As Hozaim and Akre (2017) highlight, AI is becoming an everyday tool used to make service delivery in government offices more efficient. One of the notable applications of AI in Dubai is the way the city is using sophisticated technology to monitor fatigue and the stress levels of bus drivers across the city, significantly reducing the number of accidents, which may be an interesting example for other cities to take note of. Out that smart cities integrate such ICT to enhance the quality and performance of city services, elucidating that, as urban populations swell, cities face the burden of overwhelmed transportation, public spaces, resources, and other things that may impact the quality of living and services provided to residents. Another outstanding feature in Dubai is the prospect of eliminating paper use in the civil service to protect the environment and save resources (Gugler et al., 2021)

Transportation is a key focus for the desert city, which is setting up a US\$6 billion, 151 km ultra-speed flagship project, the Dubai–Abu Dhabi Hyperloop, to reduce road pollution and congestion (Gugler et al., 2021). “The goal of this Hyperloop (based on the project of Elon Musk) is to link Dubai and Abu Dhabi faster than what has previously been achieved” (Gugler et al., 2021, p. 13). The project is designed to be sustainable through its reliance on electric propulsion, ultra-low aerodynamic drag, and solar-powered infrastructure, which collectively aim to achieve net-zero emissions. Furthermore, the Hyperloop system will be integrated with smart mobility platforms to optimise scheduling, energy efficiency, and passenger flow, making it a pioneering example of data-driven, low-carbon transportation in the gulf region. Many cities grapple with transportation, environmental sustainability, and service delivery; studying Dubai’s model for a modern, efficient, and technologically advanced system may aid other locations in reducing their expenditure significantly while meeting their environmental sustainability goals (Noori et al., 2020).

Dubai’s approach to smart urbanism is often characterized as entrepreneurial statecraft, where the government functions like a corporation to brand the city as a global hub for innovation. Critical geography literature notes that Dubai’s model relies heavily on fast policy, essentially importing global best practices, such as Hyperloop or blockchain governance, at rapid speed to maintain its competitive edge (Acuto, 2010). However, this transferability is deeply situated within a specific labour regime and social contract. The

efficiency of Dubai's smart systems often depends on a transient, non-citizen workforce and a regulatory environment that prohibits the types of lengthy public consultations found in Western democracies. Therefore, while the technologies (AI bus monitoring, paperless government) are transferable, the speed of their implementation is likely unique to the gulf's specific socio-political context.

For NEOM, Dubai acts as both a template and a rival. Both projects also share the Middle East exceptionalism framework which suggests high transferability of Dubai's successes to the Saudi context. However, a critical distinction lies in the urban fabric: Dubai is retrofitting an existing, car-centric city, whereas NEOM is a greenfield project. Transferring Dubai's model to NEOM carries the risk of replicating the spectacle of technology without addressing underlying ecological costs. If NEOM merely copies Dubai's focus on iconic infrastructure (like the Hyperloop) without questioning the sustainability of high-consumption lifestyles in an arid environment, it risks perpetuating the glittering metropolis archetype rather than achieving genuine ecological resilience (Koch, 2025). As the thesis findings discussed in Chapter 5 indicate, NEOM's internal discourse repeatedly emphasises the need to translate (not copy) regional precedents by aligning innovation with decarbonisation, resource discipline, and governance mechanisms capable of constraining consumption, precisely the point at which Dubai's model becomes most contested as a sustainability reference.

2.3.7.3 Lusail, Qatar

Lusail is an upcoming smart city in the gulf serving as Qatar's latest sustainable real estate project and the first green city in the country (Tok et al., 2014). The city is being built as part of the country's vision 2030, which aims to enhance the living standards of its people and effectuate sustainable development across four central pillars: environmental, human, social, and economic. The project was launched in 2006 and is estimated to cost approximately US\$45 billion. It has been shaped as one of the most ambitious projects in the gulf and in terms of smart cities worldwide, expected to host 450,000 people (Tok et al., 2014). Lusail's model is developed on the district and neighbourhood concept that integrates all essential services and needs of citizens in each district to eliminate the need for distance travelling (Issa et al., 2014). Furthermore, Lusail is being developed in partnership with Qatari Diar Real Estate Investment Company, and this public-private partnership approach

is recommended in the literature to cushion the government from overspending public resources in the construction of such a significant project (Mariyam et al., 2022)

Hefnawy et al. (2018) aptly note that “Smart city ecosystems, like other systems, consist of elements, functions and interconnections, but elements are intelligent and adaptive” (p.442), and like many smart cities, Lusail has focused on infrastructure and systems that integrate ICTs and IoT devices alongside others, such as fibre optic networks and high-speed Wi-Fi across the city, aimed at efficient and sustainable services for a better liveability, governance, economy, environment, and mobility (Issa et al., 2014; Tok et al., 2014). A particularly interesting aspect is that although Lusail is a new city, it blends modern facets of architecture with traditional norms, meaning the model can be replicable for already established cities or other green city projects starting from scratch (Hefnawy et al., 2018). As part of its design, Lusail includes using the underground space to distribute electricity and chilled water to power and cool buildings to enhance environmental conservation (Al Sharif & Pokharel, 2021). The underground tunnels system will also be critical in waste management, meaning that physical spaces in the city will remain pristine, significantly improving liveability and well-being (Al Sharif & Pokharel, 2021; Issa et al., 2014; Tok et al., 2014). The tunnel system will also reduce the traffic associated with garbage and fuel trucks in densely populated areas since waste will be disposed of through a 24 km waste pipe network and pumped directly to recycling treatment plants outside the city (Mariyam et al., 2022).

Lusail is an excellent example of a future smart city built from scratch thanks to its approach to sustainability in architecture, construction, and infrastructure (Hefnawy et al., 2018). According to its developers, the aim is to significantly reduce the carbon footprint primarily associated with conventional cities while creating a groundwork or sustainable legacy by integrating sustainable facilities and utilities (Tok et al., 2014). Research cites the power supply and cooling system as one of the utilities that is aimed to reducing CO₂ emissions equivalent to 29,000 homes annually (Mariyam et al., 2022; Hefnawy et al., 2018). Furthermore, as cities grapple with how to make mobility more efficient with an increasing number of cars and urban populations and most have resorted to the use of AI and IoT to monitor and manage traffic, Lusail is taking a new approach that could be replicated for future cities by reducing the need for long-distance travelling. By making

essential services available close to the people in every district, building a light-rail system network and a series of underground tunnels made for pedestrians and transporting other amenities, the city seeks to effectively reduce traffic and the need for personal cars (Tok et al., 2014).

Lusail exemplifies a specific typology of gulf urbanism where smartness is defined by the vertical segregation of infrastructure. By burying metabolic flows like waste and cooling, the city sanitises the surface level, a strategy scholars identify as splintering urbanism (Graham & Marvin, 2001). This approach is deeply situated in a context where urban planning prioritises visual order and elite consumption over the organic, messy complexity of traditional cities. Therefore, the transferability of this model is restricted to greenfield sites where a single developer controls the entire subsurface, making it nearly impossible to replicate in established cities with legacy infrastructure.

For NEOM, Lusail serves as a direct precedent due to the shared framework of Middle East exceptionalism. Both projects rely on rentier state model where sovereign wealth funds, Qatari Diar and the Public Investment Fund (PIF), drive development, allowing for speed and scale that bypasses democratic planning friction (Koch, 2025; Rizzo, 2014). The transferability of Lusail's district concept to NEOM is high, particularly the strategy of using underground layers to hide service logistics, which aligns with NEOM's The Line concept. However, this creates a risk of producing enclave urbanism, where the city functions as a series of disconnected, high-security compounds rather than a cohesive social fabric (Datta, 2015). As the Chapter 6 findings indicate, this tension is explicitly recognised in NEOM's internal planning discourse: stakeholders describe the need to translate regional precedents like Lusail by coupling infrastructural efficiency with design and governance mechanisms that can sustain social integration, rather than reproducing enclave urbanism under a different aesthetic.

2.3.8. Smart City Initiatives in Saudi Arabia

2.3.8.1 Saudi Vision 2030

Saudi Arabia's Vision 2030 is a strategic plan aiming to diversify the country's economy, reduce its dependency on oil and enhance public service delivery in health, infrastructure, recreation, tourism, and education (Grand & Wolff, 2020). The details of this ambitious plan were unveiled in 2016 following the collapse of global oil prices in 2014, which adversely affected the Kingdom's economy (Doheim et al., 2019). The plan originated under the stewardship of King Salman bin Abdulaziz and is now the flagship of Crown Prince Mohammed bin Salman and promises a sustainable Saudi for current and future generations, characterised by accelerated energy transition, unprecedented economic growth, and other sustainability goals (Kinninmont, 2017; Grand & Wolff, 2020).

One of the notable features of Saudi's Vision 2030 is its plan to combat climate change through unique initiatives that include the development of smart cities and transitioning from traditional gas and oil energy to greener energy sources (Alqahtany, 2025; Alomi, 2017). Many countries and cities, especially in developed nations such as the United States of America, grapple with climate change, including how to reduce the carbon footprint of their cities (Nurunnabi, 2017). Much of the blame for the emission of greenhouse gasses that have enhanced global warming and accelerated climate change has been directed at the use of fossil fuels to power cities, industries, and transportation (Nurunnabi, 2017). Urban administrations are still in the process of establishing the right frameworks to address their carbon footprints, and, particularly as an oil producing country, there might therefore be much to learn from the Saudi transition model outlined in vision 2030, which saw the government launch a National Renewable Energy Program (Nurunnabi, 2017; Alomi, 2017). The launch was followed by a series of clean energy initiatives, including forming the council of royal reserves, a national environment strategy, joining the international solar alliance, establishing national environmental centres, an environmental fund, and various smart city projects (Rahman & Qattan, 2021). The government adopted new smart city strategies that include building smart cities from scratch, such as in the case of NEOM city, or transforming existing cities by leveraging digital technologies and ICT through the IoT devices, such as in the case of Riyadh (Thompson, 2017). The Riyadh initiative employs the bottom-up model by inviting the

participation of all municipalities and then making plans and strategies based on the challenges facing each municipality (Thompson, 2017).

There is a level of consensus among specialists in urban governance, sustainable development, and digital planning that it is easier to implement multi-sectoral initiatives rather than having a one-block approach to transforming significant cities and urban centres. Saudi's Ministry of Municipal, Rural Affairs, and Housing is cited as an example, where its Future Saudi Cities Program looks to launch over 50 initiatives across nine sectors in line with the country's vision 2030, including smart parking, smart community management, and smart housing and urban planning among others (Thompson, 2017; Nurunnabi, 2017; Alomi, 2017). Rahman & Qattan (2021) argue that as a staged development, cities and countries could viably replicate Saudi's vision 2030, which includes phased developments through a bottom-up model that focuses on the most urgent issues in each region and then employs technology to offer lasting solutions.

Vision 2030 represents a paradigmatic shift in urban governance, transitioning from traditional petro-urbanism to a diversification strategy rooted in state-led capitalism. Geographically, this is a form of state entrepreneurialism, where the government, via the Public Investment Fund, acts as the primary master developer rather than a mere regulator (Moser et al., 2015). This strategy is deeply situated within the specific political economy of the gulf, characterised by high capital liquidity and centralised decision-making. Consequently, the transferability of this model is limited; while other nations may share the goal of sustainability, few possess the autarchic power to reshape their national geography by executive decree.

The dual approach of retrofitting Riyadh while constructing NEOM highlights the internal logic of Middle East exceptionalism. While the text mentions bottom-up elements in Riyadh, critical scholars argue that gulf urbanism remains fundamentally top-down, driven by the need for a spatial fix to absorb surplus capital (Harvey, 2011; Molotch & Ploger, 2010). This context suggests that the success of Vision 2030 depends less on organic urban growth and more on the durability of the state's financial commitment. Therefore, the model is not easily exported to democratic contexts where urban planning is subject to the friction of public contestation and electoral cycles.

For NEOM, Vision 2030 provides the geopolitical mandate that justifies its radical departure from conventional planning. Unlike the incremental adaptation seen in European or Australian cities, NEOM is the physical manifestation of a policy moonshot, designed to bypass the incrementalism of traditional development. The risk, however, is that this creates a state of exception where the city becomes an enclave of global capital detached from the social reality of the wider Kingdom (Rizzo, 2014). If NEOM relies entirely on this exceptional status, it also risks becoming a sterile spectacle rather than a deeply rooted urban system, replicating the challenges of social integration seen in other gulf megaprojects.

2.3.8.2 *King Abdullah Economic City (KAEC), Saudi Arabia*

KAEC is a mega smart city project in the gulf along Saudi Arabia's Red Sea Coast at an estimated cost of US\$100 billion (Osra, 2017). The city is among a series of planned smart cities to be launched in the desert Kingdom to improve the region among the six dimensions of smart cities, including smart people, mobility, governance, economy, environment, and liveability (Moser et al., 2015). Like other smart cities, KAEC's strategy emphasises the significance of ICT in enhancing the functionalities of its urban system and the advanced transfer of knowledge (Aina, 2017). The planning model is the creation of the Saudi Arabian General Investment Authority, focusing mainly on the energy and transportation industries (Moser et al., 2015; Osra, 2017; Doheim et al., 2019). The industry focus demonstrates that future smart city projects do not necessarily need a holistic approach and can concentrate instead on particular industries in a phased or staggered approach that is economically viable (Moser, 2014; Moser et al., 2015). The first stage of the city was completed in 2010.

KAEC integrates Wireless Sensor Networks, Radio Frequency Identification, and IoT across various smart city applications to develop a smart urban centre. As noted above, focus has been specifically given to energy and transportation. The creation of a smart grid is a key aspect aimed at energy efficiency, integral to which has been the installation of smart meters to provide critical information and education for grid users regarding energy use, enhancing distribution and more efficient energy consumption (Angelidou, 2017). Energy consumption is also addressed in the actual construction of buildings, where the city employs particular architectural properties such as passive cooling systems, high-performance insulation materials, reflective surfaces, and energy-efficient façades to reduce reliance on artificial heating and cooling to construct smart buildings that are energy

efficient, producing less greenhouse gas emissions. Investment has also been made in smart transportation to enhance mobility, including managing traffic flows through traffic light systems fitted with sensors that act on AI (Moser, 2014).

As Doheim et al. (2019) and Aina (2017) highlight, the urban revolution, particularly characterised by rural-to-urban migration, has given rise to a range of issues as populations expand and concentrate in urban centres, including high unemployment rates, waste management challenges, and transportation challenges that can only be solved by the creation of new, smarter cities or the integration of new technologies capable of arresting the current situation. In seeking to be an innovative urban centre that begins to address these issues, KAEC is not without its challenges, and has faced delays in implementation, low occupancy rates, and difficulties in attracting long-term investment and a permanent population base, factors that raise questions about the feasibility and scalability of its original smart city vision (Gugler et al., 2021; Alkhabbaz & Swain, 2015). Additionally, concerns remain about the city's long-term viability in attracting and retaining skilled labour, as well as fostering the vibrant urban life necessary to sustain innovation ecosystems. As KAEC is part of the construction programme across Saudi Arabia that includes NEOM, it forms a particularly interesting comparison as a city further along in its development in terms of both its positive lessons and the struggles it has faced in its implementation. It is to NEOM itself that the next section (2.4) now turns to examine its context and the theoretical framework behind its design.

From a critical geographical perspective, KAEC represents the friction between the imagined city of master plans and the lived city of daily reality. Scholars describe KAEC as an example of speculative urbanism, where the primary value lies in the branding and real estate potential rather than immediate habitation (Moser, 2014). The struggle to attract a permanent population highlights a crucial limit of transferability: while the physical shell of a smart city can be constructed using oil revenues, the social and economic networks that make a city live are historically situated and difficult to manufacture instantly. KAEC's difficulties serve as a stark reminder that urban vibrancy cannot be purely engineered from the top down; it requires an organic stickiness that keeps residents and capital from leaving.

For NEOM, KAEC is the most immediate and critical precedent, serving effectively as version 1.0 of the Saudi economic city model. The transferability here is direct, yet the lessons are cautionary. KAEC illustrates that Middle East exceptionalism; the ability of the rentier state to fund megaprojects indefinitely, has limits. Capital liquidity can overcome physical barriers but not social ones. If NEOM relies on the same governance and economic models as KAEC, it risks replicating its slow growth and ghost city phases. To succeed where KAEC faltered, NEOM's strategy must move beyond infrastructure provision to address the soft infrastructure of social inclusion, regulatory freedom, and cultural vitality that actually attracts global talent. As discussed in Chapter 5, the findings suggest that NEOM's internal discourse explicitly recognises this distinction: stakeholders emphasise that success hinges on soft infrastructure, social inclusion, regulatory and institutional credibility, cultural vitality, and mechanisms that anchor talent beyond short-term incentives, rather than on physical megaproject delivery alone. KAEC, in this framing, operates less as a model to emulate and more as a diagnostic baseline that clarifies the conditions NEOM must exceed if it is to sustain long-term settlement, innovation, and global competitiveness.

2.3.9. Conclusion: The Limits of Best Practice Transfer

Across the cases reviewed in provinces sections, a consistent lesson emerges: "best practice" in smart city development does not travel as a finished template, but as a set of partial ideas, technologies, and governing rationalities that are reworked, sometimes productively, sometimes problematically, when they land in new places. In critical urban geography, this is the central insight of policy mobility: models circulate globally through networks of consultants, corporations, and states, yet are always "translated" by local political economies, institutional arrangements, and socio-spatial conditions rather than simply replicated (McCann & Ward, 2011; Peck, 2011; Söderström et al., 2014). Smart urbanism, therefore, is best understood as a situated socio-technical process: its outcomes depend not only on digital infrastructure but also on governance culture, regulatory capacity, civic norms, and the material constraints of place (Luque-Ayala & Marvin, 2015; Marvin & Luque-Ayala, 2017).

A key comparative distinction in the reviewed cases is between retrofit smart urbanism (e.g., Barcelona and Amsterdam) and greenfield master-planned smart urbanism

(e.g., Songdo, Masdar, Lusail, KAEC, and proposed PlanIT Valley). Retrofit models demonstrate that smartness can be layered into complex, historically sedimented urban fabrics through incremental programs, participatory experimentation, and open data ecosystems (Aurigi & Odendaal, 2020; Capdevila & Zarlenga, 2015; March & Fumaz, 2016). Yet these cases also show that the transferability of participatory governance and digital rights is limited, as such practices rely on deep civic traditions, institutional decentralisation, and legal protections around privacy and transparency (Calzada, 2018; Cardullo & Kitchin, 2019; Kitchin, 2014). Conversely, greenfield projects suggest that integrated sensor networks, district-scale infrastructure, and platform-based governance can be deployed quickly under conditions of high capital availability and centralised decision-making; however, they repeatedly expose the difficulty of manufacturing “soft infrastructure”, urban culture, long-term residency, and civic legitimacy, through design and technology alone (Cugurullo, 2013; Günel, 2019; Moser et al., 2015).

This tension is clearest in cases where data-intensive urbanism collides with local political cultures. Toronto’s Sidewalk Labs controversy illustrates that smart-city technologies are never politically neutral: data extraction, platform governance, and sensor-driven planning activate disputes over accountability, consent, and digital sovereignty (Goodman & Powles, 2019; Valverde & Flynn, 2020). The collapse of the project underscores that technical systems may be mobile, but the institutional “software” required to legitimate them is place-bound, particularly in liberal-democratic contexts where public contestation shapes the limits of corporate urbanism (Peck & Theodore, 2015; Söderström et al., 2014). Related critiques are also central to debates on smart governance more broadly: smart systems can improve efficiency, but they can also intensify surveillance, depoliticise decision-making, and narrow participation if governance remains technocratic and opaque (Cardullo & Kitchin, 2019; Kitchin, 2014).

For NEOM, these comparative lessons sharpen the central analytical point: high transferability of “hardware” does not guarantee transferability of “urban life.” In the gulf, Middle East exceptionalism, often linked to rentier political economy, sovereign wealth funding, and centralised authority, can reduce the “friction” that slows smart projects elsewhere (Molotch & Ploger, 2010). This helps explain why certain platform-based or operating-system imaginaries (as in PlanIT Valley) appear more feasible under conditions of strong state capacity and capital liquidity, even if they stalled in austerity-constrained

contexts (Kitchin, 2015; McCann & Ward, 2011). Yet the same exceptionalism that enables speed and scale also amplifies risks documented across gulf megaproject scholarship: enclave development, splintered infrastructures, weak public accountability, and the production of spectacular but socially thin urbanism (Datta, 2015; Graham & Marvin, 2001; Rizzo, 2014). In other words, removing democratic and regulatory friction may accelerate delivery, but it can simultaneously remove safeguards that support long-term legitimacy, inclusion, and civic trust (Cardullo & Kitchin, 2019; Kitchin, 2014).

The reviewed cases also reveal that “best practice” often reflects context-specific problem framings rather than universal solutions. Durban’s sectoral and modular climate approach demonstrates “actually existing” smart urbanism under conditions of institutional fragmentation and resource constraints, an adaptive logic that differs markedly from totalising master-planned models (Datta, 2015; Odendaal, 2011; Roberts, 2010). Curitiba similarly shows that feedback infrastructures and service platforms work when embedded within durable participatory cultures; without civic trust, imported interfaces can become hollow “zombie” systems with low uptake and limited legitimacy (Söderström et al., 2014). These cases matter for NEOM because they suggest that resilience is not only a function of integrated technology, but of institutional flexibility and socio-political embedding, qualities that cannot be engineered solely through design.

Finally, the Middle East exemplars (Masdar, Dubai, Lusail, and KAEC) collectively caution against equating high-tech sustainability narratives with delivered outcomes. Masdar has been widely interpreted as an emblem of eco-modernisation: a technical enclosure that performs sustainability through design and branding, while struggling to realise full social and demographic vitality at scale (Cugurullo, 2013; Günel, 2019). Dubai illustrates entrepreneurial statecraft and fast-policy urbanism, where global technologies are imported rapidly to maintain competitiveness, yet such speed is tied to specific labour regimes and governance models that may not translate beyond the region (Acuto, 2010; Molotch & Ploger, 2010). KAEC most directly foregrounds the challenge NEOM must confront planned smart cities can build infrastructure quickly, but they often struggle to attract stable populations and self-sustaining economic ecosystems, demonstrating the limits of speculative urbanism when “cityness” is assumed to follow from real estate and megaproject form (Moser et al., 2015; Doheim et al., 2019; Moser, 2014).

Taken together, these cases suggest that NEOM should be framed not as the recipient of transferable “best practices,” but as a site where globally circulating models will be selectively reassembled under distinctive Saudi governance logics, environmental conditions, and socio-political realities. The most defensible lesson, therefore, is methodological: smart city learning must proceed through critical adaptation rather than imitation. This means treating global exemplars as comparative experiments, useful for identifying design principles, institutional mechanisms, and risk patterns, while recognising that transfer requires translation across political economy, civic culture, and ecological constraint (Luque-Ayala & Marvin, 2015; McCann & Ward, 2011; Söderström et al., 2014). For NEOM, the decisive challenge is not whether advanced technologies can be imported, but whether an urban system can be produced that is socially durable, institutionally legitimate, and environmentally resilient conditions that “best practice” alone cannot guarantee.

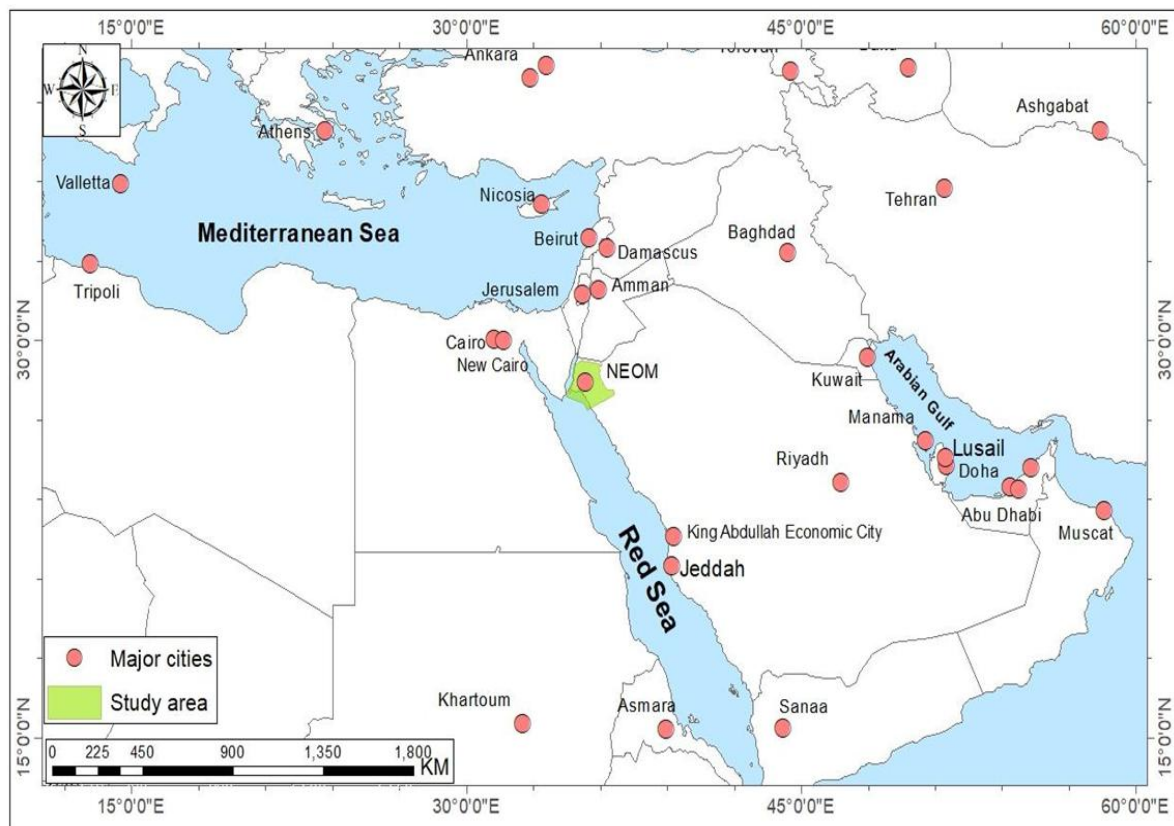
2.4. NEOM Context and Its Theoretical Framework

2.4.1. Introduction

Thus far, the chapter has engaged with the pertinent literature on how a smart city might be defined and examined the key lines of argumentation as to the factors that can be determined as constituting the characteristics or dimensions of a smart city, before considering how these are manifest in a selected set of smart cities across the globe. The purpose of this section is to situate NEOM within what has emerged from the literature regarding measuring the dimensions of a smart city and against the background of the examples of current smart cities discussed above. This aims to provide a preparatory evaluation of how NEOM may fulfil the requirements of a smart city, and to what extent, based on the available literature on NEOM's plans, which is then tested by the qualitative aspect of the research, as discussed in Chapter 4. NEOM City has been introduced in detail in Chapter 1, but before engaging with the main pillars of its smart design, a brief overview of its conception and underlying rationale is offered below to give context to the discussion.

The idea of developing NEOM was initiated by Crown Prince Mohammed in 2017 as a central part of the Saudi Vision 2030. It is intended to make a step towards the diversification of the entire economy by constructing a connected urban centre comprising smart towns, cities, ports, enterprise areas, research centres, cultural, sports and entertainment areas, and tourist resorts (NEOM, n.d.). As depicted in Figure 15 below, NEOM City is a major construction project that will span an area in the Tabuk province in northwest Saudi Arabia, bordering the Red Sea, Egypt, and Jordan (Madakam & Bhawsar, 2021). The project comprises 26,500 km² of undeveloped land, together with 500 km of seashore, and is estimated to cost a total of US\$500 billion (Alam et al., 2021). The primary intention is for NEOM to intelligently respond to the challenges faced by urban living globally, thereby becoming a worldwide hub for commerce, innovation, knowledge, and sustainability (Algumzi, 2022).

It is anticipated that the metropolis driven by AI would stimulate diversification. Its developers have set a goal of adding 380,000 jobs and US\$48 billion to the domestic GDP by 2030 (Burbano, 2022). NEOM will be built from scratch on greenfield lands, providing it with a unique opportunity to stand out from other established locations (Algumzi, 2022).

Figure 15*Map Location of NEOM City*

Source: Adapted by the author from SANSRS (Saudi Arabia National Spatial Reference System Implementation Guidelines, 2022).

As a smart city, NEOM is planned to be driven by clean energy and built and designed in a way that achieves zero carbon emissions (NEOM, 2022c). AI is poised to play a central role in connecting the various communities of the metropolis and managing the diverse systems and services.

The scope of NEOM is highly ambitious, from the proposed vertical structure of The Line, futuristic forms of public transportation, an industrial area “Oxagon”, where people, technology and industry will come together in harmony with nature (NEOM, 2025a; see Figure 16), a technologically advanced security infrastructure (Frag, 2019), to a proposed ‘cloud seeding’, which looks to the production of artificial clouds by means of technology to increase the amount of rain that can naturally occur (Sansom et al., 2022).

Figure 16*Overview of NEOM's Oxagon***Source:** NEOM.com

Hassan (2020) frames the goal of NEOM, as one of the largest urban construction initiatives ever attempted, as being to revolutionise how people conceive, design, build, plan, implement, use, and reuse capital projects. Accomplishing this, as Alhefnawi (2022) rightly observes, requires an ecosystem of unsurpassed performance and efficiency outcomes that takes into account the speed of implementation, maintaining a sustainable environment, retaining talented individuals, and conserving resources.

This brief outline sets the scene for a more detailed exploration of the core pillars around which, according to the available literature, NEOM is being designed to examine how its stated aims match particularly with the measures determined by the Boyd Cohen Smart City Wheel, and reflect the practices already identified as effective in the existing smart city examples.

2.4.2. Boyd Cohen's Smart City Wheel and NEOM's fifteen pillars

In line with the literature reviewed thus far, it is a reasonable deduction that to ensure that NEOM becomes an ideal smart city, the NEOM project should carefully consider each aspect of the BCSCW (Govada et al., 2017; Ondiviela, 2021). As already noted, according to the BCSCW, a smart city should manifest smart facets in areas related to government, the economy, people, living, mobility, and the environment. Thus, regarding smart government, the NEOM project should consider open government, infrastructure, and online services. A smart economy is reflected in opportunity, productivity, and local and global interconnectedness (Ondiviela, 2021). Smart people should show a level of education, inclusivity in their society, and creativity, which should be accompanied by smart living that encompasses health, safety, and well-being (Qonita & Giyarsih, 2022). In smart mobility, NEOM should show mixed modal access, clean mobility, and integrated ICT (see Table 2). To achieve a smart environment, the NEOM project should uphold sustainable urban planning, resource management, and smart building (Madakam & Bhawsar, 2021).

Table 2*Dimensions and Working Area of a Smart City*

Dimension	Working area
Smart environment	Smart Buildings.
	Resource management.
	Sustainable urban planning.
Smart mobility	Efficient transport.
	Multi-modal access.
	Technology infrastructure.
Smart governance	Online services.
	Infrastructure.
	Open Government.
Smart economy	Entrepreneurship and innovation.
	Productivity.
	Local and global connexion.
Smart people	Inclusion.
	Education.
	Creativity.
Smart living	Culture and well-being.
	Safety.
	Health.

Source: Adapted by the author from Cohen (2013)

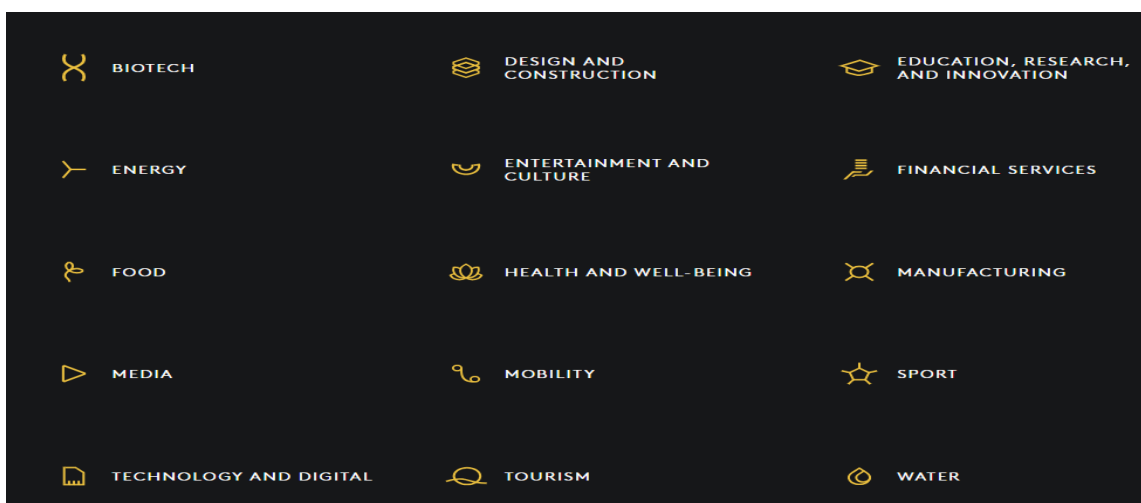
Theoretically, realising each point from the BCSCW would help in establishing the smart city of NEOM. However, a qualification needs to be made at this point: while there are aspects (e.g., smart building and smart environment) that can be measured and achieved during the initial processes, there are other aspects (e.g., happiness, creativity, and an inclusive society) which cannot be measured until NEOM is constructed and residents are living there (Alamoudi et al., 2022). Accordingly, it is not possible to fully assess whether the future city of NEOM is compatible with BCSCW until the smart city is finished and it can be tested in practice (Greco & Bencardino, 2014). Hence, it is only possible to consider whether decision-makers are working towards realising the maximum number of aspects mentioned in the BCSCW. This, in turn, requires understanding the pillars of the NEOM

economy and how each pillar should be addressed in light of the BCSCW and related literature (Nuseir et al., 2020).

The key pillars of the NEOM economy are as follows: Biotechnology; Design and Construction; Education, Research and Innovation; Energy; Entertainment and Culture; Financial Services; Food; Health and Well-being; Manufacturing; Media; Mobility; Sport; Technology and Digital; Tourism; and Water (see Figure 17). Each of these pillars is discussed in turn to explore how the NEOM project can benefit from the already completed projects of smart cities around the globe to realise each one of its key pillars and to highlight whether achieving each pillar would satisfy the requirements of the BCSCW (Madakam & Bhawsar, 2021). The literature reviewed for this exploration largely comprises official NEOM planning documents, Vision 2030 policy frameworks, feasibility reports, academic studies, expert interviews, and public-facing promotional material. While some of the available information originates from government-backed communications and marketing channels, these sources still provide valuable insight into the strategic intentions behind NEOM's development. In parallel, a growing body of academic literature has begun to critically assess NEOM's planning model, its techno-economic narratives, and the feasibility of its smart city ambitions (e.g., Madakam & Bhawsar, 2021; Nuseir et al., 2020).

Figure 17

Key pillars of NEOM economy



Source: NEOM.com

Biotechnology

The city aspires to become a hub where innovative projects are translated into technologies that meet global needs (Alqahtany, 2025; Saudi Vision 2030, n.d.a). A particular focus for NEOM is on the biotechnology sector, which, according to the official documents (NEOM, 2022c; ENOWA Water, 2023), is dedicated to addressing significant human and environmental health challenges by establishing a cutting-edge biotech innovation ecosystem, built upon world-class infrastructure, stringent regulatory standards, and global partnerships (NEOM, 2024a). As a key part of Saudi Arabia's National Biotech Strategy to advance biotech innovation, the NEOM Investment Fund is set to back transformative ventures across medical, agricultural, and industrial biotechnology sectors. This strategic investment aims to cultivate a thriving biotech ecosystem within NEOM, bolstered by a global network of innovators (NEOM, 2024a) and other global partners to establish local research, development, and manufacturing capabilities. Alongside innovation, the intention is to scale new industrial biotechnologies.

The city plans to tackle global healthcare challenges, including antimicrobial resistance and treatments for heart and metabolic diseases. The goal is to develop an ecosystem for the fast integration of innovations into health practice would allow the NEOM to serve as a home to both aspiring and existing enterprises in the biotechnology industry (Madakam & Bhawsar, 2021) for research into the understanding of human health and illness, as well as to advance the diagnosis and treatment of present and subsequent generations. According to Bulgariu and Bulgariu (2017), biotechnology research is an investment in the world's long-term economic health, and due to the attractiveness of leading and developing research, cooperation, and the application of new technologies, NEOM is positioned to become a worldwide centre for the biotechnology industry of the future (Denning, 2017; Farag, 2019; NEOM, n.d.).

In terms of the environment, NEOM is looking to encourage innovation towards a more sustainable and resilient world (NEOM, n.d.), which includes developing genetically improved plants suitable for desert environments and advancing synthetic biology. Biotechnology may make it possible for intelligent cities to build developments and adopt ways of living that do not depend on the use of fossil fuels (Eisenstein, 2016). The

availability of abundant renewable energy in NEOM also supports the development of biofuels using cell engineering (Saudi Vision 2030, n.d.a).

In summary, the focus of NEOM's biotechnology sector is on becoming a global leader in biotech innovation, addressing critical health and environmental issues through strategic investments, partnerships, and infrastructure development. These may be laudable and highly valuable ambitions but are still not without potential challenges in terms of the technology itself. For example, as the development of biotechnology would require the adoption of considerable Big Data from IoT devices, this could raise concerns about cybersecurity (Luh & Yen, 2020). Moreover, ethical concerns might be raised on matters concerning gene mutation and thus hamper the marketing plan (Bulgariu & Bulgariu, 2017).

Energy

It might be argued that all six core aspects of a smart city are related in some way to systems for energy and power. In this respect, the plans for NEOM look to a high level of technological innovation and sustainability. The aim is for the city to achieve unprecedented increases in solar and wind energy capacity, offering competitive pricing comparable to other renewable sources (Albalawi et al., 2019). Through the large-scale production of green hydrogen, NEOM intends to establish a new enterprise that contributes to the next wave of the global energy revolution (Boretti, 2022). By leveraging clean energy at a low cost, NEOM aims to develop energy-intensive industries capable of leading on a global scale while ensuring a fully carbon-neutral energy ecosystem from the ground up. To support its vision, NEOM will feature an advanced transmission and distribution network equipped with state-of-the-art technology (Denning, 2017). The city will also serve as a hub for research and development, fostering innovation through collaboration between academia, technological advancements, and new business ventures. This ecosystem is planned to create a conducive environment for innovation and sustainable economic growth, making NEOM a pioneer in clean energy solutions. This foundational energy strategy could highlight the advantage of building a city from scratch, where possible, allowing planners to integrate zero-carbon infrastructure into every layer of urban development, from mobility systems and building designs to data centres and water desalination. Here, a useful comparative lesson emerges from Masdar City, which similarly sought to run entirely on solar power. Although Masdar pioneered this approach, its limited scale and challenges with

population retention reveal that technical innovation alone is insufficient without broader socio-economic integration and long-term liveability planning (Cugurullo, 2016).

Water

NEOM targets to become a global leader in water production, desalination, and storage, ensuring an integrated water value chain. The city's water infrastructure will rely exclusively on renewable energy to achieve 100% desalination with zero CO₂ emissions and no brine effluent, thereby preserving the natural ecosystem (Rezk et al., 2020). The purified seawater will produce brine containing valuable minerals and compounds, while NEOM's wastewater treatment systems will generate electricity, fertiliser, and clean irrigation water (Denning, 2017; Farag, 2019). This holistic approach aims to promote waste reduction and establish a fully circular water and wastewater system.

To minimise water wastage, NEOM's distribution network will be fully integrated with cutting-edge Internet of Water technology, enabling real-time monitoring and efficient management (Riera et al., 2022). Like Masdar City, Abu Dhabi, which employs smart water meters and low-flow appliances to reduce consumption (Randeree & Ahmed, 2019), NEOM will empower its residents to track their water usage and receive alerts for unusual consumption spikes, thus preventing resource wastage (Boretti & Castelletto, 2022).

NEOM's desalination and water recycling initiatives align with global best practices, as seen in Singapore's water management strategy, where desalinated and recycled wastewater constitute significant portions of the city's supply (Senthilingam, 2014). By adopting proven water conservation technologies, NEOM aims to provide sustainable water access to its future population (Alshehri et al., 2021; Fallatah, 2019).

Mobility

NEOM proposes to approach mobility from the broadest of definitions that will include international, regional, and urban linkages by sea, air, and land (NEOM, 2022c). The mobility agenda includes the establishment of a port to stimulate international trade with NEOM and the opening of an intermodal gateway with the territory immediately around NEOM (Nuseir et al., 2020). As noted in Chapter 1, NEOM is planning the most advantageous air link possible with the rest of the world with an airport designed to serve as a worldwide technology benchmark for an integrated travel experience that is centred on the needs of the customer (Denning, 2017; Farag, 2019; NEOM, 2022c). To eliminate congestion and provide a smoother arrival experience, the architectural landmark airport is being biometrically processed (NEOM, n.d.). NEOM is recognised as offering a global reference in the management of human and unmanned air traffic for the sake of public health, safety, and environmental policy, which are an integral part of BCSCW.

NEOM aims to construct the world's first supply chain that is intelligent and autonomous, to facilitate the smooth management of commodities for both its people and the businesses that operate within the city (NEOM, n.d.). All of this will be orchestrated by NEOM using AI, towards becoming a primary global trade hub (Hassan, 2020). When compared to Singapore, NEOM appears to have leveraged the lessons learned on smart mobility. Joo (2023) noted that Singapore is keen on utilising AI to not only enhance road safety but also reduce traffic congestion. The role of AI seems indisputable in enhancing mobility, especially taking into account the increased utility of big data. Such was also the case in Curitiba, where, using AI, the city was able to roll out its Bus Rapid Transport System (Antonialli et al., 2022). In this regard, it seems to hold that NEOM City should indeed be able to deliver smart mobility on account of leveraging the lessons from other cities. By making a comparison with the requirements of mobility as set out in BCSCW, it could be deduced that decision-makers are also capable of assuring clean non-motorised options for NEOM.

Health and Well-being

If we were to take the BCSCW dimension of smart living, which needs to encompass ensuring health and safety in a technologically advanced environment, we might point to

the integrated systems and access to healthcare envisioned in NEOM as aligning with this principle. NEOM plans to implement digital health infrastructures such as AI-assisted diagnostics, telemedicine services, wearable health monitoring devices, and predictive healthcare analytics, all of which aim to provide accessible, preventative, and personalised medical care (NEOM, 2022c; ENOWA Water, 2023). This could also be extended to NEOM's approach to energy and water in terms of ensuring public health and safety. However, the concept of happiness, or in this case, we might say well-being, a key factor in smart living, remains subjective and cannot be replicated from other cities (Farag, 2019). Unlike physical infrastructure, happiness is deeply psychological, requiring unique policy interventions to enhance quality of life in NEOM (Kamel Boulos et al., 2015; Zhu et al., 2022). Thus, decision-makers in Saudi Arabia must consider tailored strategies to foster well-being, making happiness a fundamental part of NEOM's smart living ecosystem.

In addition to this, NEOM places a strong emphasis on the ecology that is interwoven to promote health and well-being (NEOM, n.d.). NEOM intends to take a global lead in health and welfare by developing an environment that encourages healthy lives and is positive and individualised for providing top-tier illness treatment using machine learning and the IoT (Farag, 2019; Quasim et al., 2019; Khan, 2020). Real-time evaluations of patients' conditions will be made possible thanks not only to genetic and other advanced technologies but also to AI (Hassan, 2020). In addition to the extensive wellness services that are provided at the health resorts, a network of global specialists and centres of excellence will be set up, following best practice to provide luxurious medical care.

Food

NEOM aims primarily to make use of genomic technologies in a variety of different ways in terms of its approach to food supply and security. For instance, in the field of aquaculture, the few species that have been tamed and domesticated are not indigenous to the Red Sea (NEOM, n.d.), which generates dangers for the surrounding environment. This could be addressed by making use of genetic information to accelerate the domestication of species from the Red Sea by picking those characteristics that are most suited for this goal. In addition, the effects of climate change pose a risk to the agricultural systems that we use across the world, including for NEOM, which is located in a desert environment (Alhefnawi,

2022). As a result, the city's agricultural sector will have a critical need for newly discovered species or kinds that are resistant to salt or drought (Al-Sayed et al., 2022). However, NEOM's first focus will be on gene-editing technologies. This implies that the company will initially work toward the goal of modifying the sequences of genes that already exist inside the plant's genome or controlling the expression of those genes.

The architects and builders of NEOM acknowledge that taking a circular approach to business is one of the essential steps toward achieving sustainable growth (Ansari et al., 2022). This is because the application of circularity requires the adoption of solutions throughout the supply chain to minimise, reuse, recycle, and recover resources and materials (Ansari et al., 2022). This is of utmost significance in desert conditions, where biological matter ought to be regarded as a valuable resource. In addition to NEOM's efforts to repurpose and recycle packaging, the city will place a significant amount of emphasis on reducing food waste while simultaneously optimising the amount of organic waste that is converted into agricultural inputs. For NEOM, this seems to be in alignment with emerging global best practices in smart city food systems. For instance, Singapore's "30 by 30" strategy integrates genomics, vertical farming, and AI-driven analytics to enhance food resilience within a land-scarce urban environment (Yuen, 2021). In the gulf region, Masdar City experiments with saline hydroponics and desert-adapted agriculture, offering context-specific lessons in food production under extreme environmental conditions (Cugurullo, 2016). These comparative examples reinforce the relevance of NEOM's proposed strategy. By combining genetic innovation, circular economy principles, and smart Agri-tech solutions, NEOM articulates a coherent and forward-looking food security model that is both technologically advanced and ecologically responsive.

The term smart agriculture is frequently applied on a worldwide scale to encourage companies and academic institutions to create more efficient methods of food production by leveraging technological advances to combat issues of food insecurity (Viljoen et al., 2015). A technological response to the issue of agricultural sustainability, smart agri-tech solutions sit alongside other eco-efficiency approaches such as genomics, nanotechnology, genetic modification, and computerisation (Alex et al., 2021). The smart agri-tech solution offers a technological approach to the challenge of agricultural sustainability. However, as Viljoen et al. (2015) argue in their critique of large-scale urban agricultural schemes,

ambitious projects often encounter ecological, social, and governance constraints, suggesting the need for caution when envisioning transformative urban developments such as NEOM. Freidberg (2014) noted that technological advances often face criticism from persons who do not fully appreciate the innovation and thus the issue becomes more socio-political rather than purely technological.

Manufacturing

Designing the future of manufacturing is a crucial component of the NEOM journey, which aims to create the region's leading zone for advanced and clean industries by utilising state-of-the-art approaches such as Industry 4.0 and the circular economy to assist in the creation of the factories of the future (NEOM, n.d.). Industry 4.0 draws on the automation and digitisation of what has been called the Third Industrial Revolution, but with a focus on strengthening the interconnection of machines and systems rather than the former two aspects (Rashed & Mahmoud, 2018). In essence, the means of developing factories that are capable of self-optimisation and adaptation. The "clean" dimension of NEOM's manufacturing vision is guided by circular economy principles, emphasising the elimination, recycling, and reuse of materials at every stage of production (Komnitsas, 2011; NEOM, n.d.). This is particularly relevant to the smart environment pillar of BCSCW, which promotes resource efficiency and ecological balance in industrial ecosystems. NEOM also proposes an industrial symbiosis model, where the waste outputs of one plant become the inputs for another, mirroring closed-loop systems seen in cities such as Barcelona has developed the 22@Barcelona Innovation District, a space dedicated to smart manufacturing and digital industry clusters, supporting agile production ecosystems and clean technologies through cross-sector innovation (March & Ribera-Fumaz, 2016). Similarly, Singapore's Jurong Innovation District integrates Industry 4.0 facilities, R&D centres, and start-ups into a cohesive urban-industrial landscape, supported by smart logistics and sustainability frameworks (Yigitcanlar et al., 2020). These precedents reinforce the viability of NEOM's vision, where advanced manufacturing is not only a driver of economic productivity but also a core mechanism for embedding sustainability and technological resilience into the city's DNA.

Media

NEOM is set to have the world's first physically and technologically integrated hub focused on digital publishing, gaming, and screen production (Al-Gasawneh & Al-Adamat, 2020). This will result in the establishment of a new centre for these industries in the wider Middle Eastern region. According to the documents published by NEOM, there are four primary areas of concentration that are now under consideration (NEOM, 2022c). The first is increasing capabilities in terms of physical infrastructure and services, with the end goal of becoming the most advanced organisation in terms of the facilities and technology that are merged into a single creative campus in the centre of NEOM (NEOM, n.d.). The second is having clearly defined incentives and a cost advantage. While cost advantage aims to ensure NEOM is competitive on a worldwide scale, financial and production incentives across the value chain are designed to attract existing enterprises and smart start-up financing. This should assist in the development of a well-balanced ecosystem and an operational basis that delivers both financial competitiveness and operational efficiency for businesses.

The third priority is the cultivation of labour and the expansion of capacity, both of which are controlled in collaboration with industry (NEOM, n.d.) and by building relationships and curriculums with some of the most prestigious institutions of artistic, technical, and vocational education in the world. This should provide the competent workforce pool demanded by the sector (Al-Gasawneh & Al-Adamat, 2020). The fourth and final focus is on ease of business and accessibility, which aims to create a seamless and industry-centric approach for individuals and organisations across all the points where there is interaction with the government (NEOM, n.d.). The creators of NEOM consider that if successful in fulfilling these four goals, NEOM aims to be able to separate itself from its regional rivals and place itself on par with global industry centres.

Whereas the insights provided by NEOM creators allude to revolutionary media infrastructure, nothing specific, in terms of technology, has been offered to distinguish it from what other smart cities currently offer. Nevertheless, suppose the developers do provide facilities much like those available in Dubai City. In that case, it is then arguable that NEOM would be able to offer high-level media services to its prospective media practitioners.

Entertainment and Culture

As with the above area, it seems that NEOM is largely following in the footsteps of cities like Dubai in their approach to entertainment in particular, where technology will offer a high degree of individualisation and sensory experience (Denning, 2017) in a various range of activities, whether that is playing games, shopping, watching a film, or even going to the library.

NEOM's strategy proposes a hyper-curated entertainment ecosystem that leverages AI, AR/VR, and real-time behavioural data to tailor experiences for individual users while ensuring inclusivity across age groups and demographics (NEOM, n.d.). Cultural programming is anticipated to include a network of museums, theatres, music venues, digital art platforms, and cultural festivals, many of which will be integrated into The Line, Oxagon, and Trojena, each acting as nodes in a digitally connected cultural infrastructure.

This strategy speaks directly to the BCSCW dimensions of smart people and smart living. The smart people pillar emphasises creativity, diversity, and inclusivity, all of which are supported by NEOM's vision of a multicultural, technologically empowered society that promotes access to high-quality cultural experiences. Meanwhile, the smart living dimension centres on quality of life, well-being, and cultural vitality, all of which are enhanced by NEOM's goal to provide open-access creative spaces, digital libraries, smart art installations, and wellness-oriented public events (NEOM, n.d.).

Comparative models can be found in Barcelona, whose Ciutat Vella cultural district uses urban regeneration and digital platforms to enhance public access to art (Tetuà, 2019), and Seoul, which employs smart technology in its Dongdaemun Design Plaza and Smart Museum Project to integrate interactive digital experiences into cultural venues (March & Ribera-Fumaz, 2016; Kwak & Lee, 2023). These examples illustrate how entertainment and culture, when embedded into smart city frameworks, can drive not only tourism and economic development but also civic engagement and social cohesion. NEOM's approach, if implemented with attention to cultural authenticity and accessibility, may thus position it as a leader in technologically integrated creative urbanism.

Technology and Digital

The fact that Saudi Arabia has granted citizenship to the first humanoid robot, known as ‘Sophia’, is quite intriguing (Walsh, 2017), demonstrating that Saudi Arabia is highly receptive to new technologies and is also very proactive in adopting them. The government of Saudi Arabia has the ambitious goal of turning NEOM into a ‘town of robots’, which would make it the first town in the world to have more robots than humans, so establishing its reputation as a metropolis of the future (Web Desk, 2024). Robots will be used for things like providing security, deliveries, and helping in healthcare. However, the techno-utopian appeal of cities populated predominantly by robots has been met with academic scepticism. Social science research indicates that integrating robots into urban spaces can provoke anxiety, alienation, and diminished community belonging, thereby challenging assumptions about seamless human–robot coexistence (Savela, 2024). Furthermore, critics argue that smart-city narratives frequently overstate technological promise while neglecting ethical, governance, and equity concerns (Ahmad et al., 2020). Empirical studies additionally highlight unintended consequences of humanoid service robots, such as customer confusion, reduced interpersonal trust, and altered patterns of human interaction, complicating simplified visions of robotic urban futures (Wang et al., 2024). Collectively, these critiques underscore the importance of a cautious, contextually grounded approach when engaging with claims about robot-dominated cities.

The notion of the smart city is predicated on the utilisation of information (Alam et al., 2021). Big data analytics are playing an increasingly important part in the strategic planning process, where the integration of big data analytics and smart city solutions helps cities enhance the management in crucial areas, from managing traffic flows, the efficient distribution of electricity, to linking government programmes while simultaneously immersing individuals in public governance, to delivering personalised services.

The analysis of large amounts of data is necessary for the operation of smart city programmes. The IoT generates massive databases that need to be analysed and saved before smart city activities can be implemented (Kaur & Maheshwari, 2016). NEOM will use edge computing technologies, which allow immediate data analysis at or near the source, significantly reducing latency and improving response times. In tandem, cloud computing

ensures scalable storage and centralised processing, enabling city-wide monitoring and control. NEOM also intends to use digital twin technology, creating dynamic virtual models of physical infrastructure to simulate, predict, and optimise system performance, from energy flows and transportation networks to emergency response scenarios (NEOM, 2022c).

To support city-wide integration, NEOM is building a cognitive digital platform that employs artificial intelligence (AI) and machine learning to analyse big data and generate predictive insights for policy and operations (NEOM, n.d.). These technologies underpin applications such as adaptive traffic management, precision environmental monitoring, and personalised healthcare. Moreover, blockchain technology is being considered for secure, decentralised data management, especially in areas like identity verification, smart contracts, and transparent service delivery (NEOM, 2022c). A city-wide open-data architecture and interoperable digital fabric will connect these systems, facilitating real-time communication between public services, businesses, and citizens

In the technology employed, NEOM is not just envisioned as a ‘smart’ city but also a ‘cognitive’³ or ‘predictive’ one (Al-Sayed et al., 2022). The cognitive city is constructed on three pillars: the capability for residents and businesses to connect digitally to physical objects; the capability to compute or analyse those things; and the capability to contextualise, utilising that connectivity to support future decisions (Saeed et al., 2022). This move beyond concepts of smart to cognitive would seem to indicate, in terms of the requirements underlined in the BCSCW, that decision-makers are capable of assuring there will be mixed modal access and integrated ICT throughout NEOM.

According to Kamruzzaman (2021), the Smart City Networking Model can be applied to address key challenges in IoT systems, including data storage, edge processing, data ingestion, cloud computing, and data visualisation. Also, Kamruzzaman (2021) indicated that 6G WPAN network lightweight security could be used in NEOM to connect the city to the world. The literature on smart city frameworks, such as the BCSCW model

³ The term “cognitive city” first appeared in Marcos Novak’s 1997 essay, which envisioned intelligent urban environments shaped by ubiquitous computing and ambient intelligence (Novak, 1997).

(Petrova-Antonova & Ilieva, 2019), highlights the importance of aligning technological needs with integrated ICT systems and mixed-modal access to support urban connectivity.

Financial Services

NEOM's vision for financial services aligns strategically with the smart economy aspect of smart city frameworks, focusing on technological innovation, digital transformation, and global competitiveness (Cohen, 2013). As a futuristic economic hub, NEOM seeks to develop a technologically advanced financial ecosystem that employs blockchain technologies, AI-powered financial analytics, and decentralised finance models (NEOM, 2022c). These innovations aim to promote a digital economy characterised by transparency, efficiency, and inclusivity. By integrating smart banking infrastructure and fintech capabilities into its urban landscape, NEOM hopes to attract international investors, fintech entrepreneurs, and multinational corporations, thus fostering a resilient and adaptable financial sector. This strategy mirrors initiatives already underway in other prominent smart cities, such as Singapore's Smart Financial Centre and Dubai's blockchain-enabled government services, which demonstrate how digitally integrated finance can become a foundation for sustainable urban economic growth (Alawadhi et al., 2012; OECD, 2020).

Sport

NEOM's strategic focus on sport represents a distinctive intersection between the dimensions of smart living and smart economy within BCSCW (Cohen, 2013). The project outlines an ambitious agenda to integrate sports with advanced technologies, including the development of AI-assisted athletic performance platforms, immersive virtual reality (VR) sports experiences, and smart stadium infrastructure equipped with sensor networks and real-time analytics (NEOM, n.d.). These initiatives are not only designed to position NEOM as a global hub for professional and e-sports events but also to promote wellness, recreation, and quality of life, thereby reinforcing the liveability of the city.

According to NEOM's website (NEOM, n.d.), sport is explicitly framed as a driver of both economic diversification and citizen well-being, two pillars central to the Smart Economy and Smart Living dimensions. This integration goes beyond conventional urban sporting infrastructure by embedding sport into a broader digital and economic ecosystem,

supported by AI, IoT, and immersive media technologies. While other smart cities such as Singapore and Amsterdam have integrated sport and wellness initiatives into urban planning (Alawadhi et al., 2012; Caragliu et al., 2011), NEOM's approach appears more radical in scale and ambition. Its vision incorporates not only health and recreation but also commercialisation of sports tech, talent incubation, and the hosting of international mega-events, including e-sports tournaments.

Recent studies highlight the evolving role of sport within smart-city frameworks, positioning it as both a lifestyle enabler and a contributor to urban economic development (Orłowski & Parsamyan, 2023). Scholars argue that the integration of ICT, AI, and data-driven management systems is transforming traditional urban sports provision into innovation-led and globally networked ecosystems (Orłowski & Parsamyan, 2023; Tjønndal & Nilssen, 2019). Within this context, initiatives such as NEOM frame sport as a strategic urban function that supports health, livability, and economic competitiveness, aligning with broader smart-city objectives of sustainability, inclusivity, and technological advancement (NEOM, n.d.).

Tourism

As already highlighted in Chapter 1 (see section 1.2), as a unique global destination, NEOM seeks to redefine tourism through sustainable luxury, eco-tourism, and immersive cultural experiences such as augmented reality heritage trails, AI-guided ecological tours, and personalised itineraries driven by user data analytics (Denning, 2017; NEOM, 2022c) (Denning, 2017). Smart hospitality services align closely with the smart living and smart economy dimensions of BCSCW (Cohen, 2013). AI-driven personalisation and interactive travel experiences will cater to high-end travellers while preserving NEOM's natural landscapes. Inspired by Dubai's tourism model, NEOM could offer futuristic attractions and focus on visitor experiences that tie in with the natural environment and cultural and heritage narratives (Farag, 2019).

Education, Research, and Innovation

NEOM aspires to become a global knowledge hub by investing in cutting-edge research and education. Collaborations between leading academic institutions, research centres, and

industry leaders will drive advancements in AI, biotechnology, and digital innovation (Madakam & Bhawsar, 2021). By focusing on lifelong learning and skill development, NEOM will cultivate a workforce capable of driving the Fourth Industrial Revolution. However, while this emphasis on adult education and upskilling is vital, a truly holistic and future-proof educational strategy must also encompass foundational education, particularly for children. NEOM's vision of education includes the creation of technologically advanced, future-oriented schools that move beyond conventional teaching models. These schools are expected to feature smart classrooms equipped with AI, augmented reality, and data-driven personalised learning systems (Saudi Press Agency, 2023). Learning is envisioned as project-based, interdisciplinary, and experiential, nurturing creativity, curiosity, and collaboration from a young age (Levin, Semenov, & Gorsky, 2025).

This approach is closely aligned with the smart people dimension of BCSCW, which emphasises not only high levels of education and training but also creativity, openness to lifelong learning, social inclusion, and active participation in civic life (Cohen, 2013; Bibri & Krogstie, 2020). By embedding these principles within both adult and childhood education, NEOM is positioning itself to produce not just a highly skilled workforce but an innovative, resilient, and socially conscious citizenry. Early integration of sustainability themes, circular economy principles, and digital civic engagement within school curricula ensures that future generations are equipped to contribute meaningfully to NEOM's broader smart and sustainable development goals (Aldusari, 2023; Sumra et al., 2025). In this way, NEOM's educational model seeks to transcend traditional boundaries, offering a systemic and lifelong framework for human capital development.

Design and Construction

NEOM aims to revolutionise design and construction through advanced digital twin technology, prefabrication, and AI-driven automation (Denning, 2017). Sustainable materials, energy-efficient buildings, and smart infrastructure will be core to its urban planning (Farag, 2019). By integrating innovative construction methods, NEOM will minimise environmental impacts while ensuring rapid urban development. This mirrors innovations seen in cities like Singapore, where digital twins inform energy-efficient planning, and Amsterdam, where smart buildings adapt to real-time conditions (Tan &

Taeihagh, 2020; Bibri & Krogstie, 2020). Masdar City also offers clear echoes, particularly in its use of passive design and low-carbon mobility.

NEOM integrates these global practices into a unique model that aligns closely with BCSCW. Its use of sustainable materials and intelligent infrastructure supports the smart environment pillar; rapid, integrated construction enhances smart mobility; and sensor-rich, adaptive buildings contribute to smart living. Collectively, these strategies position NEOM as not only technologically advanced but also environmentally responsive and human-centred, hallmarks of a future-ready smart sustainable city.

Overall, from what NEOM documents have outlined regarding the design intentions, the fifteen pillars seem to represent a comprehensive covering of the ‘working areas’ of the BCSCW. Notably, there is an emphasis on biotechnology not seen in other smart cities, which may reflect the more overt aim of being a sustainable smart city, looking to technology to counter rising environmental challenges. From the other examples of smart cities, like Masdar, where renewable energy and passive urban design have been central to smart system integration (Reiche, 2010), and Singapore, which has developed smart grids and energy-efficient infrastructure as part of its Smart Nation strategy (Yeo, 2022), NEOM has likewise made renewable energy, particularly green hydrogen and zero-carbon infrastructure, a central feature of its planning model (NEOM, 2022c).

Furthermore, as in other global smart cities that have capitalised on luxury and nature-based tourism, such as Dubai or Barcelona, NEOM integrates wellness, heritage, and ecological assets into its development strategy. In the area of mobility, NEOM goes beyond typical smart transport planning, aiming to establish seamless connectivity between cities, ports, and global air routes. The ambition and scale are evident across all dimensions, with a clear intention to position NEOM at the forefront of smart sustainable city innovation.

While the above does not provide an exhaustive account of each domain, it offers a representative overview of how NEOM draws on global best practices while simultaneously seeking to transcend them. As much of this remains in the conceptual and promotional stage, it provides fertile ground for empirical investigation and in-depth analysis, particularly in relation to implementation, governance, and long-term viability, issues that will be explored further in the following section on spatial planning and urban form.

2.5. Smart Cities and Spatial Planning: The Case of NEOM

The final aspect of NEOM that is important to consider at this juncture relates to the planning model itself. As the discussion on the existing smart cities noted, particularly in relation to Barcelona, there tend to be two main approaches to the planning of smart cities, characterised as ‘top-down’ and ‘bottom-up’. Where Barcelona was deemed to balance the two in a complementary approach (Angelidou & Mora, 2019; March & Ribera-Fumaz, 2016; Lynch, 2019; Calzada, 2018), it could be argued that cities built from scratch tended to major on the ‘top-down’ planning model. In the case of NEOM, the planning is top-down, based on a spatial planning approach that is based on four descendant scales as follows: on a national scale, there has been a governmental initiative, under the leadership of Crown Prince Mohammad Bin Salman, to develop NEOM as a smart city. On the regional level, the government of Saudi Arabia has considered multifarious steps to develop a smart region in the northwest of Saudi Arabia. On the municipal/local level, there have been details about the municipalities of NEOM, including The Line, the buildings, and the surrounding environment (Alqahtany, 2025; Batty, 2012; Exner, 2014). Finally, on the project-based scale, specialists have provided prototypes, pilot projects, and neighbourhood/community projects regarding NEOM city. This hierarchical spatial approach aligns closely with NEOM’s development timeline (2017–2025), reflecting the systematic execution of the top-down strategy (see Figure 18).

Figure 18*NEOM Development (2017 - 2025)*

Source: Compiled by the author based on official NEOM reports and announcements from NEOM.com

2.5.1. Conclusion

This chapter set out to review the literature on smart cities pertinent to this thesis. In a context of expanding urbanism compounded by environmental challenge, smart cities are generally perceived as a way for urban centres to begin to address the challenges that population concentrations pose to infrastructure, systems, and the delivery of necessary services to residents. By leveraging technological innovations and strategic frameworks, smart cities can transition toward urban communities that are more efficiently governed, provide improved services, foster cleaner environments, and promote sustainable growth and development. As a corollary to this, there has been a convergence with concepts of sustainability to see the rise of cities that aim not only to be smart, but to be sustainable smart cities.

While many definitions have been offered as to what exactly makes a city ‘smart’, it became evident from the literature that there is a level of consensus regarding the core characteristics that mark a smart city, as encapsulated in the BCSCW. For instance, smart governance includes transparency and e-participation; smart mobility covers intelligent transport and connectivity; and smart environment incorporates green energy and sustainable resource management. The wheel thus provides a structured, multi-dimensional lens through which the maturity, integration, and balance of smart city initiatives can be critically assessed. This has proved to be a valuable tool in beginning to assess the ways and extent to which various cities are progressing on the journey to being a smart city. The chapter, therefore, turned to examining a selected group of globally recognised cities which have been identified in various studies as representing best practices globally, providing a benchmark against which NEOM can be in-depth assessed. Cities such as Barcelona, Amsterdam, and Singapore offered insights into how existing urban areas can be transformed, particularly through digitally integrated governance, data-driven service delivery, participatory urban management, and innovations in multimodal transport. These cities have advanced through the strategic deployment of IoT technologies, open data platforms, smart mobility systems, and public–private innovation ecosystems, which together have improved efficiency, transparency, and responsiveness in urban governance. Other cities represent new cities that have been designed to embed smart technologies from their beginning. These cities tend to place particular emphasis on sustainability, especially

in energy systems and building practices, while purpose-built smart cities such as Songdo, Masdar, and KAEC have integrated smart technologies from their inception. These tend to emphasise sustainability through energy-efficient building design, renewable energy integration, district cooling systems, and sensor-enabled infrastructure that supports real-time monitoring of utilities and services. Additional best practices derived from these cases include the development of walkable urban forms, mobility models, and the creation of resilient, modular urban districts that enable adaptive growth. Collectively, these examples provide a comparative foundation for assessing how NEOM's ambitions align with, and potentially seek to advance beyond, current global smart city standards.

The chapter then turned to a survey of the documents and material currently available on NEOM in terms of its aims and core pillars as a preliminary examination of the grounds for the subsequent qualitative study that will analyse the results of interviews with those involved with the project itself in comparison with the themes extracted from the literature. Its fifteen core pillars were detailed with reference to the dimensions of a smart city determined in the BCSCW, and with reference, where appropriate, to the examples of existing global smart cities.

In summary, what is clear from the literature is that the IoT devices that are installed in smart cities generate a significant quantity of data, and even if that data is used effectively, various improvements are still possible. As a result, the concept of the smart city continues to find traction, with more than one hundred smart cities throughout the world employing ever-developing technology to raise the standard of living of their residents. Cities such as NEOM in Saudi Arabia are building based on intelligent architecture that will continue to evolve, with the explicit aim of leading technological innovation and creative industries to find alternatives to both address the challenges present globally in terms of urbanism and work towards smarter and more sustainable communities.

Where NEOM, as identified from the literature, seeks to move beyond the current concept of a smart city, is in the development of the world's first AI operating system, which will result in the creation of cognitive communities that make use of data in ways that are far superior to those of the smart cities of today. Cognitive communities make use of data to a much greater extent than are now possible in smart cities, which generally utilise less

than one percent of the data that is accessible. More than 90% of NEOM's data will be put to use in the development of a predictive system that will enable the city to provide ever-better services to its people and companies (NEOM, n.d.). Today's smart cities often concentrate their efforts on a single use case at a time, such as intelligent lighting or intelligent waste management. Nevertheless, a cognitive city is not only a collection of use cases in isolation; rather, it is a system of use cases that operate in conjunction with one another. In contrast to a typical smart city, NEOM intends to make use of practically all of the data that is produced in the city to profoundly alter the ways in which its residents work, live, and play. It is expected that the power of prediction and the capacity to forecast what will happen in the future will drastically restructure and modify human experiences. These claims will need to be tested in practice, and the next chapter (Chapter 3) sets out the rationale and methodology behind the research of this thesis that seeks to contribute to such an examination.

Chapter 3: Research Methodology

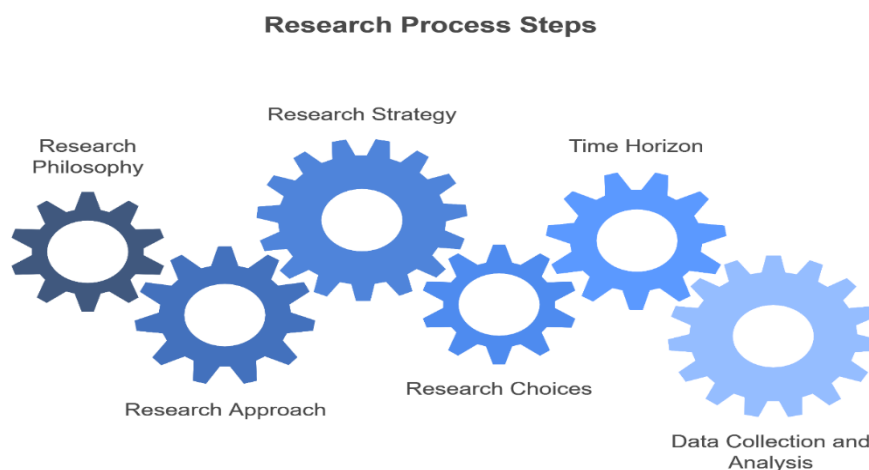
3.1. Introduction

The purpose of this chapter is to provide a comprehensive overview of the study's research design and methodological approach. It begins by outlining the underlying logic of the chosen research methodology and justifies the selection of a qualitative approach as the most appropriate method for addressing the research question. The chapter further discusses the theoretical framework guiding the study, emphasising its relevance to the investigation of NEOM as a paradigm for sustainable smart cities. Additionally, it provides a rationale for adopting a case study approach, specifically focusing on NEOM, and explains the selection criteria that support this decision.

An overview of the structure of the research methodology employed in this thesis is illustrated in Figure 19, detailing the sequential flow of data collection, analysis, and interpretation.

Figure 19

Research Methodology Process



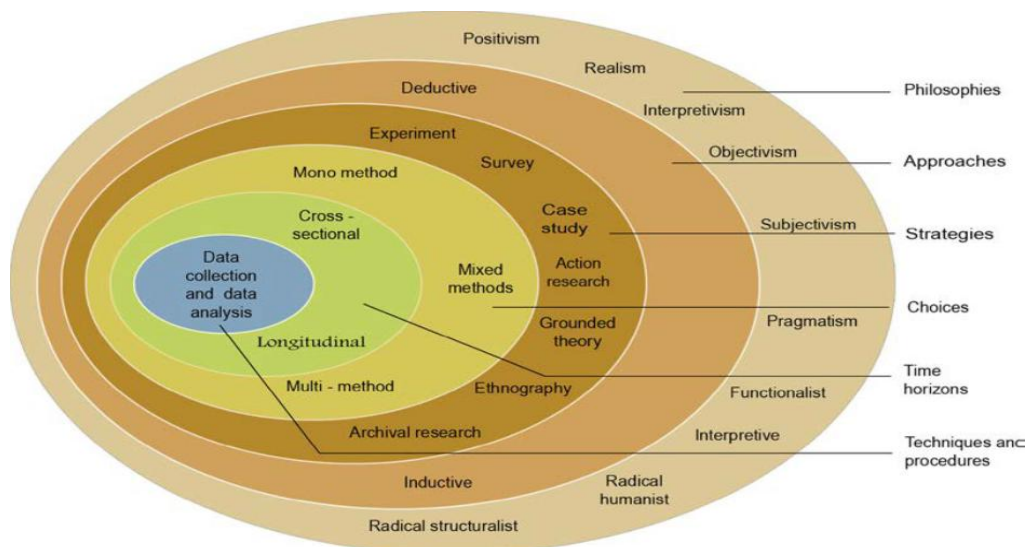
3.2. Research Philosophy

Research philosophy concerns the underlying framework that shapes a researcher's approach to the ways in which data is collected, analysed, and utilised for a particular subject

phenomenon (Tamminen & Poucher, 2020), where that philosophy is oriented with the research study's assumptions, knowledge, and nature (Holden & Lynch, 2004). The term 'philosophy' represents a variety of ideas, views, and ways of thinking. All of a person's conduct is influenced by their philosophy (Boyatzis et al., 2000), and so research must deal with matters related to the field of study by adopting a research philosophy which determines beliefs and assumptions about the character of knowledge and how it is developed. The research philosophy thus adopted then determines the most appropriate approach (Saunders et al., 2009). In light of the above, this section therefore describes the philosophical standpoint of this research, which has an effect on the methods chosen as the means of meeting its objectives. Once philosophical factors connected to the various approaches have been determined, an informed decision can be made with regard to data collection and analysis. The relationship between all these research design elements is illustrated in the 'research onion' model as shown in Figure 20.

Figure 20

The research onion



Source: Saunders et al (2007, p. 102).

As the outer layer of the figure shows, there are many research philosophies such as realism, pragmatism, positivism, and interpretivism (Ritchie et al., 2013). Considering the research question and the nature of the study, it is the interpretivist philosophy that is selected for this thesis. An interpretivist philosophy is often the medium for integrating human interest into a study (Mason et al., 2022) and regards reality as subjective, socially

constructed, and focuses on understanding the lived experiences, interpretivist research involves exploring participants' perspectives, contexts, and experiences in depth, using qualitative methods to generate rich, contextualised insights rather than generalisable laws (Bryman, 2016; Creswell, 2014). As such, interpretivism enables the researcher to understand the progress in NEOM city and its role as a futuristic smart city from the views of multifarious experts who work on or are relevant to the NEOM project.

In selecting this research philosophy, care needs to be taken regarding researcher bias; the danger lies in the potential for the researcher's own assumptions, values, and interpretations to unduly influence the data collection, analysis, or representation of participants' views. This risk is heightened in interpretivist research due to its subjective and reflexive nature, making it essential to maintain transparency, reflexivity, and rigorous methodological procedures to uphold credibility and trustworthiness (Nowell et al., 2017). To mitigate researcher bias, a comparison between the interpreted findings from the qualitative study and the findings available in the literature or on online databases is made to help justify the research findings (Hürlimann, 2019).

The following sections set out the various elements of the research design, or the 'layers' as represented in Figure 20, that subsequently follow from the selection of the interpretivist philosophy, encompassing the strategy, methodology choices, time frame, and processes.

3.3. Research Design

As defined by Creswell (2009) the research design is the proposed or planned set of methods for carrying out the research. The framework brings together the study's stated goals, guiding principles, overarching research strategy, critical analytic steps, and chosen methodologies. In addition, Matthews and Ross (2010) define research design as the blueprint that directs the researcher throughout the process of data collection and its measurement, while Bryman (2012) describes it as the overarching strategy that the researcher adopts to integrate the different parts of the research study logically and coherently to ensure that the research can effectively answer the stated research questions. As defined by Choguill (2005) and elaborated upon by Malhotra (2008), research design

provides specific guidelines for collecting the necessary data to achieve the study's stated goals. In sum, we can say that research designs are the plans that enumerate the various steps needed to be taken to ensure the collection of the relevant data that can help answer the research questions in a clear and to-the-point manner and the achievement of the pre-set aims and objectives of the research study.

3.3.1. Qualitative Research Rationale

Qualitative research is the optimal method for learning as much as possible about a research phenomenon (Holloway & Galvin, 2016). It was determined that a qualitative research approach would be the most appropriate for this study because it can provide in-depth explanations of the experiences of NEOM city master planning stakeholders, which is crucial for achieving the stated research goals and objectives. There are two main reasons for the decision to adopt a qualitative methodology.

First, one of the key advantages of qualitative research is its flexibility and adaptability to the unique context of each project. According to Creswell (2014), qualitative research allows researchers to explore and understand complex social phenomena in their natural setting. This is particularly relevant in the case of smart city initiatives, where the context and the stakeholders involved can vary significantly depending on the location and project goals. Moreover, qualitative research methods permit researchers to capture stakeholders' subjective experiences and opinions. For example, interviews and focus groups can be used to investigate the attitudes and perceptions of citizens, officials, and other stakeholders about smart city efforts (Kitchin & Tate, 2013). This can assist in identifying potential obstacles or barriers to the implementation of the initiatives, as well as the opportunities for collaboration and co-creation. In line with this, Lê and Schmid (2022) argue that qualitative research is not only adaptable but also inherently innovative, evolving through situated and reflexive practice in response to field conditions. This perspective is particularly relevant for this study, as interviewing senior NEOM planners and experts demanded iterative design choices, interpretive flexibility, and real-time methodological adaptability.

Secondly, Green and Thorogood (2018) argue that qualitative research methodologies are most appropriate when the research aims to clarify the meaning of the phenomenon under study and contribute to a deeper understanding of participants' lived experiences. Qualitative research is a scientific method for exploring a phenomenon in depth in human geography (Kitchin & Tate 2013; McGuirk & O'Neill 2016), which, Hay (2000) notes, aims to answer the 'what', 'how', and 'why' questions surrounding the subject's social dimensions. It is characterised by interpretive, naturalistic, inductive, context-based, and reflective principles (Draper, 2004), and a range of data collection methods such as observation, focus groups, interviews, dialogues, recordings, and field notes (Philip, 1998; Schneider et al. 2016), all of which facilitate the identification, documentation, and description of patterns and concepts, as well as the establishment of links between concepts and the provision of theoretical explanations of real-world situations (Braun & Clarke, 2006). Since qualitative research is widely used to comprehend the complicated causes of people's actions and behaviour, and investigate their beliefs, attitudes, values, meanings, impressions, and experiences (Jones & Evans, 2000; Polgar & Thomas, 2013), a more profound knowledge of NEOM members' emotions, actions, and decision-making processes should be obtained by employing qualitative research (McMillan & Weyers, 2007; Patton, 2014).

3.3.2. Research Approach

The research approach comprises the steps relating to the data collection, evaluation, and interpretation of the data (Mehrad & Zangeneh, 2019). There are two types of research approaches depending on the nature of the study, inductive and deductive and the selection of the appropriate research approach is associated with the nature of the research problem that is highlighted in a particular study (Opie, 2019). In this study, an inductive approach is selected where reasoning is drawn from a particular set of observations and theories to generate a new pattern or general understanding that arises from the current study (Coy, 2019). In this study, as the data is collected from a particular context, that is NEOM city, from various experts in Saudi Arabia.

3.3.3. The Case Study as Research Strategy

A case study is a useful qualitative research method that is designed to provide an in-depth, contextualised understanding of complex social phenomena within their real-life settings. In social science research, case studies are particularly valuable for exploring contemporary issues where the boundaries between the phenomenon and context are not clearly defined (Yin et al., 2015). The key advantage of adopting a case study approach lies in its ability to investigate the how and why of a phenomenon through multiple sources of evidence, offering rich insights that may not emerge through other methods such as surveys or experiments. Considering the smart city initiative NEOM as a case study thus enables the researcher to capture a wide range of perceptions about the answers to questions like how and why this initiative is effective in Saudi Arabia (Saunders et al., 2007).

The NEOM project has several advantages as a case study because of its uniqueness in redefining the idea of urban development in ways that are ahead of the current smart cities in terms of vision and design, particularly in terms of its intention for The Line and Oxagon (NEOM, n.d.).

Firstly, as NEOM is defying conventional concepts of design, urbanism, technology, architecture, and the main idea of smart cities (Alam et al., 2021), additional discussion is necessary, as Paszkowska-Kaczmarek (2021) argues, to comprehend the viability of this intriguing concept on a broader scale. It is, for example, intriguing to consider how the experiences of a similar implementation in the region such as Masdar city, may have inspired The Line's proposed solutions (Paszkowska-Kaczmarek, 2021). Additionally, Neom is being constructed with an unprecedented budget, from scratch, whilst a vast majority of smart cities are being retrofitted to show smart features (Farag, 2019). Beyond these practical reasons, NEOM also holds value as a case study because it aids in developing new urban theory. Roy (2009) argues that 21st-century urban theory must progress beyond Euro-American paradigms towards "new geographies of theory" that recognise how cities in the Global South and Middle East can generate original conceptual insights. In this framework, positioning NEOM allows the project to be analysed not only as an empirical example of a smart city initiative but also as a potential site of theoretical innovation, capable of shaping debates on sustainability, cognitive urbanism, and post-oil futures.

Secondly, as far as can be determined, it is the first project in the world that embraces an unprecedented level of sustainability in its intention as a smart city. As such, The Line will be without cars and roads which brings pollution due to transportation to zero (NEOM, n.d.). Moreover, the city will rely completely on renewable energy to satisfy the needs of its residents (Salameh et al., 2021). Thirdly, the decision-makers will prioritise the well-being and the health of its residents over infrastructure and transportation unlike other traditional or even current smart cities (Rashed & Mahmoud, 2018). The location of NEOM, in the northwest part of Saudi Arabia, will enable its residents to enjoy a diverse climate from snow-capped mountains to sunny coasts and such diverse climate and geographic features will improve people's liveability. Fourthly, NEOM will be the first city to apply the concept of cognitive city by using an AI application to provide a cutting-edge platform that aims to ease the overall communication structure of the city, including facilitating the process of data transferring and the movement of people (Ashehri, 2019). This is intended to even exceed the concept of a smart city that focuses on real-time information; in NEOM, the focus will be on being both predictive and proactive (Wade, 2024).

As Chapter 2 established (see sections 2.4.2) on the basis of the plans and available documents, NEOM appears to be the only smart city that addresses all the requirements mentioned in the Boyd Cohen Smart City Wheel, which makes it an apt case study across multiple aspects, facilitating a comprehensive view. For in-depth analysis, Gray (2004) advocates approaching the case study in terms of units of analysis. The NEOM initiative thus represents the overall case study, while the experts and managers within the project represent the units of analysis; therefore, based on Gray (2004), this research is a case study with multiple units of analysis, where every unit of analysis is a person of interest to interview. While NEOM might be seen as in essence a universal project, the case study strategy allows the researcher scope to generate new conceptions as to how NEOM is in effect contributing to the conditions of a smart city and the extent to which the project could act as a global landmark for any future smart city based on investigating the beliefs and the opinions of the selected respondents involved in the project itself.

Likewise, it can be argued that the case study approach, in capturing the various contexts and lived reality of the selected participants, enables the researcher to find and distinguish the relationship or link between the project, its surroundings, the people who

work in the project, and those who would be living in the NEOM smart city. Furthermore, as a case study is designed to capture a wide range of perspectives, where it is likely that there will be opposing perspectives, this should serve to lessen researcher bias and help the researcher in obtaining a better understanding of the chosen subject phenomenon (Vaughn & Jacquez, 2020).

3.4. Research Methods

3.4.1. The Elite Interview

This study employed an elite interview methodology to capture the insights of influential stakeholders involved in NEOM's smart city development. Given the complexity of NEOM as a case study, this methodology is particularly suited to investigating its unique urban form and sustainability strategies. Elite interviews, as described by Burnham et al. (2004) and Morris (2009), are designed to gather perspectives from individuals who hold decision-making power or possess specialised knowledge in each field. According to Hennink et al. (2020), elite interviews are particularly useful for understanding large-scale projects such as NEOM, where the decisions of key stakeholders can significantly shape the project's trajectory. Such interviews can reveal strategic motivations, governance structures, and planning considerations that conventional survey or observational methods might overlook (Harvey, 2011). Elite interviews are ideal for exploring emerging research areas, as they can generate new perspectives and inform further research directions (Boyce & Neale, 2006; Holloway & Galvin, 2016). As NEOM is a new project and given the limited existing literature on elite interviews within NEOM, this method offers a crucial opportunity to generate original findings on the project's development and its broader implications. The rationale for adopting an elite interview strategy is rooted in the ability of these high-status individuals to provide specialised insights into NEOM's development, challenges, and opportunities. In the context of NEOM, elite interviews with government officials, project stakeholders, and sustainability experts can provide valuable insights into governance structures, technological innovations, and socio-economic impacts. While Lilleker (2003) emphasises the methodological complexities of elite interviewing, such approaches remain essential for exploring the motivations, values, and strategic decision-making of high-level

actors, such as NEOM's leadership. Insights from these interviews are expected to provide a nuanced understanding of NEOM's positioning as a model for future sustainable smart cities. Additionally, by engaging with a diverse set of experts, this study aims to capture different perspectives on NEOM's role in redefining urban sustainability paradigms (Bryman, 2016).

These interviews typically employ a semi-structured or unstructured format, allowing researchers to explore key themes while adapting to the respondent's expertise and perspective (DiCicco-Bloom & Crabtree, 2006). Conducting elite interviews does present unique challenges, including restricted access, time constraints, and potential power imbalances, requiring strategies such as leveraging professional networks, demonstrating credibility, and articulating the study's significance (Harvey, 2011). Ethical considerations, such as ensuring informed consent, protecting confidentiality, and maintaining an appropriate balance of power in the interview process, are critical to preserving research integrity (Harvey, 2011). These concerns are addressed below in section 3.4.2.

3.4.2. Population/ Sampling and Recruitment

3.4.2.1 Population

The population contains all persons of interest and stakeholders related to the NEOM project, including specialists from public and private sectors. To determine the part of population from which a workable sample could be selected, a range of selection criteria were considered. To ensure the relevance and reliability of the study, participants were included based on the following criteria.

Expertise in Smart City Development and Sustainability

- Individuals with demonstrated expertise in urban planning, sustainability, and smart city development, particularly those with experience in large-scale, technologically integrated urban projects.

Affiliation with NEOM or Relevant Institutions

- Key stakeholders directly involved in NEOM's planning, design, and execution
- NEOM officials and managers

- Representatives from the Saudi Public Investment Fund (PIF)
- Officials from the Saudi Ministry of Municipal and Rural Affairs and Housing
- Academics specialising in urban geography, sustainable urbanism, or smart city policies

Global Urban Development and Policy Experts

- Representatives from international organisations such as the United Nations Human Settlements Programme (UN-Habitat) and other entities engaged in shaping sustainable urban development.

Conversely, potential participants were excluded on the following grounds:

- NEOM employees without decision-making authority. Individuals who are working on the NEOM project but not classified as ‘elite’ or key decision-makers within the initiative.
- Limited Engagement with NEOM or Similar Projects.
- Lack of relevant expertise.
- Individuals with no direct knowledge or professional experience in sustainable urban development, smart city planning, or NEOM.
- Reluctance to participate in qualitative interviews. Individuals unwilling to engage in discussions, share perspectives, or provide consent for their responses to be included in the research.

By applying these inclusion and exclusion criteria, the study effectively narrowed the target population to 2,638 participants across different entities involved in NEOM’s development, including NEOM project teams, UN-Habitat, government agencies, and private sector firms.

Eighteen private sector companies were represented in the participant pool, and are listed under the main specialist categories.

- Architecture and Urban Planning Firms: Adjaye Associates; DMAA; UNstudio; OMA; Oyler Wu; Morphosis Architects; FUKSAS, Pei Cobb Freed & Partners; Coop Himmelb(l)au; HOK, Tom Wiscombe; and Sir Peter Cook.
- Consulting and Technology Firms: Jacobs; Tonomus NEOM; ENOAW NEOM; and infrastructure and energy companies ACWA Power, ARASCO, Atkins.

The governmental agencies from which participants were selected include the following:

- Fiscal Sustainability Programme
- PIF Programme
- Quality of Life Programme
- Housing Programme
- Crown Prince Court

By implementing these rigorous inclusion and exclusion criteria, this research ensures that the data collected is drawn from highly knowledgeable and strategically positioned stakeholders, thereby providing a well-rounded and authoritative analysis of NEOM's potential as a paradigm for sustainable smart cities. As well as ensuring a diversity of perspectives, the inclusion of multiple elite interviewees also allows for identifying both points of convergence and divergence in expert opinions, offering a comprehensive view of current trends and debates in smart city development (Ritchie et al., 2013).

3.4.2.2 Sampling

Having identified the target population, a sample size was determined that would achieve data saturation. Guest et al. (2006) found that saturation of thematic elements often occurs within the first twelve interviews, while Malterud et al. (2016) emphasise that sufficient information power depends on study aim, sample specificity, and analytical strategy, which was 39 respondents. Rather than random sampling, a purposive sampling technique was followed to attain sufficient knowledge about the research topic (Pandey & Pandey, 2021). Thus, participants were selected from various entities to enable the researcher to cover various areas related to the environment, mobility, government, economy, people, and living in the NEOM project. The sample consisted of those selected from four categories: NEOM

experts (managers) and consultants; UN officials and officials from international public entities; Government officials; and academics from universities.

The purposive sampling technique carries the risk of sampling bias (Palinkas et al., 2015), where the researcher tends to choose the respondents depending upon their own subjective independent judgements, which may be biased. To reduce the level of subjectivity in this research, the background and experience of each participant was carefully considered before sending them invitation emails (DeCuir-Gunby et al., 2019).

3.4.2.3 Recruitment

Once this background information had been obtained, to recruit the participants emails were sent to the following gatekeepers: NEOM's main administration, UN representatives responsible for NEOM, governmental authorities (including two public entities, Saudi Arabia's Public Investment Fund and the Ministry of Municipal and Rural Affairs and Housing), universities with academics studying NEOM, and stakeholder companies such as ENOWA and ACWA Power. The emails requested permission for the researcher to contact managers, experts, or employees within the targeted organisations.

A total of 39 respondents were selected, while the remaining interested and shortlisted candidates were placed on a waiting list. This was done to ensure that, in the event of a selected participant being unavailable on the scheduled interview day or failing to respond after multiple reminders, replacements could be drawn from the reserve list. Replacements were selected by chronological order from the earliest to the most recently shortlisted individuals (Busetto et al., 2020).

The participants were further divided into groups representing external stakeholders, that is those who are not formally employed by NEOM but are engaged with or have expertise relevant to the project through their institutional affiliations, policy roles, or academic and internal stakeholders who are directly employed by NEOM or embedded within its organisational framework, with active roles in the strategic planning, sectoral development, infrastructure design, or operational implementation of the project, these include NEOM executives, managers and planners. The sample details of these groups of interviewees (name, job position, organisation, etc.) are presented in Tables 3 and 4, respectively.

Table 3*Sample details of the expert interviews (External stakeholders' group 1)*

No.	Name of Interviewee	Job position	Organisation	Date	Duration
1	Khaled Alnfei	Urban Adviser	Ministry of Municipal and Rural Affairs	07.08.2023	37min
2	Wadia Albarqawi	Associate Professor of Architecture and Urban Design	Umm Al-Qura University	31.07.2023	32min
3	Interviewees 3A	Urban Planner	Royal Commission for Riyadh	31.07.2023	45min
4	Suleiman Abu Kharmeh	Chief Technical Advisor - National Spatial Strategy, Saudi Arabia	United Nations Development Programme Saudi Arabia	14.08.2023	40min
5	Ziad Aazam	Head of Planning and Urban Design	PIF	11.08.2023	44min
6	Interviewees 6A	Director of the National Urban Observatory	Ministry of Municipal and Rural Affairs	08.08.2023	55min
7	Abdulrhman Alsayel	Lecturer and Researcher of Urban & Regional Planning	Imam Abdulrahman Bin Faisal University	06.08.2023	50min
8	Interviewees 8A	Senior Telecom consultant - Smart city solution	sTc	22.08.2023	42min
9	Aasm Alabdullatief	Chair of Architecture & Building Science Department	King Saud University	22.08.2023	33min
10	Mohammad Fageir	Regional government	Urban designer	28.08.2023	51min
11	Interviewees 11A	Project Management	PIF	29.07.2023	30min
12	Ahmed Krim	Professor of Urban Geography	Al-Imam Muhammed Ibn Saud University	29.08.2023	44min
13	Ibrahim Alhelali	Executive Director	United Nations-Global Compact	28.08.2023	50min
14	Khalid Al-Ghamdi	HSSE Director	ARASCO- food security	05.09.2023	31min
15	Interviewees 15A	Chair of SSC program	King Fahd University	05.09.2023	31min
16	Norah Ahmad	Executive, Strategy and Transactions	Ministry of Economy and Planning	14.09.2023	45min
17	Ahmed Alanazi	Smart City Senior Specialist	Saudi data and AI Authority	15.09.2023	33min
18	Interviewees 18A	General Manager at Smart Cities Solutions Company	Smart Cities Solutions Company	22.09.2023	30min
19	Ahmaed Ali	Economic Advisor	Decision Support Center	23.09.2023	31min
20	Interviewees 20A	Senior Manager Solutions and Application Development	Elm Company	29.09.2023	33min

Table 4*Sample details of the expert interviews (Internal stakeholders' group 2)*

No.	Name of Interviewee	Job position	Organisation	Date	Duration
1	Paul Hanger	Senior Design Manager	NEOM	24.09.2023	37min
2	Philip Mertens	Development Director Hospitality	NEOM//TROJENA	25.09.2023	40min
3	Interviewees 3B	Environment Compliance Management Manager	NEOM	31.07.2023	45min
4	Christopher Brown	Executive Director of Urban Planning	NEOM	25.09.2023	40min
5	Abdullah Almuraiqeb	Manager, Urban Planning	NEOM	27.09.2023	44min
6	Mark Cote	Chief Development Director	NEOM	02.10.2023	35min
7	Interviewees 7B	Project Engineer- Water sector	NEOM/ENOWA	26.09.2023	50min
8	Interviewees 8B	Development Lead	NEOM	22.08.2023	42min
9	Interviewees 9B	Executive Director, Development and Investments	NEOM/OXAGON	27.09.2023	33min
10	Mansoor Hanif	Executive Director Digital and Cognitive Solutions - The LINE	NEOM	28.09.2023	30min
11	Siti Syahwali	Impact Specialist -Food Sector	NEOM	23.09.2023	31min
12	Interviewees 12B	Planning Director	NEOM	04.10.2023	30min
13	Interviewees 13B	Technologies Development Manager	NEOM	09.10.2023	36min
14	Interviewees 14B	Director of Government Engagement	NEOM	11.10.2023	28min
15	Interviewees 15B	Government Engagement Specialist	NEOM	12.10.2023	33min
16	Interviewees 16B	Stakeholder Management	NEOM	12.10.2023	31min
17	Interviewees 17B	Head of NEOM Digital Cognitive Master Plan	NEOM	05.10.2023	29min
18	Interviewees 18B	Urban Planning Business Support Specialist	NEOM	06.10.2023	40min
19	Interviewees 19B	Marketing Manager	NEOM /TROJENA	14.10.2023	32min ⁴

⁴ As Tables 3 and 4 show, some participants are named while others are coded. This distinction was made based on the consent form each participant completed before the interviews. Those who agreed to be identified by name are listed as such, while those who preferred anonymity have been assigned coded identifiers (see Appendix 1 for the full consent form).

3.5. Data Collection

3.5.1. Primary Data

To explore the answers to questions such as ‘why’ and ‘how’ the NEOM smart city initiative is bringing a revolution to the urban understanding of the concept of the smart city, and why NEOM differs from other smart cities such as New Cairo and Dubai, semi-structured face-to-face interviews were considered the most suitable option for collecting valid and reliable data, enabling the collection of a substantial amount of data, which in turn allowed the researcher to develop a comprehensive view of the whole topic (Chilisa, 2019).

A semi-structured interview has the advantage of posing mostly open-ended questions to the selected respondents; a nominal number of closed questions were also included in this research. Given that the study focused on a social context, it was more appropriate to undertake face-to-face interviews, as participants had the freedom to express their thoughts openly to myself as the researcher, while I was also able to capture the non-verbal expressions and reactions of the participants (Strijker et al., 2020). The nature of the semi-structured face-to-face interviews were typically more conversational in nature, and each interview lasted for approximately 30–45 minutes. This duration proved to be feasible in minimising the risk of exhaustion and fatigue for both the researcher and the participants.

Two sets of questions were devised to guide the interviews for each of the two interview groupings.

Interview questions for External stakeholders (Group 1):

- Could you describe what motivated the conception of the NEOM project? What key factors led to its initiation?
- From your perspective, what are the unique attributes of NEOM that distinguish it from other smart city projects globally?
- Could you discuss any particular elements of NEOM that you believe could be adopted as future best practices in sustainable smart cities?
- How does the NEOM project intend to merge rapid technological development with environmental sustainability?
- What is the role of international collaborations and partnerships in creating and operating NEOM?

- How do you believe NEOM could potentially transform the socio-economic situation of Saudi Arabia and possibly beyond?
- In what ways do you believe the NEOM project aligns with the broader goals of Vision 2030 of Saudi Arabia's national transformation plan?
- Looking to the future, what are the hopes and expectations for NEOM regarding its long-term impact on the region, the country, and global sustainability efforts?
- Are there any literature or reports you think I might find useful?
- Is there anyone else you think would be useful for me to talk to
- Is it all right for me to contact you again if I think of another question?
- Finally, thank you for meeting me. Is there anything you think I should ask you about?

Interview questions for Internal stakeholders (Group 2)

- What common best practices have you observed in sustainable smart city initiatives globally?
- In your expert opinion, how have these best practices influenced the planning and conception of NEOM from existing sustainable smart city initiatives?
- What unique dimensions or innovative features could you identify in NEOM that could potentially set new standards or become future best practices in smart city development?
- Could you elaborate on how the linear urban form is anticipated to enable sustainable development in the Line City aspect of NEOM?
What is Zero Gravity Urbanism? (5min walk from every point of The Line)
- Based on your understanding of the literature and the BCSCW model, are there aspects in the model that NEOM is not doing or other things that aren't in the model that NEOM is doing?
- What is the key emphasis on these different attributes that the model lists?
- Considering the context of NEOM, could you discuss any particular strategy metrics that have been applied or could be beneficial in analysing and evaluating such a project?
- How do you think NEOM merges technological aspects with socio-economic and environmental considerations in its planning?
- What key lessons could future smart city developments learn from NEOM's planning and design to enhance their sustainability and urban environments?
- In terms of the environment, can you provide examples of unique renewable energy solutions or ground-breaking waste management systems that NEOM is implementing to address environmental challenges?

- How has NEOM assessed and adopted cutting-edge transportation technologies like hyperloop systems or smart mobility platforms?
- Could you explain the potential impact of emerging industries or sectors, such as renewable energy, advanced technologies, or sustainable tourism, on the local and regional economy within NEOM?
- How is NEOM embracing innovative approaches to promote inclusivity and social equity within its development?
- Can you provide insights into the novel approaches NEOM employs in terms of collaborative governance or public-private partnerships within its decision-making structures?
- What are the advantages and potential challenges associated with integrating smart technologies to enhance sustainability, improve quality of life, and optimise resource management within NEOM?
- Are there any literature or reports you think I might find useful?
- Is there anyone else you think would be useful for me to talk to?
- Is it all right for me to contact you again if I think of another question?
- Finally, thank you. for meeting me. Is there anything you think I should ask you about?

As part of the data collection process, pilot studies play a vital role in qualitative research, particularly in human geography, as they assist researchers in fine-tuning their methods prior to commencing the main study (De Vaus, 2001; Yin, 2015; Baxter & Eyles, 1997). Kitchin and Tate (2013) emphasise that pilot studies are key for identifying weaknesses in interview design, ensuring that questions are clear, relevant, and capable of eliciting meaningful responses. A crucial step in this process involves evaluating pilot interviews from the perspectives of the participants, which provides valuable insights into the effectiveness of the interview format and methodology.

I conducted two trial interviews with participants representing the two target groups to assess the interview process. The clarity of the questions, the logical progression of topics, and the overall level of participant engagement were all evaluated with the assistance of these pilot interviews. Interviewees were asked to provide feedback on their experiences after each session, highlighting any questions that appeared challenging to answer, repetitive, or unclear. To ensure that the final interviews would yield rich and relevant data,

this feedback was subsequently utilised to refine the wording and sequencing of the questions (Fenton & Baxter, 2016).

Along with obtaining direct input, I also observed how participants responded, looking for signs of hesitancy, unease, or disinterest. Changes were made to improve the interview's structure and pacing if participants found it too lengthy or struggled with specific topics. To ensure a smooth implementation in the main study, practical aspects such as the interview setting and the quality of the audio recording were also assessed (Kitchin & Tate, 2013). To confirm that the adjustments had enhanced clarity, engagement, and data quality, the researcher conducted a second round of pilot interviews after making the necessary changes based on the first round of feedback. By refining the interview methodology through this iterative process, the researcher ensured that the final study would be more methodologically sound and effective.

To complement the interview data and document analysis, the research design incorporated a specific phase of non-participant observation conducted at The Line exhibition in Riyadh. This site visit functioned as a critical entry point into the "lived" conceptual space of NEOM, offering direct access to the project's public-facing pedagogy. During this visit, photographic documentation was undertaken where permissible (see Figures 28–39 and 49 in the Findings chapters), and granular, contemporaneous fieldnotes were recorded. This approach generated a corpus of primary empirical material derived from the researcher's direct engagement with the spatial, visual, and rhetorical narratives constructed by NEOM.

The observation was not merely passive attendance but was structured by established methods of systematic observation (Spradley, 1980; Angrosino, 2007; DeWalt & DeWalt, 2011). Fieldwork involved the generation of thick description (Geertz, 1973), capturing not only the physical content of the displays but also the sensory and experiential atmosphere intended to persuade the viewer. Attention was rigorously directed towards three intersecting dimensions of the exhibition's narrative:

1. **Dominant Planning Narratives:** The observation scrutinised how abstract concepts were materialised, specifically tracking the visual language used to depict cognitive/smart urbanism, sustainability, liveability, and governance. This involved

noting how the smart city was presented not just as infrastructure, but as a lifestyle (Datta, 2015).

2. Representations of Urban Form: Specific focus was placed on the architectural communication of The Line's unique typologies, such as its linearity, vertical stratification, modularity, and phasing strategies.
3. Mobility Logics and Spatial Sequencing: The observation mapped how movement was visualised, focusing on the integration of walkability, mass transit/high-speed rail, and vertical circulation systems, looking for the seamlessness often promised in smart city visualisations (Kitchin, 2014).

The resulting photographs and fieldnotes formed a distinct subset of the study's empirical corpus. These materials were analysed drawing on principles from visual methodologies and visual ethnography (Pink, 2020; Rose, 2022). This analytical approach posits that images, architectural models, and curated displays are not neutral illustrations of a future reality; rather, they are active agents in shaping how urban futures are communicated, legitimised, and consumed. By treating the exhibition as a sociotechnical imaginary, a collectively held and institutionally stabilised vision of a desirable future (Jasanoff & Kim, 2015), the analysis was able to decode how NEOM constructs its legitimacy through high-fidelity visuals and immersive technologies.

These visual data points were coded thematically alongside the interview transcripts and documentary sources (Braun & Clarke, 2006). This integration supported robust methodological triangulation (Denzin, 1978; Yin, 2015), allowing the researcher to cross-reference the idealised vision presented to the public at the exhibition against the technical realities discussed by internal experts in interviews.

Reflexively, the exhibition was interpreted as a highly curated institutional performance rather than objective evidence of the built environment. To manage researcher bias and ensure rigor, an audit trail was maintained, linking specific photographic records and fieldnotes to emerging codes and analytic decisions, thereby strengthening the study's credibility and trustworthiness (Lincoln & Guba, 1985).

Ethically, the observational protocol was strictly confined to the curated displays, architectural models, and the spatial setting itself. To ensure privacy and adhere to ethical

standards regarding human subjects, the observation avoided focusing on identifiable visitors. Any incidental public presence captured in fieldnotes was recorded in non-identifying, aggregate terms, and all photographic activity was conducted in strict accordance with the venue's guidance and the ethical approval granted for this study.

3.5.2. Secondary Data

Secondary data comprises reports, statistics, governmental documents, and censuses gathered by governments, research institutions, and similar entities (Clark, 2005; Vartanian, 2011; Rezvani et al., 2013). Table 5 shows a sample of the secondary data partially analysed in this study.

Table 5

Sample of the secondary data

No.	Name of the documents	Type of documents	Source	Date of Publishing
1	NEOM is Saudi Arabia's \$500 billion bet to build a futuristic city	press	CNBC	2023
2	Which architecture studios are working on Neom	press	Dezeen	2024
3	NEOM Official Website	website	NEOM.com	-----
4	NEOM ENOWA Sustainability Report	Report	ENOWA	2022
5	NEOM Fact Sheet	Report	NEOM.com	2022
6	NEOM - THE LINE Fact Sheet	Report	NEOM.com	2022
9	Saudi Arabia's Mega-City - The NEOM Project	Report	Ipsos	2019
10	Cognitive Cities: A Journey to Intelligent Urbanism	Report	PwC	2023
11	AI in Action	Report	NYC Govt.	2023
12	NEOM Grid of the Future	Report	ENOWA	2024
13	Saudi Vision 2030 Official Website	website	vision2030.gov.sa	-----

3.5.3. Timescale of Data Collection

The fieldwork was conducted over three months, from 25 July to 25 October 2023. Semi-structured interviews were carried out primarily in professional settings, including offices and institutional meeting rooms. This approach ensured a neutral and comfortable environment for participants, fostering open and reflective dialogue. Table 6 presents a detailed timeline of the data collection process.

Table 6

Timetable for the data collection

Data Collection Method	Type of Data	Start Date	End Date
Expert interview with external stakeholders	Primary data	25-07-2023	25-10-2023
Expert interview with internal stakeholders	Primary data	25-07-2023	25-10-2023
Official reports and press data (Objective Indicators)	Secondary data	01-07-2023	17-06-2025
End of the data collection			

3.6. Data Analysis

The interviews were conducted in English and recorded in the English language and audio-recorded using a secure digital voice recorder and encrypted cloud-based storage. In addition to audio recordings, detailed written notes were taken during each interview to capture non-verbal cues, contextual observations, and immediate reflections. These notes complemented the audio data and were particularly useful in cases where minor technical issues occurred or where participants expressed reservations about full recording. Once the textual data were gathered from the respondents, they were transcribed for analysis (Joshi, 2019). NVivo 14 software was used for coding, categorisation, and thematic extraction (Allsop et al., 2022). According to Clarke and Braun (2014), thematic analysis involves six steps, and these were followed in this research. the six steps are as follows:

- **Familiarisation with the dataset**—Soon after collecting the data, it was transcribed. It is essential at this stage to ensure the authenticity, trustworthiness, and reliability of the data thus transcribed. Through this step, a basic understanding of the subject phenomenon is developed (Mukherjee, 2019).

- **Generation of codes**—The second stage included the derivation of codes from the dataset. These codes, once identified, assisted me in formulating themes linked to the subject topic.
- **Identifying key themes**—Once the themes were formulated, I extracted the potential key themes and relevant subthemes associated with the subject phenomenon (Snyder, 2019).
- **Review of key themes**—This step involved monitoring, scrutinising, and reviewing the key themes and subthemes generated from the dataset. These themes were then refined to ensure their validity, authenticity, and reliability (Vebrianto et al., 2020). Continuous monitoring of the themes, based on the original codes, allowed me to draw effective and trustworthy findings.
- **Defining and naming the themes**—In this stage, I assigned names to the key themes and subthemes in a way that added clarity and value to the overall findings of the research (Dźwigoł, 2019). A specific naming strategy was adopted to reflect the relevance of each theme.
- **Producing the final report**—This was the final stage of the analysis process, during which I derived specific words, terms, and expressions. Here, the intention is to communicate to the reader the strengths and limitations of the data used (Hennink et al., 2020). The data presented in the study remained transparent, clearly articulated, and ethically sourced.

3.6.1. Document Analysis

Myers (2010) recommends that in qualitative research studies, utilising documentary evidence as secondary data gathering effectively complements other data collection approaches. Bryman (2012) observes that academics undertaking a case study of companies may utilise publicly available information to enhance their comprehension of the case context. This study utilised electronic media sources, existing literature, and reports from reputable private entities. The secondary data facilitated the triangulation of the study's conclusions through multiple, diverse sources, enhancing its credibility (Ruggiano & Perry, 2017) and providing pertinent information regarding NEOM. The governmental regulatory requirements for smart cities in Saudi Arabia were sourced from several references.

In addition, secondary data was used as a supplementary source to support and enrich the themes emerging from the primary data analysis. Following the initial coding and thematic development based on semi-structured interviews, relevant secondary sources, including planning documents, policy reports, government publications, architectural exhibitions, and academic literature, were systematically analysed to provide context, triangulate findings, and offer additional interpretive depth. This approach aligns with what Heaton (2008) describes as supplementary secondary analysis, where existing data is used to elaborate on or corroborate new findings derived from primary research. Such an integrative strategy also reflects what Bryman (2016) and Flick (2022) describe as theoretical triangulation, enhancing the credibility of qualitative interpretations through the convergence of different data types. Furthermore, secondary sources are brought into dialogue with the themes derived from fieldwork at a later stage of analysis. Importantly, the use of secondary data in this context was not intended to generate new themes independently, but rather to strengthen, contextualise, or critique the thematic structure already identified through empirical engagement with expert informants. This strategy proved particularly valuable in the case of NEOM, where the complexity of the planning process and limited public access to internal project data necessitated the integration of multiple data layers to ensure analytical robustness.

3.7. Ethical considerations

At the outset, ethical approval was obtained from Swansea University prior to conducting interviews with participants. The ethical application ensured adherence to core principles of research ethics, including confidentiality, anonymity, voluntary participation, and non-maleficence (Orb et al., 2001). Each potential respondent who expressed willingness to provide feedback on the development of NEOM as a smart city. was emailed personally. Where participants were employed within public or private entities, the relevant organisation was contacted to obtain permission to approach eligible employees meeting the inclusion criteria.

Following institutional clearance, an email was sent to targeted individuals seeking their informed consent to participate (Al-Ababneh, 2020). Each email included a participant

information sheet outlining the research aims, the rationale for the study, and the ethical commitments being followed. Upon confirmation of interest, a formal consent form was sent to each participant, which had to be signed prior to the interview (Coy, 2019). To ensure the data produced were valid, authentic, and trustworthy, and trustworthy, established ethical guidelines applicable to social science research (Opie, 2019) were closely followed. Data obtained from interviews were stored in encrypted formats to maintain confidentiality and protect the privacy of respondents (Heffetz & Ligett, 2014). At no point were participants' views or identities disclosed. Each dataset was anonymised using coded identifiers to protect participant identities throughout the research process.

Voluntary participation was guaranteed; no coercion was applied, and all participants retained the right to withdraw from the study at any stage (Mason et al., 2022). Full transparency in reporting the data and compiling transcripts was ensured, irrespective of whether the findings aligned with the original assumptions (Vaughn & Jacquez, 2020). Data storage complied with the standards of the UK Data Protection Act 2018. All audio recordings were encrypted and securely stored, accessible only to the researcher and, if required, the research supervisor (Mukherjee, 2019).

3.8. Quality Assurance Criteria

To ensure the quality and trustworthiness of this qualitative study, I focused on four key aspects: credibility, transferability, confirmability, and dependability (Morse et al., 2002). In terms of the credibility of the research, I employed a self-reflection framework to minimise the risk of personal bias (Al-Ababneh, 2020). Transferability was supported by providing sufficient contextual evidence to enable readers to assess the extent to which the findings could be applicable to other contexts or situations. Confirmability was established by verifying the final findings through consultation and validation with the research supervisor, who confirmed the accuracy and relevance of the outcomes (Steinke, 2004; Coy, 2019). Dependability was achieved by maintaining an audit trail to document the research process in a way that allowed external reviewers to trace and evaluate the methodological rigour of the study (Anney, 2014).

In summary, this chapter has detailed the methodological framework established for this research that encompasses the underlying philosophy that guides all aspects of the qualitative study, its design, approach, and the research processes themselves. The research adopts an interpretivist philosophy as its basis, and an inductive approach, both of which take the observation and understanding of the particular as a basis for generating new conceptions and thinking. The specific research method selected for addressing the central research question is the case study of NEOM City, as a strategy facilitating a broad set of data from differing perspectives to be compared with document analysis as secondary evidence to support and enhance the credibility of the findings. Elite semi-structured interviews provide the primary data, examined by thematic analysis.

The following chapters present the findings from the qualitative research in terms of the key themes that emerged from the analysis and in concert with the way they address the research questions.

Chapter 4: Strategic Foundations of Building NEOM (External Perspectives)

This chapter presents the findings and analysis of external perspectives of the case and is designed to answer the central research question as to the ways in which NEOM can be considered a paradigm for future sustainable smart city initiatives. One key aim for addressing this question is to establish an understanding of the motivations for NEOM, and, having identified global best practices in sustainable smart city initiatives, ascertain how NEOM has incorporated these in its planning. Alongside this, the study explores the unique dimensions of NEOM, examining how its linear urban form contributes to its sustainability and the potential there is to derive lessons for future smart city developments. As Chapter 3 discussed, the core of the qualitative case study was the conducting of elite, semi-structured interviews with high-level stakeholders in the NEOM project to discover the understandings and views of those with direct experience of the project, with guided questions that aligned with the aims of the study. The study sample of 39 participants comprised NEOM experts (managers), UN officials and officials from international public entities, government officials/representatives (i.e., Saudi Arabian Public Investment Fund (PIF), Ministry of Municipal and Rural Affairs and Housing) and university academics, divided into two groups: 20 external stakeholders (Group 1), and 19 internal stakeholders (Group 2). To interpret the results of the qualitative research, a thematic data analysis technique was employed to identify the key themes that emerged, distinguishing the perspectives arising from each of these groups. To give ample room to discuss the range of perspectives investigated, the analysis in this chapter (Chapter 4) presents the findings from the interviews with Group 1 only and Group 2 findings are presented in the following chapters (Chapter 5, 6), highlighting the main issues and themes and engaging with these findings in terms of the research question and research aims.

4.1. Identification of Themes

Determining the themes from the qualitative data is the fifth stage of Braun and Clarke's (2014) approach (section 3.6). A substantial amount of time was dedicated to developing the concepts, where multiple iterations of the theme were made, making several modifications, until the one that

best captured the essence of the data was arrived at. The NVivo 14 software was utilised for data management purposes (Allsop et al., 2022). Charts were generated for each of the core themes, together with their accompanying subthemes, from which the following thematic framework emerged for Group 1 (see Table 7). Braun and Clarke (2014) emphasise the utilisation of sub-themes in organising a broad and intricate thematic context. Drawing on the participants' comments and observations, the subsequent sections of this and the following chapter provide a comprehensive analysis of each theme and sub-theme for Group 1 (external perspectives).

Table 7:

Themes and Sub-themes that Emerged from Group 1

Themes	Sub-themes	Files (how many participants discussed the theme)	References (how many times the theme was mentioned)
Strategic national development	1. Alleviating population pressures. 2. Alignment with Saudi Arabia's Vision 2030.	20	40
Global leadership and collaboration	1. Global trends and innovation in smart cities. 2. Spearheading global partnerships and collaborations.	19	55
Geo-strategic importance and sustainability	1. Strategic location and natural resource leverage. 2. Sustainability and environmental stewardship.	17	32

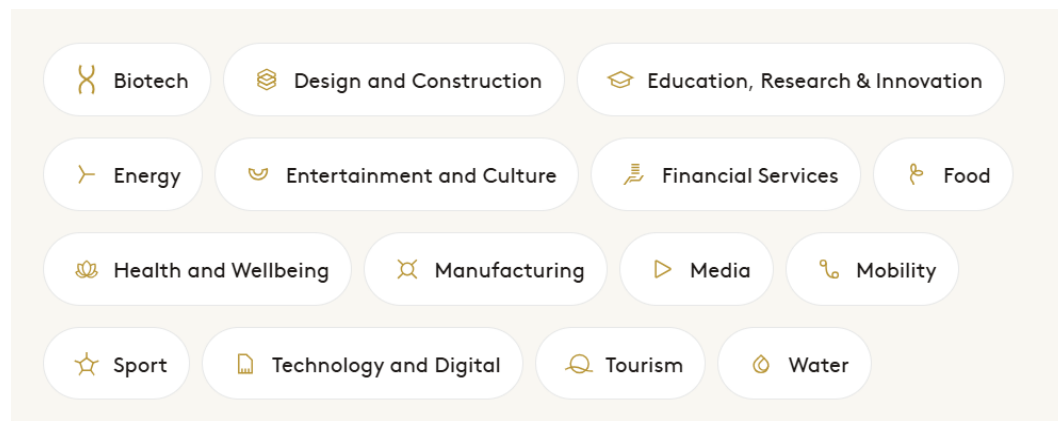
Source: Semi-structured Interviews, adapted by the author from NVivo 14 software.

4.2. Group 1

The interviews with the Group 1 participants were focused on discussing the motivations behind the NEOM initiative and exploring its potential as a paradigm for future sustainable smart city projects. As stated in Chapter 1, NEOM is a portmanteau meaning ‘New Future’ and represents perhaps the most ambitious urban development project in the world today, spanning an area larger than Kuwait. The project is part of Saudi Arabia’s Vision 2030, a strategic framework to reduce the country’s dependence on oil, diversify its economy with a focus on 15 specific sectors (see Figure 21), and develop public service sectors (Vision 2030, n.d.b). NEOM is designed to be an advanced smart city that blends sustainability and advanced technology.

Figure 21

The 15 diverse sectors NEOM will invest in to focus on achieving its goals and vision



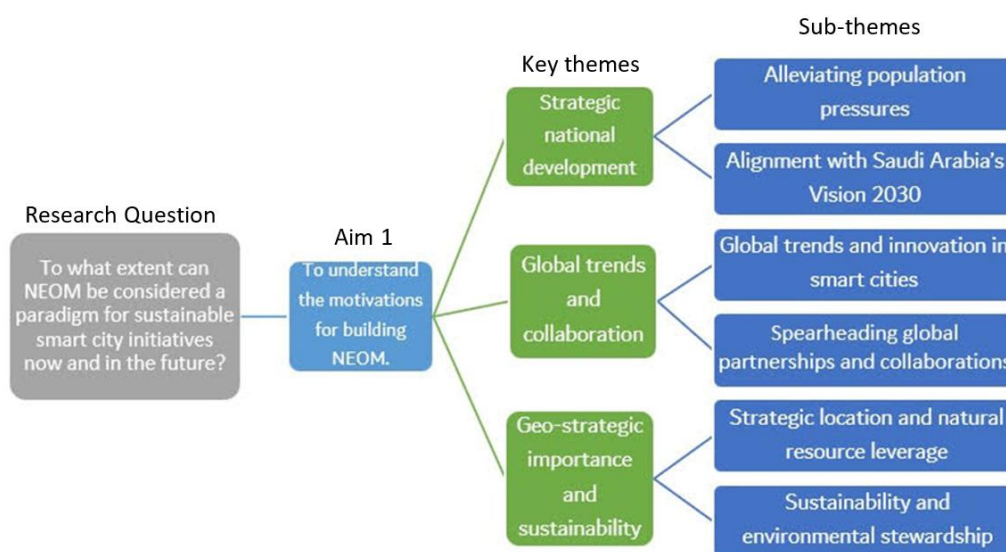
Source: (NEOM, n.d.)

It is the multifaceted motivations driving NEOM’s development that form the core discussion of the following sections of this chapter, based on the primary data gathered through the semi-structured interviews with Group 1. These were 20 experts who are either UN officials, officials from international public bodies, from two Saudi Arabian government departments, or academics from universities. These results are organised around three key themes and six sub-themes that emerged from the thematic analysis of the interview findings. It is worth noting that these themes and sub-themes are not mutually exclusive, as there are areas of overlap and interconnectedness between them. Figure 22 outlines research aim one, which is focused on

understanding motivations and the key themes and sub-themes that emerged from the coding of interview transcripts. The interpretation of these themes as communicated by the interviewees is further supported by an in-depth analysis linking primary data to relevant secondary literature.

Figure 22

Key Motivations Behind NEOM's Conceptual Development as Identified Through Thematic Analysis of External Stakeholder Interview Findings (Group 1)



4.2.1. Key Theme 1: Strategic National Development

This section focuses on NEOM motivations rooted in the Kingdom's strategic national development plans and needs. The first subsection focuses on the need to alleviate population pressures, which was identified through the interpretation of findings as a motivation for building NEOM. The linkages to Saudi Arabia's Vision 2030 are a subsequent motivation identified by the participants.

4.2.1.1 Sub-theme 1: Alleviating Population Pressures

The data showed that there was consensus among the interviewees that addressing the growing population pressures in Saudi Arabia's major cities was a significant factor driving the

development of NEOM. Rapid urbanisation and population growth have led to infrastructure and resource constraints in major Saudi cities like Riyadh and Jeddah (Chaaben et al., 2024). Chief Technical Advisor for the National Spatial Strategy, United Nations Development Programme, Saudi Arabia (Interviewee 4, Group 1), mentioned that “with the growing emphasis on sustainability, walkability, mixed-use developments, and pervasive technology, smart delivery systems have become essential. In NEOM, these advancements are key to enhancing urban living and improving the quality of life in this groundbreaking city.” This overarching concern for an improved quality of life and more efficient lifestyles was echoed by a lecturer and researcher of Urban and Regional Planning at the University of Dammam (Interviewee 7, Group 1), who also mentioned that “[i]n a similar manner, the quality of life for citizens can be improved by using smart technologies and data analysis. Moreover, all the elements of a smart city can be technologically enhanced.” Urban Planner at the Royal Commission for Riyadh (Interviewee 3, Group 1) echoes the motivation for alleviating population pressures as follows:

The initiation was influenced by a desire to shift from solving existing urban problems to creating a city that doesn’t have those problems to begin with. There seems to be a focus on zero-carbon emissions and other sustainable practices from the outset.

It was also highlighted in various news reports that Saudi Arabia’s population is expected to reach between 50 to 60 million by 2030, with half of this number being foreigners. The Crown Prince made this statement while discussing The Line project, revealing that Riyadh is set to accommodate 25 million people, and NEOM will support approximately 10 million (Argaam, 2022). NEOM’s conception as part of addressing a growing population echoes the literature that observes that this is a pressing matter globally, pressuring many cities and governments into enhancing their infrastructure and offering creative and innovative solutions to protect their populations. In terms of Saudi Arabia, Alotaibi et al (2022) state that:

As the population grows, electricity and water consumption increase, and according to government estimates, the projected demand for electricity in Saudi Arabia will exceed 120 gigawatts by 2032. Thus, finding ways to generate

energy effectively and sustainably is a major priority of Saudi Arabian smart cities' development plans. (p. 288)

As part of the motivation to alleviate such growing population pressures, the Executive, Strategy and Transactions Officer from the Ministry of Economy and Planning (Interviewee 16, Group 1) mentioned that NEOM “can create more than 380,000 jobs in the future, which has a direct link with the economic growth of this country”.

The findings reinforce the widely accepted notion that Saudi Arabia's rapid urbanisation and increasing population pressures have been key catalysts for the development of NEOM. As highlighted by various interviewees, the challenges posed by infrastructure constraints and resource demands in major cities such as Riyadh and Jeddah necessitate forward-thinking solutions. NEOM emerges as a direct response to these urban pressures, designed as a model city that integrates advanced technologies, sustainable development, and smart urban planning to enhance quality of life.

A significant theme in the discussion is the prioritisation of smart technologies and sustainable urban design which will be further explored later in this study. Interviewees from diverse professional backgrounds emphasised that NEOM aims to pre-emptively mitigate common urban issues rather than reactively addressing them. This aligns with broader urban planning trends that advocate for proactive, technology-driven solutions. This aligns with broader urban planning trends that advocate for proactive, technology-driven solutions and with urban planners and researchers who reinforce that smart delivery systems, data analytics, and sustainable energy solutions are integral to NEOM's design, ensuring it remains resilient to future population surges.

The data also align with broader demographic projections, which indicate that Saudi Arabia's population could reach between 50 to 60 million by 2030, with Riyadh and NEOM set to accommodate significant portions of this growth (Argaam, 2022). This reality underscores the urgency behind creating self-sustaining urban environments that not only absorb population growth but also foster economic development. The potential for job creation, as highlighted by Interviewee 16 (Group 1), further solidifies NEOM's role in driving economic diversification and reducing dependency on traditional sectors.

The General Manager of Smart Cities Solutions Company (Interviewee 18, Group 1) reinforced this by saying, “I believe NEOM could significantly transform Saudi Arabia’s socio-economic landscape by diversifying the economy away from oil, creating numerous job opportunities, and establishing the nation as a hub for technological innovation.” Interviewee 3 (Group 1), further stated that “[o]ne of NEOM’s primary goals is to elevate the quality of life of citizens by providing better services and innovative transportation solutions based on automation.” The first sub-theme highlights Saudi Arabia’s planned approach to growing population pressures and how NEOM aims to address these challenges by creating new economic opportunities and improving the overall quality of life in the Kingdom. The overall strategic direction is to address the needs of the population by strengthening Saudi Arabia’s economy, streamlining resource consumption, and enhancing the services infrastructure. This comprehensive approach is critical for Saudi Arabia and many cities around the world facing similar pressures.

4.2.1.2 Sub-theme 2: Alignment with Saudi Arabia’s Vision 2030

Saudi Vision 2030 and the accompanying National Transformation Plan were found to be pivotal drivers behind the NEOM initiative, as they aim to transition the Kingdom away from its historical reliance on oil revenues towards a more diversified knowledge-based economy (Alshuwaikhat & Mohammed, 2017; Hassan, 2020). Senior Telecom Consultant (Interviewee 8, Group 1) clearly emphasised “NEOM is at the heart of Vision 2030,” while Director of the National Urban Observatory, Ministry of Municipal and Rural Affairs (Interviewee 6, Group 1), elaborated further:

NEOM is a key component of Vision 2030. It aligns with the goals of diversifying the economy, enhancing the quality of life, and positioning Saudi Arabia as a global hub for trade and innovation. NEOM embodies the vision’s aspirations for a sustainable and prosperous future.

The statements from key stakeholders highlight NEOM’s role as both a symbolic and functional embodiment of Vision 2030, integrating economic, environmental, and societal aspirations. The centrality of NEOM within Saudi Vision 2030 is underscored by its alignment with the broader national objectives of economic diversification, sustainability, and technological innovation. Interviewee 7 (Group 1), for example, gave their view as follows:

I believe NEOM is a pivotal project that could drive Saudi Arabia's transition from an oil-dependent economy to a more diversified one. Vision 2030 focuses on diversifying the economy and reducing dependence on oil. NEOM, with its emphasis on renewable energy and innovative industries, directly supports this goal. I believe that NEOM will be a cornerstone in achieving the economic diversification envisaged in Vision 2030.

Chair of the SSC Programme, King Fahd University (Interviewee 15, Group 1), likewise expressed the idea that NEOM was more than a smart city initiative:

NEOM epitomises Vision 2030's goals of economic diversification, technological advancement, and sustainable development. It's a step towards integrating Saudi Arabia more closely with the global economy and enhancing its tourism and cultural exchange.

Interviewee 8 (Group 1) reiterated this by stating that “[k]ey factors of the motivations to build NEOM include the desire for economic diversification in Saudi Arabia, reducing reliance on oil,” while Smart City Senior Specialist at Saudi Data and AI Authority (Interviewee 17, Group 1), likewise observed that “NEOM is central to Saudi Arabia's Vision 2030 strategy, which seeks to reduce the country's reliance on oil and gas and promote economic diversification through investment in innovative industries and sustainable development.”

Indeed, the stated aim in NEOM's own literature is for the project to contribute SAR 180 billion (approximately US\$48 billion) to Saudi Arabia's GDP by 2030 (NEOM, n.d.). In addition, NEOM's focus on developing cutting-edge technologies, advanced manufacturing, and a vibrant tourism sector reflects the Saudi government's concerted efforts to expand its economic base beyond the energy sector (Alshuwaikhat & Mohammed, 2017; Ouassaf et al., 2023).

The language used by the participants to articulate the place of NEOM in the aspirations of the country was notably very similar, with most interviewees recognising NEOM as a strategic effort to attract global investment in sectors other than fossil fuels (Alkhrijh & Wonsuk, 2024), and by leveraging smart technologies, emerge as a leader in sustainability and the global

knowledge economy (Khan, 2020). Economic Advisor at the Decision Support Centre (Interviewee 19, Group 1) summed this up as follows:

I see NEOM as perfectly aligned with Saudi Arabia's Vision 2030. It embodies the plan's goals of economic diversification, sustainable development, and global integration. NEOM's focus on renewable energy and smart city technology directly supports Vision 2030's emphasis on reducing oil dependence and fostering a sustainable future.

4.2.2. Key Theme 1 Discussion

The first theme identified from the findings regarding the motivations behind NEOM, is its position as part of the strategic national development of Saudi Arabia. This was articulated primarily in terms of a strategic response to Saudi Arabia's rapid urbanisation and population growth, and as a central component of the Saudi Vision 2030. With respect to addressing the recognised global challenges of expanding urbanisation, the interviewees emphasised the proactive nature of NEOM as a strategy, aligning with contemporary urban geography theories that advocate proactive and technology-driven planning (Bibri, 2021b; Batty, 2018), and reflecting a broader global trend, where governments seek pre-emptive solutions rather than reactive urban development approaches (Bibri, 2021b). As Interviewee 3 states, the initiation was influenced by a desire to shift from solving existing urban problems to creating a city that doesn't have those problems to begin with. With cities like Riyadh and Jeddah facing increasing infrastructure pressures, NEOM presents an alternative model that integrates smart technologies, sustainability, and innovative urban design to mitigate these challenges from the outset (Kitchin, 2014a).

As part of this proactive approach, a key aspect highlighted by the interview findings is NEOM's emphasis on smart urbanism, automation, and sustainability as mechanisms for enhancing quality of life. The integration of walkability, mixed-use developments, and digital connectivity aligns with Gehl's (2010) human-centred urbanism and Batty's (2018b) smart city frameworks. Beyond infrastructure, the interviewees also framed NEOM as a catalyst for economic diversification and job creation, responding to the anticipated population surge (Clark,

2013). The vision for NEOM, as discussed by the interviewees, suggests an attempt to reshape Saudi Arabia's urban landscape into a self-sustaining, globally competitive hub, reducing reliance on oil while fostering a high-tech economy (Cohen, 2019). As supported by the perspectives expressed in the research findings, it seems that the NEOM project exemplifies Harvey's (1989) urban entrepreneurialism,⁵ where cities function as engines for economic transformation.

Furthermore, the findings explicitly show an understanding of NEOM as a strategic step addressing concerns over the long-term viability of an oil-dependent economy. The expert insights highlight a strong consensus on the necessity of reducing Saudi Arabia's dependency on oil, a theme that is reinforced by the Kingdom's historical vulnerability to fluctuating energy markets (Moshashai et al., 2018). This concern was particularly evident in the responses to the question connecting NEOM to the Saudi Vision 2030. It was apparent throughout the interviews how progress, development and economic transition towards sustainability and diversification were significant to stakeholders and how these elements are deeply interconnected within the Saudi Vision 2030 and NEOM's core features (Alqahtany, 2025). There was a shared understanding among the interviewees that NEOM exemplifies this broader national objective and that the city's development represents a vital component of Saudi Arabia's economic diversification strategy.

The consensus among the interviewees on the alignment of NEOM with the Saudi Vision 2030 was notable, indicating perhaps both the effective communication and embedding of the Vision and that on several levels NEOM can be clearly recognisable as an intentional developmental strategy aimed at economic transformation, sustainability, and global integration. Interviewees repeatedly stressed that NEOM serves as a tangible mechanism for achieving Vision 2030's broader goals, particularly through its emphasis on renewable energy, AI, and advanced manufacturing. Thus, it might be argued that NEOM is not merely an economic initiative but, as other studies have already noted (Alshuwaikhat & Mohammed, 2017; Hassan, 2020), also a

⁵ Harvey's (1989) theorisation of urban entrepreneurialism refers to a shift in urban governance from a managerial approach, concerned with service provision and local welfare, towards a competitive, market-oriented model. In this framework, cities increasingly operate like businesses, seeking investment, tourism, and economic growth through branding, public-private partnerships, and large-scale flagship projects. This transformation reflects broader neoliberal trends, wherein urban policy is shaped by inter-city competition and speculative strategies rather than redistributive aims.

symbolic representation of Saudi Arabia's aspirations to position itself as a global leader in innovation and smart urban development.

In sum, regarded as a key theme in this analysis, the centrality of economic diversification and sustainable development as core motivations behind the NEOM project is unequivocal based on the evidence gathered from the expert interviews and supporting literature (see section 2.4). In addition, the pressing global climate change agenda and international scrutiny on the environmental impact of fossil fuels have been referred to in the interviews as part of Saudi Vision 2030 and the motivations behind NEOM.

4.2.3. Key Theme 2: Global Leadership and Collaboration

As identified by expert interviewees, global leadership and collaboration are some of the main motivations for building NEOM. Two key aspects emerged under this broader theme: the aspiration for NEOM to become a global hub for innovation, technology, and sustainability, and the desire to spearhead international collaborations and partnerships to drive the future of smart and sustainable cities. Interviewees emphasised Saudi Arabia's ambition for NEOM to become a globally recognised hub and paragon for innovation, technology, and sustainability as will be outlined below.

4.2.3.1 Sub-theme 1: Global Trends and Innovation in Smart Cities

There was an overall emphasis from 19 of the interviewees that Saudi Arabia's ambition for NEOM to become a globally recognised hub for innovation, technology and sustainability was a key motivation behind its conceptualisation. Interviewee 18 (Group 1) expressed it as follows:

I believe NEOM could significantly transform Saudi Arabia's socio-economic landscape by diversifying the economy away from oil, creating numerous job opportunities, and establishing the nation as a hub for technological innovation. This transformation could extend beyond Saudi Arabia, influencing regional and global economic trends.

This perspective underscores the broader strategic intent behind NEOM, not only as a national economic driver but also as a project with potential global ramifications. As highlighted by Interviewee 15 (Group 1), “The design of NEOM and its underlying concept completely differ from anything we have studied or known. This is not just about changing the idea of planning; it is about experimenting with something bold and new.” By positioning itself at the forefront of technological advancement and sustainability, NEOM aims to attract international talent, investment, and partnerships, reinforcing Saudi Arabia’s role in shaping the future of innovation and economic diversification on a global scale. Interviewee 3 (Group 1) elaborated further:

NEOM is envisioned as a global hub that embodies Saudi Arabia's ambition to transition into a knowledge-based economy. It will serve as a testbed for advanced technologies, renewable energy solutions and sustainable urban planning approaches that can be scaled and replicated worldwide.

This emphasis on NEOM as a pioneering model reflects Saudi Arabia’s broader commitment to redefining urban development and economic strategy in the 21st century. Urban Designer at the Regional Government (Interviewee 10, Group 1), mentioned that “[t]he underlying goal is for NEOM to become a global innovation hub and a model for future sustainable smart city development that can be replicated worldwide.” By integrating cutting-edge technology with sustainability-driven policies, NEOM not only seeks to transform the Kingdom’s economic landscape but also to establish itself as a benchmark for future cities worldwide. The project's success could set a precedent for similar large-scale initiatives, reinforcing its potential to influence global discourse on smart cities and sustainable innovation.

These perspectives from expert stakeholders underline Saudi Arabia's aspirations for NEOM to become a globally recognised model for smart cities that pushes the boundaries of innovation and showcases the Kingdom's technological capabilities. The findings suggest that NEOM is viewed as an opportunity for Saudi Arabia to position itself as a leader in the global smart city landscape. Interviewee 6 (Group 1) supported this in stating,

Certainly. The NEOM project was conceived with the vision of creating a new model of sustainable living, driven by technological advancement. Key factors

include the desire for economic diversification in Saudi Arabia, reducing reliance on oil, and establishing a global hub for innovation.

The clear statement of the perceived global ambitions attached to NEOM that emerged from the interview findings align with the insights from secondary sources, which outline that Saudi Arabia has plans to use NEOM as a platform to showcase its capabilities in AI, renewable energy and next-generation urban planning, and see this aim for NEOM to be a global hub for innovation and technology reflected in its bold conceptualisation as not just a smart city but as a cognitive city (Hassan, 2020; NEOM, 2022c).

4.2.3.2 Sub-theme 2: Spearheading Global Partnerships and Collaborations

In addition to the ambition for NEOM to become a global centre of innovation, the Interviewees also highlighted the motivation to leverage international collaborations and partnerships to drive the future of smart and sustainable cities, as mentioned by the Urban Advisor at the Ministry of Municipal and Rural Affairs (Interviewee 1, Group 1):

NEOM's development strategy emphasises the importance of global cooperation and knowledge sharing. The project aims to attract leading international companies, researchers and innovators to co-create solutions for the city of the future.

This emphasis on global collaboration reflects Saudi Arabia's broader strategy of integrating itself into the international knowledge economy while positioning NEOM as a model for future urban development. By fostering partnerships with leading experts and institutions, NEOM aims to accelerate innovation, ensure the adoption of best practices, and solidify its status as a hub for technological and sustainable advancements on a global scale. Senior Manager for Solutions and Application Development, Elm Company (Interviewee 20, Group 1), further elaborated:

I think that if collaboration between different countries is established for the NEOM Project, it will help to know about a wide range of talent pools from various countries ... collaboration with international organisations can be done by involving in partnership with the global educational institutions. NEOM could be

a magnet for skilled professionals which can help in creating an innovative and dynamic community. Also, global collaboration can help in getting access to international markets that helps in creating trade opportunities.

This perspective highlights the dual benefits of international collaboration; not only does it facilitate knowledge exchange and technological advancement, but it also enhances NEOM's economic potential by expanding access to global talent and markets. This view was echoed by Interviewee 15 (Group 1), who stated that:

NEOM represents Saudi Arabia's attempt to position itself as a global leader in sustainable urbanisation. It seeks to forge strategic partnerships with the world's foremost experts, companies, and institutions to shape the future of smart and sustainable city development collectively.

By engaging with leading educational institutions and multinational organisations, NEOM aims to cultivate a dynamic ecosystem that attracts top-tier professionals, fosters innovation-driven industries, and strengthens Saudi Arabia's position in the global economy. Interviewee 3 (Group 1) echoed this, stating:

NEOM's success is intrinsically linked to its ability to leverage international expertise, capital, and technology. The project's leadership is actively engaging with global partners to co-develop cutting-edge solutions that can serve as a blueprint for sustainable urbanisation worldwide.

These expert perspectives highlight how a key motivation behind NEOM is not just establishing Saudi Arabia as a global leader in smart and sustainable city development but doing so through spearheading strategic international collaborations and knowledge exchange.

Secondary sources also corroborate the emphasis on global collaborations and partnerships in the development of NEOM. It is noted that the project aims to invite "the creative class around the world" to participate in shaping the city, with promises of a new life in a beautiful, technology-driven environment (Farag, 2019, p.35); NEOM plans for establishing modern manufacturing facilities, industrial research and development, and an international airport, all of which are deemed to be unprecedented in scale and diversity for the region indicate the project's global

orientation (Mittal et al., 2024); while the intention to become a global hub for trade, innovation, and knowledge, underscore the project's ambitions to establish itself as a centre for international cooperation and collaboration (Farag, 2019). This can be regarded as a strategic move by Saudi Arabia to position itself as a pioneer in the region and a global leader in smart and sustainable urbanisation, which remains relatively limited in the Middle East.

4.2.4. Key Theme 2 Discussion

The findings from expert interviews highlight that NEOM's vision goes beyond simply being a national economic overhaul; it is planned to be an international hub for innovation, sustainability, and technology. A main driving factor in its conceptualisation, according to the interviewees, is the strategic aim to utilise international partnerships and co-working to make Saudi Arabia the leader in the smart cities of the future. This is complementary to Vision 2030's general vision to integrate globally and break reliance on oil revenues by building a diversified, knowledge-driven economy (Hassan, 2020; Alqahtany, 2025). A strong focus on international partnership was brought out in the findings through numerous references to the attraction of international expertise, investments, and human capital. Interviewee 1 (Group 1) highlighted the importance of international partnerships in determining the city's growth, stating that NEOM is already engaging international companies and researchers to co-design solutions for future living in cities. Interviewee 20 (Group 1) was in agreement, highlighting the importance of partnering with international educational institutions and professional experts in establishing an innovative and cosmopolitan community. These observations imply that NEOM is designed to be not just a demonstration of Saudi technical capabilities, but an open hub for cross-border knowledge flow, and hence an engine for international talent attraction and trade.

The role that partnerships play in positioning NEOM as a smart urbanisation leader was reinforced by Interviewee 15 (Group 1), who indicated that NEOM aims to become a model for smart city growth by teaming up with international leaders of expertise and institutions. This is part of a more widespread geopolitical effort by Saudi Arabia to become embedded in the international knowledge economy, again supported by the academic literature (e.g., Farag, 2019; Mittal et al., 2024).

Furthermore, the interview data indicate how NEOM is envisioned not only as an economic and technological experiment but also as a testbed for sustainable urban planning that can be replicated globally. Interviewee 3 (Group 1) emphasised that NEOM's success is "intrinsically linked" to its ability to leverage global expertise and capital, reinforcing the idea that its ambitions extend far beyond Saudi Arabia's borders. The city is strategically positioned to serve as a prototype for large-scale, technology-driven urban development, with its leadership actively engaging global partners to create scalable, sustainable solutions for the future of urbanisation. This aligns with the broader literature on smart cities, which argues that the most successful projects are those that integrate global best practices while adapting to local economic and environmental conditions (Frag, 2019; Fadel & Bhaa, 2024).

In sum, by pursuing international collaborations and positioning itself as a hub for technological advancement, NEOM represents Saudi Arabia's attempt to shift from being an oil-dependent economy to a global leader in smart and sustainable urbanisation. As highlighted by the interviewee insights and by supporting academic research, the project's long-term success will hinge on its ability to attract global investment, integrate cutting-edge innovations, and maintain its position as a competitive and forward-thinking model for urban development. If NEOM effectively establishes itself as a centre for global cooperation, it could serve as a precedent for future megaprojects that seek to redefine urban living on an international scale.

4.2.5. Key theme 3: Geo-strategic Importance and Sustainability

The interviews with Group 1 stakeholders revealed a third key theme that concerns NEOM's geo-strategic importance and dedication to sustainability. This theme emphasises the unique advantages of NEOM's location and how they are being utilised to build a sustainable urban environment for the future. NEOM's strategic location bordering the Aqaba gulf, with 468 km of coastline featuring beaches and coral reefs, presents both opportunities and challenges that have profoundly shaped its planning and development (NEOM, n.d.). External experts have likewise highlighted how this location offers access to abundant natural resources and positions NEOM as a potential global hub for trade, innovation, and sustainable living.

4.2.5.1 Sub-theme 1: Strategic Location and Natural Resource Leverage

Beyond the economic and global leadership motivations, several interviewees highlighted the strategic geographic location of NEOM and its potential to leverage natural resources as a key factor behind the initiative. As described earlier, NEOM is planned to be located along the Red Sea coast, which the expert stakeholders saw as a unique and advantageous factor. Interviewee 1 (Group 1) noted, “The uniqueness of NEOM’s location, leveraging the Red Sea’s natural resources, is a significant factor in its conception.” Interviewee 15 (Group 1) expanded on this, stating, “NEOM’s location along the Red Sea, with its temperate climate and rich biodiversity, presents significant opportunities to develop innovative sustainable solutions that leverage the region’s natural assets,” a view similarly expressed both by Interviewee 6 and Executive Director, United Nations Global Compact (Interviewee 13, Group 1), who emphasised its role in fostering international trade, tourism, and sustainable development. Interviewee 6 noted that “NEOM’s coastal location places it at a critical intersection for global maritime routes, which is instrumental for future trade and economic flows.” In a similar vein, Interviewee 13 highlighted that “the Red Sea’s strategic position offers immense potential not just for logistics and commerce, but for advancing sustainable tourism and environmental partnerships that align with global development goals.”

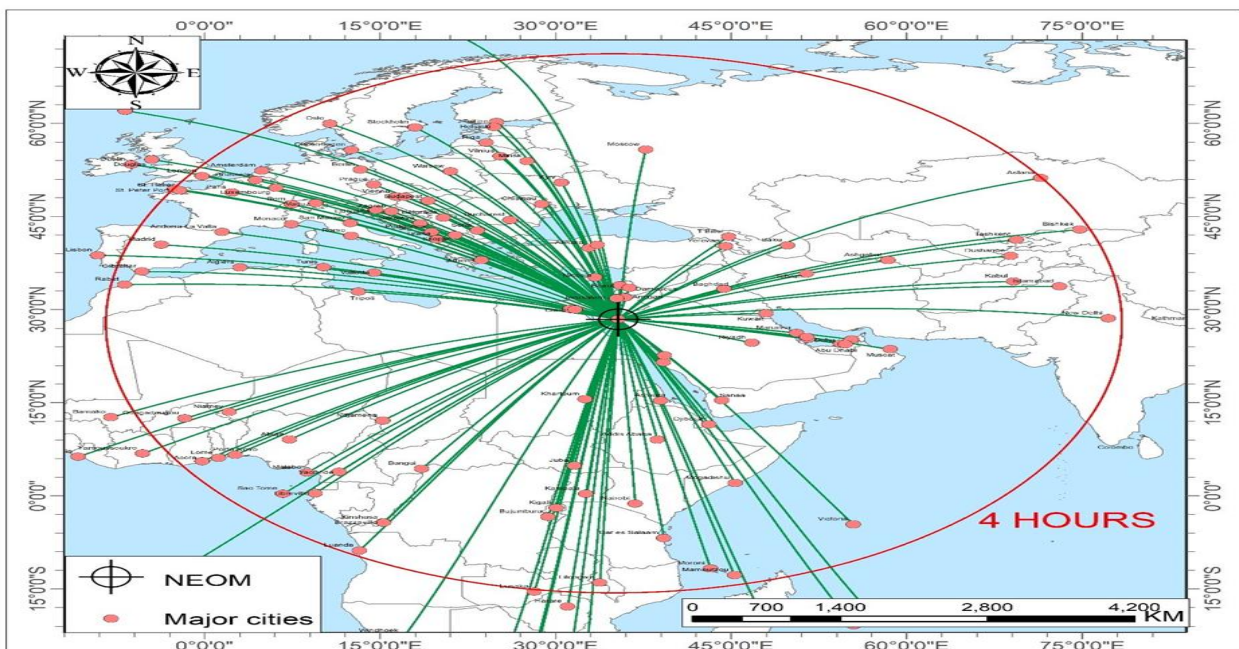
While mention was made of the natural assets integral to the region, perhaps the more particular perspective that emerged from the interview conversations related to the logistical advantages of the location acting as a major driver in shaping NEOM’s conception in terms of its potential for global connectivity. Smart City Senior Specialist at Saudi Data and AI Authority (Interviewee 17, Group 1) encapsulated this as follows:

This also gives [NEOM] a unique aspect: the strategic location and its proximity to the regions, as well as its proximity to 13% of global economic maritime traffic passing through it. NEOM’s location places it at the intersection of Asia, Europe, and Africa, making it an ideal hub for international collaboration, trade, and tourism. Its proximity to major global shipping routes is also a significant advantage.

This view reflects the literature which has noted that the Red Sea’s maritime routes position NEOM as a potential global trade hub, enhancing Saudi Arabia’s connectivity with key markets in Africa, Europe, and Asia, aligning with the broader objectives of Vision 2030 (Hassan, 2020), and is echoed by Interviewee 20 (Group 1), who adds that “NEOM’s proximity to major global markets indicates that 70% of the world’s population can reach NEOM within an eight-hour flight, significantly enhancing its potential as a global hub.” The map presented in Figure 23 visually enhances these statements by depicting NEOM’s strategic position relative to major cities within a four-hour travel radius (Figure 23), highlighting the possibility for NEOM to leverage its strategic location to facilitate easy access to international markets, attract tourists, and serve as a crossroads for international collaboration with other major urban centres.

Figure 23

Map showing the location of NEOM and its proximity to major cities within a 4-hour radius



Source: Adapted by the author from the Saudi Arabia National Spatial Reference System (SANSRS) Implementation Guidelines (2022).

The interviewees’ responses indicate that a highly significant factor in the planning and conceptualisation of NEOM was the recognition of the Red Sea coast as a strategic economic and geo-political location with natural resource potential. Perhaps the significant emphasis to emerge

from the interviews on this point is the idea of ‘leverage’: the ability to leverage the Red Sea’s ecosystems, climatic conditions, and easy accessibility to major economic markets was seen as crucial for realising NEOM’s ambitions of becoming a globally recognised model for sustainable urban development with a growing economy.

This theme of location and leverage aligns with what has already been discussed within the literature review. For example, Samoylova et al. (2018) emphasise the importance of multifactorial evaluation in choosing urban development solutions, focusing on sustainability-oriented approaches in city planning. This aligns with NEOM’s goal to use advanced modelling and simulation techniques to optimise its integration of renewable energy and urban systems, and to demonstrate, through GIS-based modelling, that approximately 198.89 km² of coastal and plain areas in southwestern NEOM are suitable for sustainable urban expansion because of their proximity to planned infrastructure and their capacity to incorporate desalination, tourism, and renewable energy (Alogayell et al., 2024).

I would suggest that what the interview data brings into more clarity is that NEOM’s geographical advantages are not merely passive assets but actively shape its development strategy, influencing its infrastructure, economic focus, and global positioning as a future-oriented city integrating trade, sustainability, and technological advancement.

4.2.5.2 Sub-theme 2: Sustainability and Environmental Stewardship

External expert interviewees also emphasised that the imperative for sustainable development and environmental stewardship were central motivations behind NEOM. Sustainability was described as a core tenet of the project, with the goal of establishing NEOM as a global benchmark for green and climate-resilient urban development. As set out in previous chapters (see sections 1.2 and 2.3.8), in line with the Kingdom’s transformation towards a better future, the project aims to reduce environmental impacts and carbon footprint through innovative approaches to energy, water, waste management and land use. These aspects were picked up by one of the external stakeholders, Interviewee 1 (Group 1), who stated

I believe that NEOM aims to be a beacon of technology and sustainability, set to be built from the ground up with a focus on different sectors like energy, water, food and more, which may distinguish it from other smart city projects globally.

It was also notable that the understanding on the part of the interviewees was that sustainability is not merely an added feature but a foundational principle driving the project's design and long-term objectives, as expressed by Interviewee 15 (Group 1):

Sustainability and environmental protection are at the heart of NEOM's vision. The project seeks to demonstrate how a city can be designed and built with the principles of sustainability, resilience, and circularity at its core.

These findings highlight a broader commitment within NEOM to redefine urban sustainability by integrating cutting-edge technologies across multiple sectors. Unlike conventional smart city initiatives, NEOM's approach appears to be deeply rooted in a holistic vision that prioritises environmental resilience alongside economic and technological advancement. Interviewee 7 (Group 1) asserted that in their understanding,

NEOM's innovative approach to urban planning and its emphasis on renewable energy, clean mobility and quality of life are designed to make it a model for sustainable development that can be replicated in other parts of the world.

These perspectives reinforce the idea that NEOM is not only a national initiative but also a potential global model for future cities. By embedding sustainability into its core design, spanning renewable energy, clean mobility, and circular economy principles, NEOM aims to set a new standard for environmentally conscious urban development. The emphasis on replicability suggests that its impact could extend beyond Saudi Arabia, influencing global discourse on sustainable city planning and resilience strategies. This also resonates with the first key theme of this section, strategic national development and Vision 2030, where sustainability and the environment are identified as crucial underpinnings of NEOM's objectives. While it was clear from the interviews that Neom is perceived as a flagship in this regard, which chimes with the overall drive for positioning the Kingdom as a global leader, the interview discussions also indicated that NEOM is seen as a serious effort to address climate resilience particularly in terms

of sustainable energy and the stewardship of resources. Comments such as a green print for future cities and climate resilience were frequently used in expressing what was seen as the key aims behind designing a smart city in this more ambitious way that fosters both economic growth and environmental protection. The need to take action was reflected on by Interviewee 11 (Group 1) who said, “We can’t delay anymore. *NEOM is a chance* to demonstrate that cities can be built to regenerate, not deplete, their environment.”.

The findings thus indicate that promoting sustainability and environmental stewardship are clearly identifiable core motivations underpinning the NEOM initiative, which align with broader literature on smart city development, which highlight the importance of embedding principles of environmental protection, resource efficiency, and climate resilience into the planning and design of smart cities (Colding & Barthel, 2017; Bibri & Krogstie, 2017), harnessing technology and innovation to drive more sustainable urban outcomes.

4.2.6. Key Theme 3 Discussion

The findings from the interviews and supporting literature highlight how NEOM’s strategic location and commitment to sustainability are not only defining aspects of the project but also key motivations behind its conceptualisation, and, I would suggest, deeply interconnected ambitions, reinforcing each other to create a unique blueprint for the future of smart and sustainable cities. The dual focus on leveraging the region’s natural assets and positioning NEOM as a model for environmental stewardship reflects broader global trends in urban development, where cities are increasingly designed to integrate economic, ecological, and technological priorities (Mori & Christodoulou, 2012; Yigitcanlar & Kamruzzaman, 2018).

NEOM’s positioning along the Red Sea is a critical advantage that extends beyond conventional economic and trade benefits. While its location provides direct access to key global markets and maritime routes, aligning with Vision 2030’s goal of integrating Saudi Arabia into the global economy (Hassan, 2020), the geographical context also enables the project to pioneer sustainable development initiatives. As highlighted by interviewees, the coastal, mountainous, and desert terrains provide opportunities for implementing climate-responsive architecture, marine

conservation efforts, and sustainable tourism models. This aligns with broader academic discourse on how geographic positioning can shape smart city design and influence long-term economic and environmental outcomes (Colding & Barthel, 2017). However, the project faces multifarious challenges such as geopolitical risks, economic uncertainty, and the need for large-scale infrastructure development (Algumzi et al., 2022). Keywords that arose in the interviews when the importance of location was emphasised were ‘leverage’ and ‘opportunity’. While not explicitly stated, this might imply that amidst the high level of positivity regarding location, there is recognition of the inherent challenges still faced in capitalising on the advantages offered by the positioning of NEOM. As Algumzi et al. (2022) point out, there are geopolitical risks, for example, NEOM borders Egypt, Israel/Palestine, and Jordan which is frequently in tension or volatile, along with the challenges of economic uncertainty and the need for large-scale infrastructure development. A significant aspect highlighted in the interview data is location in terms of strategic connectivity.

As noted by Interviewee 17 (Group 1), NEOM's proximity to global shipping routes and international markets places it at a logistical advantage, reinforcing its role as a future hub for trade and cross-border collaboration. The claim that “70% of the world’s population can reach NEOM within an eight-hour flight” underscores the project’s ambitions to attract global investment, businesses, and skilled professionals. However, while this strategic positioning enhances its economic viability, it also presents challenges in terms of balancing rapid development with ecological preservation. The Red Sea’s unique marine ecosystems, including coral reefs and biodiversity hotspots, require careful management to prevent environmental degradation. The findings suggest that NEOM is designed with this balance in mind, leveraging its natural advantages while simultaneously embedding environmental protection measures into its core development strategy.

Beyond its geographical significance, NEOM’s sustainability-driven approach distinguishes it from traditional megaprojects, positioning it as a potential global model for climate-resilient urbanisation. The interviews reveal a strong consensus among stakeholders that sustainability is not an auxiliary feature but a defining pillar of NEOM’s identity. Interviewee 1 (Group 1) described NEOM as “a beacon of technology and sustainability,” while Interviewee 15 (Group 1) emphasised that “sustainability and environmental protection are at the heart of

NEOM's vision." These perspectives align with global trends in smart city development, where cities are increasingly viewed as key players in mitigating climate change through innovative urban planning and resource-efficient technologies (Bibri & Krogstie, 2017).

Academic literature reinforces the importance of embedding sustainability into urban design, emphasising how resource efficiency, renewable energy, and circular economy practices must be integrated from the early stages of city planning (Mori & Christodoulou, 2012; Yigitcanlar & Kamruzzaman, 2018). NEOM's focus on renewable energy, clean mobility, and water conservation reflects these principles, signalling a shift towards a more responsible urban development model. This also resonates with Vision 2030's broader sustainability objectives, as outlined in the official report Vision 2030: The Journey So Far, which states that Saudi Arabia is committed to "creating a sustainable energy future that fosters continued economic growth while protecting the environment." NEOM, therefore, serves as a tangible expression of this commitment, aligning national priorities with global sustainability agendas.

4.3. Integrated Discussion (Group 1; Key themes 1 – 3)

The findings from the interviews with Group 1 stakeholders, external NEOM experts and professionals, illustrate a multifaceted vision for NEOM, where economic diversification, sustainability, and global positioning intersect as central motivations. Across the key themes that emerged from the data, it becomes evident that the underlying motivation for NEOM is not just a national project, but an ambitious initiative designed to transform Saudi Arabia's economic structure, urban landscape, and environmental strategy while positioning the Kingdom as a leader in smart city innovation. The convergence of themes, economic and strategic development (Key Theme 1), global leadership and collaboration (Key Theme 2), and geo-strategic importance and sustainability (Key Theme 3), highlights the interconnected nature of NEOM's conceptualisation and planning.

Key Theme 1, relating to strategic development, highlights NEOM's role in addressing Saudi Arabia's growing population pressures and its alignment with Vision 2030. There was clear consensus across the interviewees that addressing the challenges a growing populace is placing on

Saudi Arabian cities is a major motivation for the NEOM smart city initiative. With the population of Saudi Arabia expected to reach 50 to 60 million by 2030, cities like Riyadh and Jeddah face increasing strain on infrastructure, housing, and essential services (Argaam, 2022). NEOM serves as a strategic response, redistributing population growth through the creation of a new urban centre built on advanced infrastructure, smart technologies, and sustainable urban design (Alshuwaikhat & Mohammed, 2017; Hassan, 2020). This aligns with global urban planning strategies that advocate for decentralisation to manage rapid urban expansion (Beatley, 2013). The other clear observation made by the interviewees is that rather than reacting to infrastructural challenges, NEOM adopts a proactive planning model to alleviate pressures on existing metropolitan areas. Beyond population management, NEOM is a key pillar of Saudi Vision 2030, representing the Kingdom's shift toward economic diversification and urban transformation, and diversification was the word repeatedly used by the interviewees in describing the place they perceived NEOM taking within the 2030 Vision. Again, there was a notable shared understanding that as one of the most ambitious megaprojects, NEOM embodies the transition from an oil-dependent economy to a knowledge-based, innovation-driven model (Alshuwaikhat & Mohammed, 2017; Hassan, 2020). Clear reference was also made to the aim for NEOM, by integrating technological advancements, foreign investments, and emerging industries, to position Saudi Arabia as a global hub for innovation. Moreover, its development strengthens trade connections and enhances the country's geopolitical influence, aligning with broader national strategies that use large-scale projects as catalysts for economic reinvention (Moshashai et al., 2018).

Key Theme 2, as identified from the qualitative data, built upon this by exploring NEOM's global ambitions and its reliance on international collaboration. The expert interviews emphasised that global partnerships are a fundamental driver of NEOM's development, as they enable access to world-class expertise, investment, and talent. Stakeholders described NEOM as a platform for knowledge exchange, where international companies, research institutions, and policymakers can co-develop solutions for future urban challenges. This aligns with trends in smart city development, where cross-border collaboration plays a pivotal role in fostering innovation and ensuring cities remain at the forefront of technological and environmental advancements (Bibri & Krogstie, 2017; Yigitcanlar & Kamruzzaman, 2018). However, it was interesting that while the weight of the views identified NEOM's openness to global collaboration as strengthening its strategic vision, some question was raised about the practicalities of governance, integration, and

regulatory alignment with international stakeholders. It seems the challenge for Saudi Arabia will be to balance national interests with international engagement while ensuring that NEOM remains competitive and adaptable to evolving global trends.

The perspectives of the interviewees help clarify the aims and motivations behind NEOM, where openness to global collaboration is identified as strengthening its strategic vision. However, it should be noted that while such openness is indeed positive, there are valid questions raised in the literature about the practicalities of governance, integration, and regulatory alignment with international stakeholders at this scale. It seems the challenge for Saudi Arabia will be to balance national interests with international engagement while ensuring that NEOM remains competitive and adaptable to evolving global trends.

Key Theme 3 provided further depth by focusing on NEOM's geo-strategic advantages and its commitment to sustainability. Stakeholders highlighted the importance of NEOM's location along the Red Sea, describing it as a key factor in shaping the city's identity. The ability to leverage natural resources, optimise trade access, and implement climate-responsive urban solutions was seen as a major strength that distinguishes NEOM from other global megaprojects. The perspectives particularly brought into focus that NEOM's location is not merely a passive backdrop but an active enabler of its vision, aligning with global trends in smart city planning and underscoring its broader strategic intent. The emphasis on sustainability and environmental stewardship reinforced that NEOM is not only an economic project but also a model for climate-resilient urban development. Stakeholders described how the project aims to integrate renewable energy, circular economy principles, and innovative infrastructure to create a city that aligns with contemporary global sustainability objectives (Colding & Barthel, 2017). The fact that there was consensus across the interviewees that sustainability was not an added feature but foundational seems to reinforce Saudi Arabia's commitment to ensuring long-term sustainability works alongside economic transformation. However, the language remains as aims and objectives and the literature cautions that large-scale sustainable urban projects often face challenges in implementation, including technological feasibility, long-term resource management, and the need for adaptive governance structures (Mori & Christodoulou, 2012). The success of NEOM's sustainability vision will therefore depend on how effectively these ambitious plans are translated

into actionable, scalable solutions that balance economic growth with environmental responsibility.

Overall, the three key themes for Group 1 provide a comprehensive understanding of the motivations driving NEOM's conceptualisation and planning. Economic transformation, global engagement, and environmental sustainability are not separate objectives but deeply interconnected aspects of NEOM's development strategy. The findings indicate that NEOM is designed as more than just a megacity; it is a national and global experiment in future urban living, economic diversification, and technological progress. However, while the interviews underscore the optimism surrounding NEOM's potential, and show a coherence of understanding across the multiple stakeholders as to the stated aims, the high level of ambition present in the language may also implicitly reveal the potential depth of the underlying challenges that accompany this. The scale of investment required, the complexity of international partnerships, and the need for sustainable implementation all present potential barriers that must be addressed to realise NEOM's vision.

In assessing the qualitative material in light of the secondary literature, I suggest that even within the three themes themselves, there are a number of emphases that the interviews brought into particular focus. First is the idea of necessity. NEOM is an ambitious initiative, but as the participants observed, it represents a necessary shift for Saudi Arabia in terms of addressing population challenges and moving away from reliance on a fossil-fuel economy, as well as in aligning the Kingdom with emerging global trends in smart cities, digital economies, and sustainability-driven urbanisation. Ultimately, NEOM's development will serve as a critical test case for how nations facing similar imperatives can reinvent themselves through strategic investment in innovation, sustainability, and global collaboration.

The second aspect is the clear intention for NEOM's vision to extend beyond national transformation; it aims to be a replicable model for future cities worldwide. Interviewee 7 explicitly described NEOM as "a model for sustainable development that can be replicated in other parts of the world," reinforcing its broader global aspirations. This reflects a growing trend in smart city initiatives, where successful models are designed to be adaptable and scalable across different urban contexts (Bibri & Krogstie, 2017). From a critical perspective, however, the extent to which

NEOM succeeds in becoming a replicable model for future cities will depend on its ability to integrate economic, technological, and environmental goals into a cohesive, functioning urban system, and particularly its ability to translate ambitious sustainability plans into actionable, scalable solutions. Large-scale sustainable urban projects often face challenges related to resource allocation, technological feasibility, and governance (Colding & Barthel, 2017). Ensuring that NEOM's environmental commitments are upheld in practice, rather than being sidelined in favour of economic imperatives, will be crucial in determining its credibility as a global benchmark for sustainable cities.

The third notable strand was the emphasis on international collaboration, which is particularly relevant to its sustainability agenda. By working with global experts, institutions, and businesses, NEOM could integrate best practices in climate-resilient infrastructure, waste reduction, and ecological preservation. This aligns with literature that emphasises the role of knowledge exchange in driving sustainable urban innovation (Mori & Christodoulou, 2012). Once more, the extent to which NEOM can truly serve as a blueprint for future cities will depend on its ability to overcome the challenge of balancing national interests with global trends and pressures.

4.4. Conclusion

This chapter has provided a critical examination of the perspectives held by external experts and professionals (Group 1) regarding the motivations and strategic positioning of NEOM. The analysis reveals that for these external stakeholders, NEOM represents a fundamental rupture in traditional urban planning within the region, a necessary intervention designed to navigate the Kingdom's transition from a fossil-fuel-dependent economy to a knowledge-based, sustainable future.

The findings demonstrate that the motivations for NEOM are triadic and deeply interconnected: first, addressing the demographic pressure on existing Saudi metropolitan centres; second, establishing a global platform for innovation through international collaboration; and, third, leveraging geo-strategic advantages to pioneer a new model of environmental sustainability. As the data indicates, these elements are not viewed in isolation but as mutually reinforcing components of a broader survival strategy for the post-oil era.

However, while the external experts acknowledge the coherence of this strategic vision, the analysis also uncovers a critical tension between ambition and executability. The discussion highlighted significant challenges regarding the translation of high-level sustainability goals into scalable technological solutions, as well as the governance complexities inherent in balancing national sovereignty with the requirements of international investors and partners. The external perspective thus frames NEOM as a "high-stakes" paradigm; one that offers a potential blueprint for future global urbanism but remains contingent upon overcoming substantial implementation hurdles.

Having established the external expectations and the broader geopolitical context in which NEOM is situated, it is essential to contrast these views with the insights of those working within the project. To that end, Chapter 5 turns the analytical lens inward, examining the perspectives of internal stakeholders (Group 2) to understand how the strategic vision is being operationalised and how the project's conceptual frameworks are being defined from the inside out.

Chapter 5: NEOM's Strategic Vision as a Smart Sustainable City (Internal Perspectives I)

This chapter presents the findings and analysis derived from the internal perspectives of the case study research, drawing on insights from stakeholders directly involved in the conceptualisation, planning, and implementation of NEOM. In addressing the central research question concerning the extent to which NEOM may be regarded as a paradigm for future sustainable smart city initiatives, this chapter focuses on how the project is understood, rationalised, and operationalised from within. Particular attention is given to the ways in which internal actors articulate NEOM's motivations, interpret global smart city best practices, and frame the project's distinctive spatial, technological, environmental, and governance ambitions.

As outlined in Chapter 3, the qualitative case study methodology is anchored in elite face-to-face, semi-structured interviews conducted with high-level stakeholders who possess direct, operational experience of the NEOM project. These interviews were guided by a set of carefully structured questions aligned with the research aims and designed to elicit reflective, strategic, and critical perspectives on NEOM's vision and execution. The full study sample comprised 39 participants, including NEOM managers and planners, sustainability consultants, architects, and strategic leads, as well as external experts drawn from international organisations, government entities, and academia. These participants were categorised into two analytical groups: 20 external stakeholders (Group 1) and 19 internal stakeholders (Group 2).

A core aim of Chapters 5 and 6 is to examine how NEOM's internal stakeholders (Group 2) conceptualise sustainability and smartness not only as design objectives but as organising principles that underpin decision-making across planning, infrastructure, and governance domains. Building on the identification of global best practices in sustainable smart city initiatives, these chapters explore how these precedents are selectively adopted, adapted, reconfigured, or intentionally departed from in NEOM's planning logic. Alongside this, the chapter investigates NEOM's unique dimensions, including its cognitive urbanism, linear and vertical spatial configuration, renewable energy systems, and bespoke governance framework, with a view to

understanding how these innovations are justified internally and how they might generate transferable lessons for future urban developments.

While Chapter 4 presented the findings from interviews with Group 1, offering external and comparative perspectives on NEOM, Chapters 5 and 6 focus exclusively on Group 2, utilising internal interviews and observational data from The Line exhibition in Riyadh, supported by relevant secondary sources. The emphasis here is on internal narratives as well as on the tensions that arise when visionary planning encounters technical, environmental, and institutional constraints. By foregrounding internal perspectives, Chapters 5 and 6 provide critical insight into how NEOM's futurist vision is translated into planning rationales and governance strategies, and how uncertainties, trade-offs, and systemic complexities are negotiated from within the project.

5.1. Identification of Themes

To interpret the qualitative data, a thematic analysis approach was employed, following Braun and Clarke's (2014) six-stage framework, as detailed in Chapter 3. Significant analytical attention was devoted to the development, refinement, and validation of themes, with multiple iterations undertaken to ensure that the final thematic structure accurately captured the depth and nuance of the internal stakeholder data. NVivo 14 software was utilised to support systematic data management, coding, and analysis (Allsop et al., 2022). This process resulted in the identification of a set of core themes and associated sub-themes specific to Group 2, reflecting the distinctive epistemological, technical, and governance-oriented concerns articulated by internal participants.

In line with Braun and Clarke's (2014) emphasis on the analytical value of sub-themes in organising complex qualitative material, the themes presented in this chapter are structured to capture both overarching strategic narratives and more granular operational insights. The resulting thematic framework for Group 2 (Key themes 1 – 2) is presented in Table 8, and the sections that follow provide a detailed analysis of each theme and sub-theme. These findings are examined in direct engagement with the research question and aims, and are situated within relevant scholarly debates in urban geography, smart city theory, and environmental urbanism. Collectively, this chapter lays the groundwork for the subsequent discussion chapters, which further synthesise the internal findings and critically reflect on NEOM's positioning between visionary ambition and practical implementation.

5.2. Group 2

Table 8

Themes and Sub-themes that Emerged from Group 2; Key themes 1 - 2

Themes	Sub-themes	Files (how many participants discussed the theme)	References (how many times the theme was mentioned)
Best practices globally	1. Key Learnings from Existing Sustainable Smart Cities.	19	58
The conceptual alignment of NEOM with the dimensions of Cohen's model	1. Smart Governance. 2. Smart Environment. 3. Smart Mobility. 4. Smart Living. 5. Smart Economy. 6. Smart People.	19	60

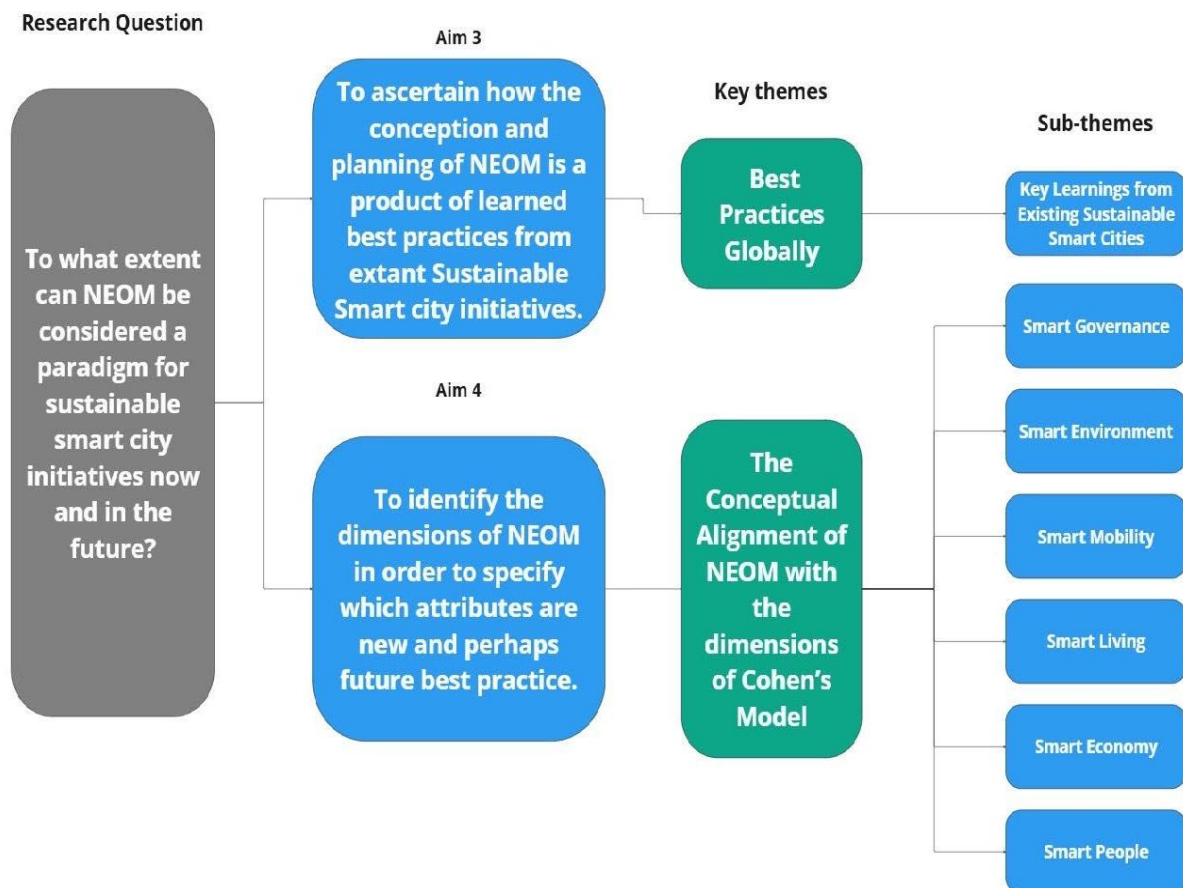
Source: Semi-structured Interviews, adapted by the author from NVivo 14 software.

To obtain the most accurate and comprehensive evidential basis for answering the main research question driving this study, primary data were gathered from diverse NEOM stakeholders via semi-structured face-to-face interviews. This chapter moves from the interviews with Group 1 external stakeholders to the analysis of the primary data from the second group (Group 2) of participants who represent 19 significant internal stakeholders in NEOM who have direct involvement in the planning and implementation of the smart city project. While the first phase of interviews focused on the first aim and the literature review addressed Aim 2, both were foundational in engaging with the central research question (see Section 1.4), the second phase was designed to meet the subsequent five key aims relating to understanding more fully NEOM's conceptualisation and development as a paradigm for future sustainable cities.

Figure 24

Key Findings of the Thematic Analysis of Interviews with Internal NEOM Stakeholders (Group 2)

Addressing Aims 3–4 of the Research Study; Key themes 1–2



The following sections in this chapter present the findings structured around two of the primary aims of this study (Aims 3, 4), where the findings under each aim are categorised into key themes and sub-themes, as illustrated in Figure 24. Each aim contributes to addressing the overarching research question: To what extent can NEOM be considered a paradigm for sustainable smart city initiatives now and in the future? The thematic analysis categorises findings under four key themes, each further divided into sub-themes that explore various dimensions of NEOM's planning,

governance, and urban development strategies. This chapter addresses key themes 1 and 2, while key themes 3 and 4 (Aims 5, 6, 7) are presented in chapter 6.

The first key theme, Best Practices Globally, examines how NEOM's conception and planning have been shaped by successful smart city initiatives worldwide. Insights from internal stakeholders highlight key learnings from established models, emphasising how global sustainability frameworks and urban innovations have influenced NEOM's approach. This theme provides a comparative foundation for assessing NEOM's position within the broader smart city landscape.

The second key theme, the conceptual alignment of NEOM with the dimensions of Cohen's model, assesses how NEOM integrates principles from the BCSCW. This section evaluates NEOM's approach to Smart Governance, Smart Environment, Smart Mobility, Smart Living, Smart Economy, and Smart People, while also introducing the cognitive dimension, an innovative feature that reflects NEOM's future-oriented vision.

5.2.1. Key Theme 1: Best Practices Globally

This section focuses on the third aim of the research, which is how the conception and planning of NEOM are a product of learned best practices from extant sustainable smart city initiatives. The literature states that as NEOM embarks on its journey to redefine urban living, its planners have drawn inspiration from some of the world's most successful smart city models (Caragliu et al., 2011; Albino et al., 2015; Kesswani & Kumar, 2018; Lombardi et al., 2012; Chourabi et al., 2012; Angelidou, 2017). Findings from the interviews suggest that indeed various best practices from around the world have influenced the planning and development of NEOM (best global practices coded 58 times across 19 interviews). These best practices are interdisciplinary and include, but are not limited to, urban planning, sustainability, technology integration, and citizen engagement.

The interviewees from Group 2 identified several cities and regions that serve as core inspirations and benchmarks for NEOM's smart city initiatives. Figure 25 is a visual representation of the most frequently used words in the Theme One interview findings. This theme addresses key perspectives of elite participants regarding the influence of established smart cities on NEOM's conceptualisation, planning, and design. NEOM has extensively studied and drawn inspiration

Figure 25

[illegible]

5.2.1.1 Sub-Theme 1: Key Learnings from Existing Sustainable Smart Cities

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Figure 26

The Main Lessons from Best Practices that Influence NEOM



Source: Adapted by the author based on expert interviews and secondary data.

Copenhagen

Copenhagen's sustainability initiatives, including its well-known efforts to promote carbon neutrality and extensive cycling infrastructure, have been key contributors to its recognition as a global leader in digital and sustainable urban development (Economist Impact, 2022). The focus on sustainability, renewable energy, and bicycle infrastructure in Copenhagen has greatly influenced the conceptualisation and planning of NEOM. Multiple interviewees emphasised Copenhagen's dedication to achieving carbon neutrality by 2025, its green spaces, and its comprehensive bicycle infrastructure as exemplary models that NEOM aspires to potentially replicate and enhance. Head of NEOM Digital Cognitive Master Plan (Interviewee 17, Group 2) identified the important elements of Copenhagen's example as follows:

So, as you know, Copenhagen is known for its commitment to sustainability and smart urban planning. The city has invested in smart grids, intelligent traffic management, and extensive cycling infrastructure. It aims to be carbon-neutral by 2025 and has implemented various initiatives to reduce energy consumption and promote green living.

Project Engineer in the Water Sector at NEOM (Interviewee 7, Group 2) likewise noted, “The inclusion of Copenhagen has helped highlight the non-motorisation of transportation and green spaces of NEOM,” while Environment Compliance Management Expert at NEOM (Interviewee 3, Group 2) elaborated on the way NEOM envisions a future where non-motorised transportation is not just a priority but the norm and where the city’s infrastructure is designed to encourage and support this lifestyle, citing Copenhagen as a significant influence:

An example of this, is the bike-sharing programmes and green spaces in cities like Copenhagen which have inspired us to think about non-motorised transportation. Additionally, urban greenery has become a new concept among citizens. These practices are not merely replicated but adapted and evolved to fit NEOM’s unique context.

It is interesting to note the comment that “these practices are not merely replicated but adapted and evolved to fit NEOM’s unique context,” which is a point reiterated by other interviewees, such as Interviewee 17 (Group 2), in reflecting on Copenhagen’s example regarding city green spaces. Copenhagen is renowned for its dedication to urban greenery and the seamless integration of green spaces into the cityscape, serving as a global benchmark for sustainable urban planning. Interviewee 17 highlighted that NEOM draws inspiration from this model, recognising the environmental, social, and economic benefits of embedding greenery within the urban fabric and is actively planning to replicate and build upon Copenhagen’s success by prioritising large-scale urban greening initiatives. However, rather than direct replication, NEOM’s approach involves modifying and adapting Copenhagen’s model to align with its distinct environmental and socio-cultural context. Given NEOM’s arid climate, implementing large-scale green spaces will require innovative solutions such as advanced water management strategies, drought-resistant vegetation, and smart irrigation systems. As Interviewee 1 (Group 2) elaborated, “To translate the Copenhagen model into NEOM’s desert setting, we are looking at advanced water reuse systems, selecting native and drought-resistant vegetation, and employing AI-enabled smart irrigation that can adapt in real time to climate conditions.” This indicates a deliberate strategy of contextual adaptation rather than simple emulation, reflecting NEOM’s broader ethos of integrating global best practices through a lens of local environmental resilience.

This adaptation reflects a broader discussion in urban planning literature on how sustainability practices must be tailored to local conditions rather than applied as a one-size-fits-all model (Beatley, 2013). While Copenhagen benefits from a temperate climate and abundant water resources to support its greenery, NEOM must explore alternative techniques, such as integrating vertical gardens, xeriscaping, and artificial shading to mitigate the harsh desert environment. Additionally, cultural factors play a crucial role in shaping urban green spaces. Unlike Copenhagen, where green spaces are often designed for cycling and pedestrian activity, NEOM may need to integrate shaded communal areas that align with local social customs and lifestyle preferences. Calzada and Cobo (2015) argue that the transfer of smart city practices is most effective when cities demonstrate the capacity to learn from, incorporate, and contextualise approaches developed elsewhere, thereby fostering more flexible and adaptable urban structures. The approach can serve as a guide for other developing urban initiatives, especially by emphasising the importance of relevant modifications for future urban development.

Another strength of the Copenhagen example, mentioned along with London, is their open access approach to data. Copenhagen is likely seen as an excellent example of making city data openly available and accessible to the public and stakeholders. The Line's Executive Director of Digital and Cognitive Solutions (Interviewee 10, Group 2), made the following observation:

For instance, Copenhagen City can be looked at, for that to see how that works. The best open data publishing model is in London with the Greater London Authority. Copenhagen is the more commercial-minded one, according to scholars.

Interviewee 10 (Group 2) also commented on the importance of data accessibility, highlighting its potential to drive innovation and collaboration and “in terms of best practice” specifically naming Copenhagen and London in the way they've tried to publish data ...

We want to publish as much open data as possible in the public interest, and that's to make sure there's easy access to third parties and entrepreneurs and businesses. And if there's no reason not to publish, then we should make sure they have access to that [data] free of charge and they can build cognitive applications on top of that.

Following Copenhagen's emphasis on open access to urban information, NEOM has similarly prioritised improved accessibility and simplicity in its planning. The continuation of such practices is intended to strengthen coordination mechanisms that support adaptability and facilitate the management of expanding urban developments. By highlighting these aspects of Copenhagen's urban planning and sustainability efforts, the expert interviews suggest that NEOM is studying and seeking to learn from Copenhagen's best practices in order not only to incorporate similar strategies, technologies, and initiatives into NEOM's development, but potentially surpass or enhance certain aspects to align with NEOM's unique vision and context. Within this, it might be argued that the interviews indicate that NEOM's commitment to urban greenery is not just an aesthetic or environmental consideration; it is positioned as a fundamental pillar of the city's liveability and sustainability strategy. By drawing from global best practices while ensuring locally responsive adaptations, NEOM aims to redefine green urbanism in the context of smart cities, setting new standards for sustainable development in arid regions. Similarly, the emphasis on non-motorised transport aligns with NEOM's broader commitment to sustainable mobility, where walkability, cycling infrastructure, and autonomous transport systems are integrated to reduce carbon emissions and enhance urban liveability.

Singapore

The second city the interviewees drew attention to was Singapore, with regard to two particular practices. While Copenhagen serves as a model for NEOM's integration of digital openness, sustainability-driven mobility, and coordinated urban planning, Singapore provides a framework for sustainable land-use regulation and ecological preservation. As NEOM seeks to balance urban expansion with environmental conservation, the interviewees noted that Singapore's approach to protecting natural reserves while supporting economic growth offers valuable insights.

A notable aspect of Singapore's land management practices is its constitutional protection of 95% of its land as a nature reserve, offering a globally recognised model for integrating environmental conservation with urban expansion. This approach resonates strongly with NEOM's stated environmental strategy, which similarly seeks to preserve vast portions of its natural landscape while concentrating urban development within a limited footprint. The interviews revealed, or perhaps confirmed, that NEOM's vision is directly inspired by Singapore's

ability to maintain ecological integrity alongside economic growth, ensuring that urbanisation does not come at the cost of environmental degradation. Urban Planning Manager of NEOM (Interviewee 5, Group 2) elaborated:

And because Singapore has a scarce land resource and requires land management that is efficient is the reason why NEOM is looking at Singapore as an example in that aspect specifically because NEOM has a constitutional foundation which says that 95% of NEOM is a natural reserve that is going to be preserved for nature and that is going to be completely untouched land, and therefore only 5% is going to be developed.

This perspective highlights the deliberate alignment between NEOM's strategic planning and Singapore's well-established land management framework. The reference to Singapore serves as a validation of this approach, demonstrating that a city can thrive economically while maintaining a strong commitment to ecological conservation. Singapore's experience and expertise in land management, urban planning, and maximising the use of scarce land resources are valuable lessons for NEOM, which faces the challenge of carefully planning and utilising a relatively small portion of its total land area for urbanisation and development projects. Marketing Manager at NEOM (Interviewee 19, Group 2) similarly stated that

[t]he efficiency in land management highlighted in the case of Singapore is highly appreciated and impacted by the planning approach of NEOM. In addition to the constitutional preservation, to manage the commitment of nearly 95% of the natural reserves.

The repeated emphasis on efficiency in the face of scarcity seen in the quotations above, underscores the recognised necessity of efficient land use planning, particularly in regions with geographical and environmental constraints, and in this it seems Singapore's success in integrating high-density urban areas within a carefully preserved natural landscape is acknowledged as offering valuable insights into how NEOM can optimise its urban footprint while fostering biodiversity and sustainable growth. This alignment between environmental stewardship and urban development positions NEOM as a forward-thinking project that seeks to balance modernisation with nature conservation.

Interviewee 3 (Group 2) drew attention to the place of technology in environmental protection:

The planning of NEOM has been influenced by several global best practices... look at how Singapore has leveraged technology to monitor air and water quality in real-time has informed our own environmental monitoring systems.

The expert implies that NEOM recognises the importance of incorporating advanced technologies and cutting-edge practices for monitoring and managing environmental quality. By studying Singapore's successful implementation of real-time air and water quality monitoring systems, NEOM aims to adopt and potentially enhance similar technological solutions tailored to its environmental monitoring needs as part of its smart city infrastructure. The implementation of real-time air and water quality monitoring aligns with NEOM's broader commitment to data-driven governance, where environmental sustainability is continuously assessed and managed through AI-powered systems (Lim et al., 2021). The deployment of real-time air and marine water-quality monitoring, through AQMesh⁶ sensors and oceanographic buoys, supports NEOM's broader Environmental Monitoring Framework. This framework integrates data on drivers, pressures, and states to enable continuous, "SMART" State of Environment reporting. It also aligns with NEOM's AI-driven governance model, which uses intelligent systems to monitor and optimise air quality, resource use, and urban operations (GPC, 2025; AQMesh, 2025). Interviewee 17 (Group 2) likewise pointed to the example of Singapore in successfully leveraging digital technologies and IoT-enabled sensors to provide real-time environmental insights:

Also, Singapore has implemented a range of smart technologies, including smart transportation systems, efficient waste management, and widespread sensor networks for environmental monitoring. The city-state leverages data analytics for urban planning and employs smart city solutions to enhance the overall quality of life for residents.

The highlighting of Singapore's use of smart technologies beyond environmental monitoring seems to confirm that NEOM is following suit in actively exploring similar elements

⁶ AQMesh is a compact air quality monitoring system that measures particulate matter, gases, and environmental conditions in real time, and is being deployed across NEOM to support its ecological monitoring strategy (AQMesh, 2025).

to encompass urban mobility, waste management, and predictive analytics. Studies indicate that Singapore's Smart Nation initiative has significantly improved waste-to-energy conversion, traffic optimisation, and water recycling efficiency (Tan & Taeihagh, 2020), providing a scalable reference for NEOM's sustainability-driven development. The emphasis on the way Singapore leverages data for urban planning similarly suggests that in taking on board this as a best practice NEOM is positioning itself at the forefront of smart city innovation, ensuring that technology serves as a backbone for both environmental sustainability and urban efficiency (Caragliu et al., 2011).

These findings highlight the impact of Singapore's land administration and environmental initiatives on NEOM's arrangement. Singapore's ability to manage its natural resources is evident as a significantly influential best practice in the fact that NEOM likewise intends to conserve 95% of its natural resources, making sustainability and natural preservation crucial components of NEOM's development plan (NEOM, 2022c; Tan & Taeihagh, 2020). Moreover, Singapore's advanced environmental checking systems, which involve live discussion and monitoring water quality, have informed NEOM's strategy to adopt similar developments. By utilising these frameworks and taking inspiration from Singapore's implementation of advanced innovations, NEOM's own practices can ensure that better guidelines for nature are maintained and environmental assets are effectively managed.

Barcelona

According to the interview data, NEOM also draws inspiration from Barcelona's pioneering smart city initiatives, and its emphasis on pedestrian-friendly spaces, micro-mobility solutions, and human-centred urbanism, which aligns with NEOM's vision of creating a seamlessly connected and highly liveable city.

Barcelona's smart city blocks, where car traffic has been drastically reduced, and the emphasis on pedestrianisation and micro-mobility have been noted as best practices that align with NEOM's goals for liveability and quality of life. NEOM aims to create a walkable, human-centric urban environment that prioritises pedestrians and active modes of transport over private vehicles. Executive Director of Urban Planning at NEOM (Interviewee 4, Group 2) explained:

There [are] multiple examples; Barcelona is another example in terms of its smart city blocks. Barcelona is very well known for its grid and its hierarchy of streets. But what Barcelona has done quite bravely is to say, ... within these superblocks, we're going to remove or drastically reduce the number of cars and traffic. So again, that allows people to have a better quality of life, use of micro-mobility, more pedestrianisation.

According to Ali Shihabi, a member of NEOM's advisory board, The Line's modular urban form has been likened to Barcelona's traffic-free "superblocks". He explained that each block will be developed in stages and designed to be self-sufficient, incorporating essential amenities such as shops and schools within a five-minute walking or cycling distance (Thomas & Venema, 2021). The reference to Barcelona, noted for its willingness to experiment "quite bravely" with car-free zones, suggests that NEOM may similarly pursue ambitious strategies to reduce car dependency and promote sustainable mobility (NEOM, 2022c). Adopting a superblock-inspired model could also contribute to a more vibrant, community-oriented urban environment, enhancing walkability, encouraging social interaction, and reinforcing NEOM's vision of a human-centric and technology-driven city (Mueller et al., 2020). Interviewee 17 (Group 2) draws attention to the comprehensive nature of Barcelona's urban strategy that seeks to take full account of its local context.

Barcelona has embraced a comprehensive smart city strategy. These examples represent different approaches to smart and sustainable urban development, with each city tailoring its initiatives to its unique geographical, cultural, and economic context. These cities serve as inspiration for others looking to embark on similar journeys toward creating more liveable, efficient, and environmentally friendly urban environments.

This highlights NEOM's holistic and adaptive approach to learning from global best practices while ensuring that these lessons are tailored to its unique geographic, cultural, and economic context. Batty (2018b) asserts that rather than a mere replication of existing smart city models, an adaptive strategy not only enhances practicality and feasibility but also fosters

innovation-driven growth, as knowledge acquired from external models is continuously refined and incorporated into NEOM's particular urban framework.

The interview data confirms that Barcelona's innovative superblock strategy is one such model that NEOM is actively exploring, particularly in its efforts to prioritise pedestrian accessibility, micromobility, and urban liveability. The superblock framework, which redistributes road space to prioritise non-motorised transport, has been credited with reducing pollution, enhancing social cohesion, and improving the overall quality of urban life (Rueda, 2019), and aligns with broader sustainable urban development trends, where cities are increasingly shifting away from car-centric infrastructure in favour of multi-modal transportation networks (Newman & Kenworthy, 2015). Additionally, as highlighted by the internal experts of Group 2, Barcelona's data-driven and technology-infused urban planning framework, which incorporates smart traffic management, energy-efficient infrastructure, and AI-driven public services, serves as a compelling model for NEOM's ambition to integrate cutting-edge technology into its urban ecosystem (Bakici et al., 2012). By thoughtfully adapting these strategies, NEOM can enhance mobility, reduce environmental impact, and foster a higher quality of life for residents, reinforcing its position as a blueprint for future sustainable cities (Mueller et al., 2020).

In sum, as the interview data analysis highlights, Barcelona offers NEOM valuable lessons, particularly through its superblock model, in creating pedestrian-centric urban environments by drastically reducing car traffic, promoting micromobility, and enhancing overall liveability. This approach aligns with NEOM's vision of prioritising human-scale mobility and sustainable transportation to improve the quality of life for residents. However, the literature notes that Barcelona's experience also highlights potential limitations, such as the challenge of balancing bold urban transformations with cultural and infrastructural preferences, the risk of exacerbating social inequalities if inclusivity is not prioritised, and the need to address the environmental impacts of implementing such systems. Thus, for NEOM, adapting these lessons to its unique geographic, cultural, and economic context will be crucial to ensuring the success and sustainability of its urban strategies, addressing social inequalities if inclusivity is not prioritised, and the need to address the environmental impacts of implementing such systems. For NEOM, adapting these lessons to its unique geographic, cultural, and economic context will be crucial to ensuring the success and sustainability of its urban strategies. By integrating Barcelona's

pedestrian-first urbanism with NEOM's advanced mobility solutions, the city aims to redefine sustainable urban living, fostering a seamless, human-centric environment. This globally inspired yet locally contextualised approach ensures that NEOM does not simply replicate urban solutions but actively enhances them, positioning itself as a pioneering model for future cities (Glaeser, 2012).

Amsterdam

Following on from Barcelona's example regarding urban mobility, Amsterdam's progressive policies and infrastructure, which facilitate a transition from car-centric cities to a more balanced and diverse transportation system, emerged as a significant influence on NEOM's plans, according to the expert interviews. Urban Planning Business Support Specialist at NEOM (Interviewee 18, Group 2) stated that "Amsterdam is a great example of a city that has really prioritised sustainable mobility and active transportation. They've invested heavily in high-quality cycling infrastructure, pedestrian spaces, and public transit to reduce private vehicle usage." Amsterdam's efforts to enable a modal shift away from private cars towards more sustainable modes like cycling, walking, and public transport are seen as a model for NEOM to emulate. Planning Director at NEOM (Interviewee 12, Group 2) underscored Amsterdam's significance as a key reference point for NEOM's urban planning, stating, "Amsterdam's transition from a car-centric city to a more balanced transportation system that heavily incorporates cycling is particularly inspirational." This remark highlights how Amsterdam's deliberate shift towards sustainable mobility, prioritising cycling, pedestrian-friendly infrastructure, and efficient public transit, serves as a model for NEOM's vision of reducing car dependency and promoting environmentally conscious urban transport solutions.

NEOM aims to create a greenfield city that is not encumbered by existing car-centric infrastructure, allowing it to leapfrog to a more progressive, multimodal and sustainable transportation system from the outset. According to Interviewee 17 (Group 2), "Amsterdam's infrastructure prioritises cycling and public transportation, which aligns with NEOM's goals of creating a sustainable and liveable city." Interviewee 12 (Group 2) shared the same view and added, "Amsterdam has set a benchmark with its cycling infrastructure and public transportation systems. NEOM aims to create a similar environment that prioritises sustainable mobility."

Amsterdam's success in integrating cycling, public transportation, and pedestrian-friendly urban design provides a compelling case for NEOM's own mobility planning, with the added advantage that, unlike many legacy cities that must retrofit their infrastructure to accommodate sustainable transport, NEOM can design its systems from scratch. Research indicates that cities with well-planned multimodal transportation systems see improvements in public health, reduced congestion, and lower carbon emissions (Banister, 2008; Mueller et al., 2020).

By drawing from Amsterdam's example, NEOM has the possibility to pre-empt many of the urban mobility challenges faced by rapidly growing cities. The Director of Government Engagement at NEOM (Interviewee 15, Group 2) indicates the areas that are being considered in NEOM's construction:

Learning from Amsterdam, NEOM plans to integrate cycling as a primary mode of transportation, reducing the city's carbon footprint and enhancing liveability. This model reflects on multiple urban planning aspects such as integrated mobility solutions that seamlessly connect different transport modes, strategic investments in cycling and pedestrian infrastructure, and the provision of comprehensive public amenities to enable a shift away from private car usage. Amsterdam's experience serves as a valuable blueprint for NEOM to develop a transportation system aligned with its sustainability and liveability objectives.

It is not just in terms of mobility where lessons are being drawn from Amsterdam. The interviewees also drew attention to the influence of the Amsterdam Smart City programme, which brings together public and private stakeholders to drive sustainable urban development initiatives. This collaborative model of engaging diverse partners to co-create smart city solutions is something NEOM aims to replicate. As stated by the Technologies Development Manager at NEOM (Interviewee 13, Group 2),

The way Amsterdam has fostered a dynamic innovation ecosystem around its smart city agenda, with active participation from businesses, academia, and citizens, is a model we're keen to learn from and adapt to our own context.

The interviews highlighted Amsterdam's transportation innovations, its emphasis on liveability and sustainability, and its collaborative smart city framework as significant inspirations

for NEOM's development. Interestingly, while interviewees did not mention it, the secondary literature points to Amsterdam's integrated approach to urban resilience, which balances socio-economic development with ecological sustainability, particularly in relation to water management. Castán Broto (2017) underscores the importance of governance learning in advancing urban resilience, while Hossain et al. (2023) emphasise resource efficiency as a central component of sustainable city-making—both themes that resonate with NEOM's ambition to create a regenerative, resource-efficient city. More concretely, Amsterdam's floating neighbourhoods, green infrastructure, and digital water governance systems provide compelling models of how technology and nature-based solutions can be combined to enhance climate resilience. Drawing on Hajer and Pelzer's (2018) concept of "techniques of futuring", NEOM's long-term planning vision may be interpreted as an effort to mobilise desirable imaginaries of sustainable development. While Amsterdam's integrated urban water management remains a global benchmark for water-sensitive urban design (Van Leeuwen & Sjerps, 2015), NEOM seeks to innovate beyond such models by leveraging AI-driven water monitoring, smart irrigation, and large-scale desalination technologies to secure water provision in its arid environment.

In sum, from the interview data, it can be argued that Amsterdam provides a critical reference for NEOM's approach to sustainable mobility and climate resilience, offering valuable lessons in integrated urban transport and adaptive infrastructure. The city's transition from car dominance to a multimodal system, underpinned by extensive cycling infrastructure and efficient public transport, exemplifies how cities can rebalance mobility to prioritise sustainability and liveability. NEOM's greenfield development presents a unique opportunity to embed such principles from the outset, circumventing the structural constraints that often hinder transitions in legacy cities. However, the social and cultural dimensions of transport behaviour must also be considered, as Amsterdam's cycling culture evolved over decades through policy interventions, urban design, and societal shifts, and NEOM will need to foster a similar cultural shift, ensuring that sustainable transport options are not just available but actively embraced by its future residents. By integrating these best practices within its distinct environmental and socio-political context, NEOM aspires to establish a globally relevant model for sustainable urban development.

As a final note, the secondary literature, while supporting these findings would also highlight other areas that perhaps surprisingly, were not raised by the interviewees with respect to

Amsterdam, namely Amsterdam's expertise in water-sensitive urban planning and climate adaptation. The literature argues that practices there further inform NEOM's ambitions, particularly in addressing arid-region challenges through resilient infrastructure and innovative hydrological management.

Other Cities and Regions

The Interviewees also mentioned several other cities and regions as sources of inspiration and best practices, including Curitiba, Masdar and other cities. The lessons learned from their experiences in areas like sustainable mobility, renewable energy, urban design, and integrated planning are being carefully evaluated by NEOM's internal experts. Alongside Amsterdam, Stakeholder Manager at NEOM (Interviewee 16, Group 2) brought in two other cities:

For instance, Curitiba in Brazil is known for its innovative public system of transportation that highlights dedicated bus lanes and planning done with integration. Another example is Masdar City in the UAE. It is striving and taking active initiatives to become a carbon-neutral city with the help of the utilisation of wind energy and solar power for its operations. Amsterdam is promoting the bicycle as a mode of sustainable transportation.

In using these three cities as examples of innovative and forward-thinking, Interviewee 16 (Group 2) reveals both the range of best practices the NEOM experts have been prepared to adopt or adapt, but also the diverse strategies cities adopt to address the challenges of urban sustainability. These cases underscore the importance of tailoring approaches to specific geographic, cultural, and socio-economic contexts. These insights reinforce the argument that sustainable urban development is not a one-size-fits-all endeavour but a dynamic process shaped by local priorities, resources, and capacities. This diversity highlights the need for a nuanced understanding of how cities can innovate and adapt in response to global sustainability imperatives.

However, Interviewee 10 (Group 2) cautioned regarding the challenges presented by diversity across cities within the UK as learnings for NEOM:

In every city in the UK, they don't have the same list of services they do between Birmingham, London, Bristol, and Cardiff. So that means that the vendors and the ecosystem, the supply chain, they can't scale up because the market is fragmented ... what we're trying to do here in NEOM is use the scale of The Line that we're building, making sure it has an open architecture and open standards that we push and we impose that upfront as we build so that we can impose a much better interconnectivity and open architecture to interconnect everything and go full speed on the automation across everything.

Although even in this respect, it could be argued that this confirms the intention to learn from the diversity of approaches globally, as every city can offer valuable lessons from the specialities and smart practices it has distinctively developed to the challenges they have conversely faced.

Overall, NEOM is presented as a collective learning model drawing on cutting-edge technological advancements, strategies, and models globally implemented and tested. Experts believe that this gives NEOM an edge from a planning, building and governing perspective. Interviewee 17 (Group 2) elaborated:

NEOM deliberately aligns technological implementations with urban development and governance aims. Sustainable smart cities emphasise data-driven decision-making. Resource allocation and public service improvement require robust data collection, analysis, and interpretation. NEOM uses different data to guide policy decisions, improve infrastructure efficiency, and improve the urban experience. Successful smart city models use renewable energy and energy-efficient technologies. This global best practice matches NEOM's ambitious solar and wind power aspirations. Modern energy solutions boost city resilience, self-sufficiency, and environmental sustainability.

It is essential to highlight the fact that NEOM does not plan on replicating existing models. However, the expert interviews strongly suggest that the city leverages global best practices and adapts them to its own local context and vision, with the aim of pushing boundaries and creating a truly transformative model city (Bahreldin et al., 2025). This approach aligns with the notion of

learning from cities and trans-local knowledge assemblage in urban development (McFarlane, 2011a).

5.2.2. Key Theme 1 Discussion

NEOM's urban development strategy reveals a complex and multi-scalar engagement with international urban best practices, reconfiguring them through the lens of its unique geographic, socio-economic, and environmental realities. This method is closely aligned with the principles of trans local urbanism, a framework that highlights how urban knowledge is transferred and reconfigured across different geographical contexts (McFarlane, 2011b; Cugurullo et al., 2023). Rather than merely imitating exemplar smart cities, NEOM synthesises a pluralist array of models, such as those of Copenhagen, Singapore, Barcelona, Amsterdam, Curitiba, and Masdar City and more, into an urban prototype that is simultaneously global in inspiration and local in application.

The research findings indicate that NEOM's planning embraces the principles of the "learning city" (Calzada & Cobo, 2015), in which adaptation and contextual calibration are pivotal. Interviews with Group 2 revealed that international case studies are not taken as fixed templates, but as flexible frameworks to be tested, reworked, and operationalised within the bounds of NEOM's tabula rasa terrain. Interviewee 10 (Group 2) described this as a process of leveraging data accessibility to promote innovation and cross-sector collaboration, drawing on best practices from cities such as Copenhagen and London. This view highlights that open data ecosystems and transparent digital governance are not just technical tools but strategic enablers for adaptive and globally informed urban development in NEOM. However, as Cugurullo (2018) cautions, experimental cities that borrow from diverse global models often face governance and sustainability challenges, raising questions about the extent to which such practices can be successfully transplanted into new contexts.

While the learning approach is clear, four existing smart cities emerged from the findings as those most frequently cited as significant influences. Copenhagen's emphasis on non-motorised mobility, public green space, and net-zero targets informs NEOM's design of a carbon-neutral, walkable urban form. However, in contrast to Copenhagen's temperate setting, NEOM's arid

desert climate demands adaptive strategies such as smart irrigation and vertical greening, reflecting Beatley's (2017) call for geo-culturally embedded ecological urbanism. The integration of open data and citizen-centric governance systems in NEOM mirrors Copenhagen's smart governance model, aligning with Batty's (2018a) concept of cognitive urbanism, which frames cities as real-time sensing and responsive systems that are constantly developing.

Singapore offers another important reference, particularly in the domain of spatial efficiency and environmental resilience. Its land-use optimisation and real-time monitoring systems resonate strongly with NEOM's vision to preserve 95% of its landmass for conservation, a commitment grounded in ecological modernisation theory. NEOM's planners, as per Interviewee 3 (Group 2), described this not as conservation in isolation but as an infrastructural ecology, where natural systems co-function with built forms to maximise sustainability gains.

Barcelona's superblock initiative offers lessons on urban decentralisation and micro-mobility, reclaiming more liveable streets for people. It seems the highlighting of this model by the interviewees as a significant influence supports the secondary literature that notes the way NEOM extends this logic through its unique contribution: vertical urbanism, and proposing compact, five-minute neighbourhoods embedded within The Line's linear form. This evolution of the superblock concept draws from Rueda's (2019) vision of reclaiming streets for people but integrates AI-managed mobility systems for dynamic flow regulation, linking smart infrastructure with human-centric public spaces (Nieuwenhuijsen et al., 2024).

Amsterdam's multimodal transport network and climate-sensitive planning provide an additional layer of influence. However, NEOM's greenfield status allows it to bypass the limitations of legacy car-based infrastructure, enabling the early integration of progressive mobility solutions. Interviewees 12, 15, and 17 (Group 2) consistently pointed to the strategic value of pre-emptive planning, which facilitates the design of a city that supports modal shift through integrated transport infrastructure. NEOM is thus able to embed AI-optimised logistics and autonomous transport from the ground up, along with decentralised water management, which, interestingly, was not an aspect mentioned by the interviewees, although it is observed in the literature. This extension of the best practices is an example of what Evans et al. (2016) call the experimental city, where planning is iterative and responsive, unconstrained by path dependencies.

The inclusion of Masdar City and Curitiba in NEOM's benchmarking exercise indicates an awareness of both successes and limitations in prior smart city attempts. Masdar's renewable energy agenda resonates with NEOM's ambition to build a city powered by solar, wind, and green hydrogen (Lau, 2012). Yet Masdar's struggles with occupancy and liveliness remind planners of the need to focus on liveability and socio-cultural dynamics alongside technology (Caprotti, 2014). Similarly, Curitiba's pioneering transit-oriented development informs NEOM's focus on integrated, high-frequency, AI-enabled mobility, while also signalling the importance of policy coherence and user experience.

Critically, NEOM advances beyond imitation to a position of potential paradigmatic leadership. Following the caution observed by Interviewee 10 (Group 2) regarding the challenges faced by cities in the UK that do not effectively link their systems, NEOM's plan to incorporate interlinked digital systems and open data standards suggests a scalable governance architecture, responding to growing concerns around fragmented and opaque smart city regimes globally (Beckers & Mora, 2025). As Interviewee 10 (Group 2) further noted, NEOM's digital infrastructure is intended to facilitate co-production between systems and citizens, highlighting a civic technology frontier that merges innovation with participatory urbanism.

The findings reinforce that NEOM's strength lies in its capacity to internalise the logic of adaptability. Rather than seeking a universal solution, NEOM's planners deploy an intentionally reflexive, context-aware methodology. This is evident in their translation of Copenhagen's lush green infrastructure into water-sensitive urban design suited for desert ecologies, and in their reinterpretation of Barcelona's pedestrian corridors into vertically stacked, AI-orchestrated urban blocks. Such recalibrations align with the notion of assemblage urbanism, in which urban practices are spatially and politically reconfigured across diverse terrains (McFarlane, 2011b).

Likewise, NEOM's intention for the systemic integration of AI, decentralised infrastructure, and open architecture reflects a deliberate shift from technological determinism toward technological relationality.⁷ Smart cities must move beyond surface-level innovation to

⁷ The shift from 'technological determinism' to 'technological relationality' denotes a move away from viewing technology as an autonomous driver of urban change, toward recognising its entanglement with social, political, and ecological systems. Rather than assuming linear causality, this view frames technology as shaped by and shaping urban contexts in dynamic, co-constitutive ways (Gabrys, 2016; Karvonen et al., 2019).

prioritise interoperability, equity, and inclusion. This lesson from best practice was a major feature in the discussion with Interviewee 10 (Group 2), who maintained that NEOM's commitment to open standards is intended not only to future-proof infrastructure but also to facilitate co-production between stakeholders and systems, redefining governance as a dynamic and participatory process.

The literature would reinforce the importance of transparency in all of this, raising critical questions around data governance, privacy, and accountability. The cautionary example of Toronto's Sidewalk Labs underscores the risks of techno-utopianism when corporate or state actors bypass transparent governance processes (Goodman & Powles, 2019). As scholars such as Sadowski (2020) and Artyushina (2020) warn, without robust rights-based frameworks, data-driven urbanism can replicate surveillance logics and reinforce structural limitations. NEOM's success will depend on embedding ethical safeguards and fostering civic trust alongside its digital systems.

NEOM's environmental strategy echoes the paradigm of ecological urbanism, wherein cities are designed as metabolic systems in symbiosis with natural processes (Mostafavi & Doherty, 2016; Gandy, 2022). Its commitment to preserving 95% of its land and marine territories reflects not only Singapore's land conservation model (Lim et al., 2021) but a broader transition from expansionist planning to compact, regenerative design. Yet, as interviewees noted, the operationalisation of such ambitions requires robust legal, technological, and social enforcement, without which greenwashing becomes a prominent risk (Cugurullo, 2013).

In conclusion, the interviews underscore NEOM's multidimensional approach to future urban development, clearly drawing on best practices from current smart cities. However, it does not just position itself as a learner, rather as representing a paradigmatic shift in future city-making. It does not merely borrow from the world's best urban experiments; it reconfigures them through a site-specific lens of adaptability, experimentation, and ecological intelligence. By combining insights from cities such as Copenhagen, Singapore, Barcelona, and Amsterdam with the anticipatory governance of smart systems and the affordances of a greenfield site, NEOM offers a living model of urban evolution and not a simple blueprint or manual. Whether it succeeds or fails,

its iterative approach will provide critical insights for the next generation of smart, sustainable, and contextually attuned cities.

5.2.3. Theme 2: The Conceptual Alignment of NEOM with the dimensions of Cohen's Model

This section presents the findings of expert interviews conducted to assess NEOM's alignment with the BCSCW. The analysis explores two primary aspects: (1) alignment with Cohen's Smart City Model and (2) NEOM surpassing the model by introducing new dimensions to more fully address the research aim of identifying NEOM's dimensions to determine which attributes are new and may establish future best practices in smart city development. Utilising the BCSCW as a standardised evaluative framework, this section is structured around the six core aspects of the BCSCW, smart governance, smart environment, smart mobility, smart living, smart economy, smart people, and finds that the interviews with experts reveal both consistencies and innovations within NEOM's planning that redefine traditional smart city concepts. The section contends that one of the major findings, also supported by the secondary data, is that while NEOM's conceptual framework closely aligns with Cohen's model in its emphases on the six core dimension of a smart city where the strong alignment validates NEOM's foundations as consistent with global smart city standards, it also moves beyond these dimensions by introducing a cognitive layer that leverages cutting-edge technologies such as AI, robotics, and advanced urban planning (Zaman et al., 2017; Greco & Bencardino, 2014; Komninos, 2013; Saeed et al., 2022) (see the fuller discussion on the cognitive city in 4.5.5.1).

To set the following analyses in context, it is valuable to first observe that while the internal stakeholders clearly articulate NEOM as an intentional smart city, they were not necessarily familiar with the BCSCW model beforehand, which makes it an interesting tool against which to consider the validity and the nature of the decision making regarding the intentions for NEOM both in terms of the best practices adopted for effective smart cities and its aims to transcend the model by integrating more radical and holistic urban innovations.

In terms of the intentionality as a smart city, interviewees agree that this is the strategic direction intended for the Kingdom's envisioned city, where the Development Director of Hospitality at NEOM/ Trojena (Interviewee 2, Group 2) states,

I think there is a recognition at the government level here in Saudi Arabia that there needs to be this development of going into the smart city. This is our smart city concept ... This is seen as an advancement of the state and of the economic development of the country meant to move into the cutting edge of industry, government, social support, et cetera. ... I have not been involved in the actual direct, clinical smart city infrastructure and implementation efforts, but you hear the word smart city being utilised.

The Development Lead at NEOM (Interviewee 8, Group 2) also adds that they see the expressed aims for NEOM as in step with other sustainable smart cities:

I have observed several best practices in sustainable smart city initiatives around the world that seem to align well with NEOM's goals. These include robust public transportation systems powered by renewable energy, comprehensive waste management that includes recycling and composting facilities, and the use of smart grids to optimise energy consumption.

In examining the BCSCW model, there was consensus among the 19 Interviewees regarding the alignment between BCSCW and NEOM as clearly communicated by Interviewee 8 (Group 2): "Upon reviewing [BCSCW], I find that NEOM aligns with many of the model's facets, such as smart governance, smart environment, and smart mobility." Executive Director, Development and Investments at NEOM/ OXAGON (Interviewee 9, Group 2) further expresses the alignment of NEOM with the model:

I just see it. So smart economy ... 3 dimensions of smart economy, entrepreneurship, innovation, productivity, and local governance. We're doing that for sure. Smart environment, mostly green buildings, mostly green energy, green urban planning. Smart government enabling supply and demand side policy transparency, open data, ICT and eGov. So ICT Absolutely... Smart living, yes,

absolutely. 100% on all three of those. And smart mobility, absolutely all of those ... we are doing all of those elements. I like this BCSCW.

Interviewee 12 (Group 2) added, "I see that NEOM will apply almost the same thing that this researcher Boyd Cohen mentioned." Table 9 presents an initial summary of the interview findings, illustrating where the expert participants clearly highlighted the alignment of NEOM's core components with Cohen's smart city model, but as noted above, they also emphasised how the new city intends to surpass existing archetypes through the innovative 'cognitive' approach, all of which will be discussed in more detail below.

Table 9

Comparison of BCSCW and NEOM's Cognitive Dimensions (Findings of interviews and official documents)

Boyd Cohen's Dimension	Working area	NEOM's Dimension	NEOM's Approach
Smart Governance	Transparency, Open Data, Participatory decision-making	Cognitive Governance	Autonomous governance, Innovative regulatory environment
Smart Environment	Sustainable resource management, Pollution reduction	Cognitive Environment	Zero-carbon and zero-waste principles, Large-scale renewable energy projects
Smart Mobility	Efficient public transport, Reduced car usage	Cognitive Mobility	Car-free design, Automated and integrated transport systems, Zero-gravity urbanism
Smart Living	High quality of life, Access to amenities, Safe environment	Cognitive Living	Human-centric design, Sustainable living practices, Advanced urban planning (e.g., "The Line")
Smart Economy	Innovation hubs, Start-up ecosystems, Economic growth	Cognitive Economy	Hub for emerging technologies (AI, biotech, renewable energy), attracting global talent and investment
Smart People	Education, Social interaction, Inclusivity	Cognitive People	AI-driven education and social systems, Cognitive technologies, Proactive and predictive urban environment

Source: Adapted by the author from findings of Interviews and official documents.

5.2.3.1 Sub-theme 1: Smart Governance

According to BCSCW, smart governance revolves around transparency, open data, and participatory decision-making (Lim et al., 2021; Qonita & Giyarsih, 2022). The interview findings indicate that NEOM's aims to go beyond these established smart governance principles by implementing a unique and exclusive autonomous, approach to city management within the Kingdom of Saudi Arabia. At the core of NEOM's governance framework is the concept of Cognitive Governance, which aims to create an autonomous, responsive, and innovative regulatory environment. It was mentioned that NEOM will adopt an independent regulatory framework that allows for faster decision-making and more flexibility in adapting to new technologies and changing circumstances (Hassan, 2020). The Development Director of Hospitality at NEOM/Trojena (Interviewee 2, Group 2) further elaborates on this approach: "There's an intent to establish NEOM Foundational loads which will set a different governance structure for NEOM compared to the rest of the country."

The Manager of Urban Planning in NEOM's infrastructure development (Interviewee 5, Group 2) elaborates:

It is the reason why, given that it's being designed as its own economic zone that is governed by its own, ... legal framework in order to create an environment that is investor friendly and opens up opportunities for the wider international communities to come and thrive in that ecosystem. NEOM has also different organisations. We have the holding company, but also subsidiaries and each is designed in order to have what call it a decision-making process that is independent of people and is also designed in order to allow for voices to be raised and heard. And also, NEOM as a company is the company that is making decisions when it comes to development.

This suggests that NEOM is envisioned as a self-governing, responsive system to create an attractive investment destination and foster innovation, a significant advancement from traditional top-down smart city governance models. The Senior Design Manager at NEOM (Interviewee 1, Group 2) corroborates the progressive nature of NEOM's governance approach and expands on its cognitive dimension "Smart governance, I would think... because the way that the whole zero

gravity model has been put together, it's a new way of governing a city from a regulatory point of view and it's also a highly automated process.”

Interviewee 1(Group 2) further elaborates that “NEOM’s cognitive approach involves a holistic, integrated AI urbanism system that leverages emerging technologies to optimise decision-making, resource allocation, and citizen engagement across all aspects of the city’s operations” (see also Cugurullo et al., 2023). While this aligns with Cohen’s Smart Governance dimension, which emphasises transparent, participatory, and efficient governance practices supported by information and communication technologies, the aspirations for NEOM to develop its own autonomous governance structure indicates a more advanced and progressive approach to city management that extends beyond the typical smart governance model as per Interviewees and existing research (Pira, 2021). These insights from the interview data indicate that NEOM’s cognitive governance represents a significant leap beyond the traditional smart city governance paradigm by creating a self-regulating, technology-driven system that empowers innovation and responsiveness based on the zero-gravity urbanism concept. Such a governance framework, if implemented effectively, could enable NEOM to be highly responsive, agile, and innovative in proactively addressing the complex challenges of the 21st century city.

It could be argued that NEOM’s intended governance framework positions it at the frontier of post-smart urbanism⁸ (Cugurullo et al., 2023). While the BCSCW outlines the role of smart governance in terms of transparency, efficiency, and participation (Cohen, 2014; Lim et al., 2021), NEOM’s emerging cognitive governance model reconfigures these principles within a highly automated, AI-augmented regulatory structure. This approach reimagines governance as a dynamic, autonomous system capable of self-regulation and iterative responsiveness, supported by decentralised decision-making and bespoke legislative frameworks.

In this light, NEOM appears to extend beyond the typical smart governance model observed in global cases such as Singapore or Barcelona – often cited for their integrated ICT infrastructures and participatory urban governance (Komninos, 2019; Pira, 2021). Instead,

⁸ ‘Post-smart urbanism’ is a concept introduced by Cugurullo et al. (2023) to describe a critical evolution beyond first-generation smart cities. It refers to an emerging paradigm where cities are no longer defined solely by technological optimisation or efficiency, but by a more reflexive, experimental, and ethically attuned engagement with AI, automation, and urban governance. Post-smart urbanism emphasises open-endedness, unpredictability, and the co-production of urban futures, challenging the deterministic logic of earlier smart city models

NEOM's cognitive governance is intentionally designed to function as a regulatory sandbox, decoupled from national legislative constraints, thus offering a fertile environment for experimentation and rapid policy iteration. As Interviewee 5 (Group 2) notes, the establishment of independent legal entities within NEOM's ecosystem serves to institutionalise flexibility and agility, attributes rarely afforded in traditional urban governance models (Hassan, 2020; Caprotti, 2019).

Furthermore, the zero-gravity urbanism model referenced by Interviewee 1 (Group 2) illustrates a significant ontological departure from existing urban paradigms. It conceptualises governance not merely as a layer of urban administration but as a deeply embedded, systemically automated layer of city-making, where governance is conducted by the city through a constellation of cognitive technologies (Townsend, 2013; Kitchin, 2014b). This integration of AI-driven optimisation mechanisms into regulatory functions suggests a city that can learn, adapt, and govern itself, drawing parallels with the logic of cybernetic systems and responsive urban infrastructures (Batty et al., 2012).

Yet, such transformations also invite critical inquiry. What was not mentioned by the interviewees was how Cohen's categories of transparency and participation are linked to ideas of accountability and how a system that makes decisions "independent of people" (Interviewee 5, Group 2) would be equitable and attractive to residents. Such transformations indeed invite critical enquiry in this respect. While NEOM's governance model may offer unprecedented efficiency and adaptability, it risks detaching governance from democratic deliberation and embedding decision-making in opaque algorithmic processes. This tension between innovation and accountability requires sustained scholarly attention, where questions of power, access, and equity remain central to understanding emerging urban futures (Greenfield, 2013; McFarlane, 2011b). Ultimately, NEOM's model offers a glimpse into the future of governance in digitally mediated cities, but it also underscores the need for robust theoretical frameworks to critically assess the implications of such post-smart systems.

5.2.3.2 Sub-theme 2: Smart Environment

The research findings suggest that the environmental dimension of NEOM is a key area of alignment with the BCSCW. Interviewees consistently highlighted NEOM's commitment to

sustainability and environmental protection as a core part of its vision, as Interviewee 10 (Group 2) stated:

NEOM's environmental approach is centred around the concept of a 'circular economy', one that minimises waste, maximises resource efficiency and integrates renewable energy sources. The goal is to create a self-sustaining, carbon-neutral city that serves as a model for sustainable urban development globally.

Interviewee 8 (Group 2) added:

However, what sets NEOM apart is the scale at which these attributes are being planned and the level of integration between them. For example, NEOM's commitment to zero-carbon and zero-waste takes the 'smart environment' facet to a new level by not just minimising but completely eliminating carbon emissions and waste generation from the ground up.

This ambition signals a paradigmatic departure from existing models. As Interviewee 8 (Group 2) stated, "NEOM is not conceptualised as an iteration of existing models but as a quantum leap; 'smart city 3.0'⁹. This vision aligns strongly with the Smart Environment dimension of the BCSCW, which prioritises sustainable resource management, renewable energy integration, and climate resilience (Cohen, 2019; Arroub et al., 2016). NEOM appears to extend these ambitions by embedding environmental innovation not just into urban infrastructure but into the city's core identity and operational model. By foregrounding circular economy principles and regenerative design, as the above quotations emphasise, NEOM positions itself as a testbed for ecological urbanism, pushing the boundaries of sustainability beyond mitigation into proactive environmental regeneration (Mumtaz & Happonen, 2023; Greco & Bencardino, 2014). It is worth noting that all the smart city dimensions, and especially smart environment, have a strong interdependence and

⁹ The concept of *Smart City 3.0* refers to the third and most advanced generation of smart cities, defined by fully integrated infrastructures, citizen-led innovation, regional interconnectivity, and real-time digital governance. This stage emphasises circular economy practices, participatory urbanism, and socially inclusive development strategies (Vishnivetskaya & Alexandrova, 2019)

must be approached holistically (Bibri, 2021a; Gazzola et al., 2019). Interviewee 3 (Group 2) expanded on NEOM's environmental initiatives in this regard:

NEOM will be powered entirely by renewable energy, with a focus on solar and wind power. The city is also designed to minimise resource consumption through advanced water treatment and recycling systems, as well as a comprehensive waste management strategy. Sustainable building practices and green spaces will be integral to NEOM's urban fabric.

As well as indicating a strong alignment between NEOM's environmental vision and the smart environment dimension of the BCSCW NEOM's intentional holistic sustainability approach further underscores the potential for NEOM to emerge as a pioneering model for future conscious urban development, and, as Interviewees 8 and 1 (Group 2) seem to explicitly state, suggest that NEOM's environmental approach may even surpass the typical smart city archetype.

Interviewee 8 (Group 2) described NEOM's plans as follows:

NEOM is investing heavily in innovative renewable energy solutions, such as localised microgrids that not only use solar and wind energy that also employ advanced battery storage systems for energy retention. I would say that we are exploring novel waste management systems like automated waste sorting and converting waste to energy. In addition, there is ongoing research on utilising desalination by-products for other industrial applications. As a result, we will be able to ensure a closed-loop system that minimises waste.

While Interviewee 1 (Group 2) highlighted the level of scale involved:

What differentiates NEOM is the ambitious scale and integration of its sustainability initiatives. The goal is not just to reduce environmental impact, but to create a net positive impact, where the city's systems actually improve the surrounding natural environment... by consolidating the city in a small space, you're opening up all the rest of the area for nature and I think that's quite key. The sustainable nature of the line as well, driven by 100% renewables, is also central to that.

It is clear from the research findings that NEOM's environmental strategy closely aligns with and in many ways exceeds the smart environment dimension of the BCSCW. On one hand, the city is embracing comprehensive sustainable practices such as renewable energy, water recycling, and waste management; on the other, it aims to push the boundaries of urban sustainability to create a net positive environmental impact, aiming beyond the typical 'smart city' and creating a cognitive environment. Traditional smart city frameworks have often been critiqued for privileging techno-centric solutions that prioritise datafication, efficiency, and green aesthetics over systemic ecological transformation (Cugurullo et al., 2023; Bibri & Krogstie, 2020). NEOM, by contrast, appears to engage with a more ambitious agenda, one that could be situated within emerging discourses of regenerative urbanism and planetary urban governance (Graham & Hewitt, 2013; Concilio et al., 2016), where rather than simply reducing negative environmental externalities, NEOM seeks to operationalise a net-positive ecological footprint, suggesting a radical break from the environmental mitigation strategies typical of most smart city projects.

From a critical urban geography perspective, this signals a paradigmatic shift in how urban-environmental relations are being reimagined. One aspect also highlighted by the interviewees in regard to the environment was the consolidation of urban functions within The Line, a compact linear city within NEOM powered entirely by renewable energy. Such consolidation reflects a deliberate spatial strategy that challenges dominant models of urban sprawl and excessive land consumption. Interviewees frequently emphasised NEOM's capacity to give back space to nature, which may be interpreted as an attempt to spatialise environmental justice through design. Yet, while such aspirations are commendable, they also prompt necessary scrutiny regarding implementation, accessibility, and long-term ecological outcomes. Moreover, constructing a city in a previously undeveloped area brings with it a host of environmental and logistical challenges (Govada et al., 2017). The harsh desert climate, limited water resources, and the need to preserve the area's unique biodiversity must be carefully considered and addressed during the planning and execution stages of the project (Burbano, 2022).

I would contend that while recognising the significance of NEOM's ambitions, caution needs to be maintained over the potential disjuncture between visionary rhetoric and operational realities. The framing of NEOM as a "closed-loop" cognitive environment offers a compelling counter-narrative to business-as-usual urban development, but it must be grounded in socially

equitable governance structures and context-sensitive environmental practices to avoid the pitfalls of eco-modernist determinism (Joss et al., 2019; Gazzola et al., 2019). In this regard, NEOM can serve as a critical empirical case through which we interrogate not just how smart cities are becoming greener, but how sustainability itself is being redefined and mobilised within post-oil urban imaginaries in the Middle East.

5.2.3.3 Sub-theme 3: Smart Mobility

Interviewees consistently highlighted NEOM's progressive approach to mobility as a key area of alignment with the BCSCW. Specifically, the findings indicate that NEOM is envisioning a seamless, zero-emission, and multimodal transportation system that leverages autonomous and electric vehicles, hyperloop, and air taxis to enhance connectivity, accessibility, and environmental sustainability. Interviewee 17 (Group 2) highlighted this as follows:

Smart mobility is a critical aspect of sustainable urban development. Cities globally are promoting public transportation, cycling, and pedestrian-friendly infrastructure to reduce congestion and environmental impact. NEOM's commitment to smart mobility is evident in its innovative transportation solutions, including autonomous vehicles and high-tech public transit systems, contributing to a seamless and eco-friendly urban mobility experience.

NEOM's mobility strategy emerges not merely as a technological innovation exercise but as a deliberate spatial and socio-political reconfiguration of how cities orchestrate movement, access, and interaction. While traditional smart city frameworks often prioritise mobility in terms of efficiency, flow optimisation, and emissions reduction (Cohen, 2014; Bibri & Krogstie, 2020), NEOM appears to embed mobility within a broader urban imaginary that integrates spatial justice, decarbonisation, and anticipatory planning. The adoption of emerging technologies such as hyperloop, drone logistics, and AI-regulated autonomous vehicles suggests a move towards what Cugurullo et al. (2023) describe as cognitive urbanism, where infrastructural systems are dynamically responsive, predictive, and embedded in a city's AI logic.

A critical update to NEOM's mobility vision was presented at the 2025 World Economic Forum in Davos, where Chief Development Officer Denis Hickey outlined a vertically integrated,

six-layered mobility system specifically designed for The Line (Hickey, 2025). The concept moves beyond traditional transit models by embedding all mobility infrastructure directly into the vertical structure of the city. The system includes an underground high-speed rail corridor (The Spine), metro lines, large high-speed elevators functioning as vertical trams, light rail trams on horizontal primary decks, autonomous micromobility shuttles (~800m range), and extensive pedestrian routes. These primary decks, positioned every 100 metres vertically, act as stacked boulevards, with 50-metre widths and tram stops every 150 metres. Such verticalisation offers what Hickey (2025) calls “3D mobility”, where vertical and horizontal movement are seamlessly integrated, reducing travel times across the city to under 30 minutes. A central hub, NEOM City Station, will serve as a buried multimodal interchange, connected via The Connector, a high-speed north–south line linking NEOM Bay Airport and Oxagon. Although these ambitions are still in the planning phase, emerging research is beginning to explore their feasibility. Bahi and Ourici (2025), for example, employ agent-based simulations to examine human mobility in The Line, illustrating both the opportunities for efficiency and the potential limitations of its unprecedented spatial arrangement. Their study underscores the importance of evaluating NEOM's mobility not only as a visionary concept but also as a lived, socio-material practice influenced by pedestrian behaviour, accessibility, and behavioural variability.

In addition, as part of NEOM's development, the first electric air taxi flight was completed successfully, marking the revolutionary cognitive mobility dimension the city aims for (Volocopter, 2023). Interviewee 3 (Group 2) drew attention to the forward-looking nature of NEOM's plans:

When it comes to mobility, NEOM is pushing the envelope with the incorporation of autonomous vehicles and drone taxis.... The plan involves the integration of smart mobility platforms that can adapt to real-time demands and conditions. These platforms not only reduce congestion but also make transportation energy efficient. We are closely monitoring the development of hyperloop systems, our immediate focus is on creating a seamless, interconnected, and multi-modal transport system that can be upgraded as new technologies mature.

Overall, the findings indicate that NEOM is poised to go beyond the smart mobility archetype by incorporating cutting-edge, futuristic, and environmentally-conscious transportation solutions that would position it as a global pioneering model. As explained by Interviewee 10 (Group 2),

NEOM's mobility vision is remarkably advanced, with a focus on sustainable and intelligent transportation solutions that will redefine how people and goods move within the city. There will be a heavy emphasis on electric and autonomous vehicles, as well as innovative mass transit like hyperloop, to create a truly integrated and emissions-free mobility network.

From an urban geography standpoint, NEOM's mobility vision offers an opportunity to rethink the socio-material assemblages that underpin connectivity and urban experience (Sheller, 2018). The emphasis on frictionless, zero-emission transport combined with an infrastructural commitment to multimodality suggests a redefinition of accessibility not just in functional terms, but also in symbolic and experiential terms. Interviewees' narratives convey that movement in NEOM is imagined as seamless and almost invisible, hinting at a 'post-mobility' ethos wherein transport infrastructure is integrated into the urban environment so holistically that it ceases to feel like infrastructure in the conventional sense.

Furthermore, the interviews suggest that NEOM's approach to mobility extends beyond just infrastructure and technology to encompass innovative policies and citizen-centric planning. Interviewee 8 (Group 2) elaborated thus:

NEOM will be designed around the needs of its residents, with mobility being a key consideration. Private car ownership will be discouraged in favour of public and shared transport options. We are envisioning walkable and bikeable neighbourhoods that prioritise pedestrians and reduce reliance on personal vehicles.

These findings indicate that NEOM's mobility strategy aligns with and in many ways exceeds the Smart Mobility dimension of the BCSCW, by incorporating environmentally sustainable, technologically advanced, and human-centric approaches to urban transportation. However, this radical departure from car-centric, fragmented mobility systems raises important

questions about inclusivity, equity, and the digital divide. The emphasis on sustainability, connectivity, and citizen centricity in NEOM's mobility vision directly mirrors the Smart Mobility aspect of the BCSCW, suggesting a strong conceptual alignment. Smart mobility is viewed as a key enabler of NEOM's broader goals of environmental protection, economic competitiveness, and improved quality of life for its residents. Emphasising the interconnectedness between mobility, technology, and liveability, Interviewee 8 (Group 2) noted that

In terms of transportation, NEOM is planning to be a frontrunner in adopting evolutionary technologies. We are in the assessment phase for hyperloop systems to connect different parts of the city and even looking at drone transportation for goods and possibly people. We also envision a robust network of autonomous vehicles, integrated into a smart urban mobility platform to reduce traffic congestion and lower carbon emissions. Inclusive citizen engagement is recognised as a cornerstone of successful smart city initiatives. Cities that prioritise digital inclusion and actively involve citizens in decision-making processes tend to be more resilient and adaptive.

While NEOM's mobility system is projected to be sustainable and efficient, it is essential to interrogate who this system is designed for, how user needs are incorporated, and whether the futuristic modes of mobility will be accessible across demographic and socio-economic spectra (Graham & Marvin, 2001; Joss et al., 2019). There is an inherent tension between technological utopianism and grounded urban realities, especially when advanced mobility solutions may risk prioritising spectacle and innovation over basic, inclusive transport needs.

Nevertheless, NEOM's mobility blueprint presents a compelling case for how infrastructure can serve as both a technological backbone and a socio-political artefact, shaping patterns of urban life, economic opportunity, and environmental responsibility. If implemented as envisioned, this model has the potential not only to align with but to expand the smart mobility dimension of the BCSCW into a new paradigm of anticipatory, embedded, and environmentally regenerative mobility.

5.2.3.4 Sub-theme 4: Smart Living

The research findings indicate that Smart Living, which encapsulates quality of life, cultural vibrancy, social inclusion, health, and safety (Cohen, 2014; Arroub et al., 2016), is a central tenet of NEOM's vision, and in many ways, is reimaged through a highly curated, technology-mediated lens. Interviewees emphasised NEOM's aspiration to not only meet but redefine the global standard for quality of life by embedding wellness, innovation, and inclusivity into the city's fabric. Interviewee 12 (Group 2) highlighted this as follows:

Smart living in NEOM is about creating a lifestyle that integrates well-being, digital convenience, and meaningful human interaction. This is not just about smart homes, but about fostering communities with access to green spaces, cultural programmes, and digital services that enhance everyday life.

This perspective reveals NEOM's departure from a purely technocratic vision of smart living, one often critiqued in existing smart city literature for its overemphasis on efficiency and surveillance (Kitchin, 2014a; Marvin & Luque-Ayala, 2017). Instead, NEOM aims to build a conscious urbanism that actively designs for happiness, cultural identity, and human flourishing, concepts that are often overlooked in traditional smart city metrics.

While liveability was stressed within the interviews, indicating that NEOM's vision for smart living aligns with the corresponding dimension in the BCSCW, their comments also pointed to the way that in some respects, it surpasses the BCSCW dimension. Interviewees highlighted NEOM's focus on enhancing the overall quality of life for its residents through a range of innovative approaches, mainly pertaining to The Line. According to Interviewee 10 (Group 2), the Line concept is a fundamental component of NEOM's strategy for smart living: "Liveability is absolutely critical for us.... the shape and size of the line is part of that. And we're defining everything we do about being smart, [aiming for] a new standard for liveability."

Moreover, NEOM's urban model, particularly in The Line, prioritises vertical zoning, walkability, and 5-minute city principles, aiming to eliminate commuting stress, increase access to services, and optimise health outcomes through physical design (Interviewee 1, Group 2). This aligns with Bibri. (2021a) who argue that smart cities must integrate compactness, accessibility,

and green infrastructure to truly deliver smart living outcomes. The interview data likewise emphasises that NEOM's approach to smart living focuses on creating a high-quality, technology-enabled lifestyle for its residents. Interviewee 5 (Group 2) elaborated on this as follows:

People have to come and live in The Line and the whole idea of opening up possible spiritual strife is also being done with people in mind... The idea is that you are in The Line, you're in your city, but you have direct [technological] access to the 95% [the retained natural environment]. So you have the possibility of very quickly connecting with nature, with the different modes of transportation... [and] the possibility of moving around between the different master plans.

This indicates that NEOM's smart living vision goes beyond just the physical infrastructure and amenities but also focuses on the experiential and spiritual aspects of urban life, something that is not as prominently featured in the BCSCW. Furthermore, the interviews suggest that NEOM's approach to smart living also prioritises personalised services, advanced technologies, and a focus on residents' wellbeing. NEOM's emphasis on mental and emotional well-being is particularly noteworthy. Interviewee 9 (Group 2) stated, "Wellbeing is central to everything, from building materials to urban layout to digital engagement. We're exploring how ambient technologies, AI, and biophilic design can respond to emotional states and promote mindfulness." This suggests a cognitive turn in smart living, where the environment is designed to intuitively adapt to its residents' physical and psychological needs. Such aspirations resonate with recent scholarship on affective urbanism and the emerging discourse of "emotionally intelligent" cities (Huang et al., 2025, p. 19), which posits that future urban environments must nurture not just the body but also the mind and soul.

Interviewee 10 (Group 2) expanded on this, commenting that "we are creating a new way of living, one that is enhanced by technology and focused on wellbeing." This suggests that NEOM's integration of nature, mobility, and urban amenities is designed to enhance the overall quality of life and well-being for its residents, a key tenet of the smart living dimension. Focusing on the human-centric approach across all dimensions of the city, coupled with the advanced technologies powering the city, NEOM appears to be aiming to create a new model of cognitive living that goes beyond the typical smart city model. Interviewee 3 (Group 2) explained:

NEOM is envisioned as a city that caters to the highest standards of living, with a focus on wellness, leisure, and community-building. This includes designing walkable, human-centric neighbourhoods, providing access to high-quality healthcare and education, and fostering an inclusive, vibrant cultural scene.

In summary, the research findings indicate that NEOM's approach to smart living aligns with, and in some respects goes beyond, the BCSCW by placing a strong emphasis on holistic quality of life, and the well-being and spiritual/experiential dimensions of urban living, in addition to the more conventional infrastructure and services. However, these aspirations also raise important socio-spatial questions. Who defines well-being in a highly curated, tech-mediated environment? Will NEOM's vision for smart living be equally inclusive across all resident profiles, or risk becoming an enclave of privilege, shaped by datafied subjectivities and behavioural optimisation (Vanolo, 2014)? From an urban geography lens, it is crucial to critique how such high-tech interventions might obscure or marginalise more traditional forms of place-based identity, social belonging, and informal urban cultures (Townsend, 2013).

Nonetheless, NEOM's smart living framework, if realised holistically and equitably, has the potential to expand the BCSCW's dimension of smart living into a new experiential domain, where well-being is not merely an outcome but a foundational design principle. By embedding culture, health, aesthetics, and empathy into the city's operating system, NEOM may offer a provocative prototype for urban futures that are as emotionally intelligent as they are technologically advanced.

5.2.3.5 Sub-theme 5: Smart Economy

The research findings underscore that NEOM's vision for a smart economy is not merely about digital transformation or technological advancement but about cultivating a new model of economic productivity that is deeply embedded in innovation, entrepreneurship, and global competitiveness. This ambition aligns strongly with the Smart Economy dimension of the BCSCW, which emphasises innovation ecosystems, digital industries, and economic sustainability (Cohen, 2014; Arroub et al., 2016). Interviewee 14 (Group 2) articulated NEOM's economic vision as follows:

NEOM is not just about building a new city; it's about creating a new economic paradigm. We are positioning NEOM as a global hub for emerging industries, biotech, AI, energy, media, and even space technologies. We are actively designing policies and infrastructure to attract and incubate global talent.

According to the internal experts, NEOM's smart economy is positioned to significantly outperform existing smart city archetypes. The findings highlight that NEOM aims to create an attractive, business-friendly environment that fosters local and international investment, as mentioned by several interviewees. The human-centric approach, combined with advanced digital infrastructure and cognitive governance, is expected to enable NEOM to pioneer new cognitive economic models and industries, allowing it to go beyond the BCSCW (Govada et al., 2016). Interviewee 10 (Group 2) elaborated on the concept of smart economy as explained in the BCSCW:

Smart economy ... actually follows on from everything else because today's economy is not something that's separate to sustainability and liveability and human centric, it's actually spurred by those things. And you can see that the biggest sectors of society globally are those which are linked to increasing sustainability and liveability. So, a few years ago, when we [NEOM] started, people thought you have to make a compromise between being economically viable and environmentally sustainable and technologically advanced. But actually, no. Today all of the investments are going in that direction... it's actually a magnet for a smart digital economy to be focusing on these factors.

This represents a shift from traditional urban economies rooted in industrial or service-based sectors toward a knowledge- and innovation-based economy, as also discussed by Mumtaz and Happonen (2023). It reflects aspirations for NEOM to become what Florida (2003) termed a creative economy, driven by high-skilled workers, research and development (R&D), and disruptive technologies. Unlike many smart cities that retrofit economic innovation onto existing structures, NEOM is being designed from its inception as a platform for experimental economic governance.

Moreover, the findings reveal an economic vision that integrates spatial-economic restructuring through clustering innovation districts, technology campuses, and SEZs. Interviewee

5 (Group 2) explained, “We are working on sectoral innovation hubs across NEOM, each economic cluster will be vertically integrated, supported by advanced logistics, data infrastructure, and governance autonomy. It’s a new economic geography, really.”

Interviewee 8 (Group 2) further explained the extent of the economic planning:

NEOM aims to be an economic powerhouse, especially in emerging sectors like renewable energy and advanced technologies. We are planning for large-scale solar and wind farms, which will not only power NEOM but could also be an exportable commodity. In advanced technologies, we are looking at becoming a hub for R&D in AI, robotics, and biotechnology. We aim to attract start-ups and established firms alike in these sectors to provide them with the infrastructure and policy support they need to innovate and flourish.

This indeed suggests that NEOM’s smart economy model goes beyond the typical smart city focus, actively nurturing new innovation-driven industries and economic activities that can generate sustainable long-term growth. It is further evident that this economic vision is firmly anchored in the twin goals of environmental sustainability and technology, as Interviewee 3 (Group 2) stated:

The economic strategy for NEOM is multifaceted, focused on pioneering sectors that are at the nexus of sustainability and technology. Take, for example, the field of biotechnology; we are creating a conducive ecosystem for the development of lab-grown meat, which is far less resource-intensive than traditional agriculture. Similarly, NEOM aims to be a hub for green tech start-ups that would stimulate innovation in fields ranging from carbon capture to sustainable construction materials. This not only creates new economic avenues but also positions NEOM as a global leader in sustainable industries.

This resonates with Scott and Storper’s (2015) theories on agglomeration and spatial innovation systems. It also draws on Bibri’s (2021a) conceptualisation of smart eco-cities as data-driven platforms for sustainability transitions and innovation ecosystems. Building on this, I interpret NEOM using a ‘neo-endogenous development’ approach: the city acts both as an incubator and as an experimental test-bed for digital capitalism, potentially transforming spatial

economies in the gulf and beyond. However, NEOM's smart economy ambitions are not without contradictions. Interviewee 7 (Group 2) remarked, "There's a risk that this becomes a kind of 'innovation enclave', attracting global capital and talent, but disconnected from the existing regional economy or labour market." Moreover, economic uncertainty poses a considerable challenge to the NEOM Project (Fallatah, 2019). Saudi Arabia has vast oil reserves and financial resources; nevertheless, the global economy has shown signs of fragility in recent years, with volatile oil prices and the impact of the COVID-19 pandemic. Moreover, as the world moves towards renewable energy sources, the demand for oil is expected to decline, putting pressure on Saudi Arabia's primary source of income (Aina, 2017; Hertog, 2022). In this context, attracting investors and ensuring the financial viability of a multi-billion-dollar project such as NEOM becomes increasingly difficult. Economic fluctuations could lead to delayed timelines, budget overruns, or even a potential scaling down of the project (Bradshaw et al., 2019). Furthermore, the need for large-scale infrastructure development is a monumental challenge for the NEOM project (Frag, 2019). Building a city from scratch requires not only the construction of essential facilities, such as housing, transportation networks, and utilities, but also the development of advanced technology and systems to meet the project's ambitious goals (Carvalho, 2015). This necessitates investments in research and development, as well as attracting top talent from around the world. Several interviewees raised concerns about the social inclusivity of this model, and whether the high-tech economic vision will translate into equitable job creation and local capacity-building.

This concern parallels critiques of other smart cities, such as Songdo and Masdar, which have struggled to move from symbolic global ambitions to real, inclusive economic integration (Shelton et al., 2014; Cugurullo et al., 2023). There is thus a need to interrogate how NEOM's economy will be grounded locally: Will it foster grassroots entrepreneurship and digital literacy for local populations? Or will it prioritise foreign investment and elite economic actors?

While this was not a topic that emerged from the interviews, it is nevertheless important to note that the governance of NEOM's economic system, especially with its autonomous legal and financial structures, raises questions about transparency, regulation, and ethical AI deployment. As Arroub et al. (2016) and Kitchin (2014a) argue, the success of smart economic ecosystems depends not just on technology but on robust and inclusive policy frameworks. NEOM's smart economy model is a highly ambitious attempt to reconfigure urban economic development around

future-facing industries and cognitive capitalism. While it strongly aligns with and expands the smart economy dimension of the BCSCW, its success will hinge on whether it can embed economic innovation into an inclusive, equitable, and contextually grounded urban framework.

5.2.3.6 Sub-theme 6: Smart People

The research findings suggest that NEOM's vision for Smart People is closely aligned with the corresponding dimension in the BCSCW, with a focus on education, innovation, and citizen engagement. According to the interview data, NEOM is positioning itself as a hub for talent attraction and development. Interviewee 3 (Group 2) explained, "NEOM is designed to be a magnet for the world's brightest minds. We want to create an environment that fosters creativity, entrepreneurship, and lifelong learning."

The research findings reveal that NEOM's approach to the smart people dimension is not merely focused on technological proficiency or education levels, but rather on cultivating a globally competitive, cognitively agile, and culturally adaptive population. In line with the BCSCW framework, smart people involves attending to creativity, lifelong learning, social capital, and digital literacy, amongst other attributes (Cohen, 2014; Giffinger et al., 2007). However, NEOM appears to reimagine this pillar through the lens of cognitive capacity-building, intending to attract and foster what Interviewee 2 (Group 2) referred to as "the minds of the future."

Moreover, the interviews highlighted NEOM's plans to invest heavily in education and human capital development, as reflected by Interviewee 10 (Group 2):

NEOM will be home to cutting-edge research centres and educational institutions that focus on emerging technologies, sustainability, and other future-oriented fields. We want to empower our residents to become innovators and problem-solvers who can help shape the future of our city and the world.

Interviewee 11 (Group 2) similarly commented:

We're not just recruiting talent for jobs. We are trying to create an ecosystem that nurtures critical thinking, interdisciplinary problem-solving, and continuous

learning, because that's what future cities need. NEOM is where people will come not just to work, but to learn and co-create the future.

This vision resonates with Bibri's (2021a) notion of the cognitive city, in which learning, experimentation, and co-creation are integrated into the city's operational logic. NEOM's emphasis on immersive education technologies, AI-driven personalised learning, and cognitive diversity reflects a significant advancement of the traditional smart people model, which often remains confined to generic metrics like university rankings or internet penetration to assess human capital, NEOM seeks to foster a more nuanced and transformative learning ecosystem that prioritises individualised learning experiences, creativity, and diverse cognitive capabilities.

Interviewees also underscored NEOM's ambition to be a global attractor of talent, targeting researchers, entrepreneurs, and creatives from diverse disciplinary and cultural backgrounds, as Interviewee 14 (Group 2) explained:

We envision NEOM as a melting pot of global talent, an environment where diverse people can collaborate on solving global challenges. This includes highly educated professionals, but also young people, creators, and those who think differently.

Interviewee 2 (Group 2) notes that smart living and smart people are deeply intertwined: "You can't look at it separately...if you don't have the living environment that fosters creativity, education, and all people, it will not happen." Their point underscores the interdependence of NEOM's smart living initiatives and its focus on creating an ecosystem that supports innovation, education, and well-being. Additionally, the research findings indicate that NEOM is also placing a significant focus on citizen engagement and participation, which aligns with the smart people dimension of the BCSCW.

From an urban geography standpoint, this taps into debates around the creative class (Florida, 2003) and talent clustering, but with a cognitive urbanism twist. NEOM seeks not just to attract talent, but to engineer the socio-spatial conditions for collaborative innovation, a vision echoed by Greco & Bencardino (2014) and reinforced by Cugurullo et al.'s (2023) idea of post-smart urbanism. However, there are emerging tensions. While NEOM aspires to be a cosmopolitan

knowledge society, questions remain around accessibility, inclusivity, and socio-cultural integration. Interviewee 6 (Group 2) expressed, "It's important to ensure that NEOM isn't just a city for elites or expats. Building a truly smart society means integrating locals, ensuring social mobility, and fostering cross-cultural understanding. Education and innovation should not be exclusive."

This echoes Mumtaz and Happonen's (2023) critique of how smart city mega-projects often reinforce elitist urban agendas that marginalise local communities and prioritise global capital flows. The risk is that while cognitive and technological capacities are cultivated at the top, local populations, particularly in the surrounding Tabuk region, may be marginalised or excluded from NEOM's human capital agenda. In addition, the automation of knowledge work, driven by AI and digital governance in NEOM, may redefine the very nature of participation and civic agency. As Kitchin (2014b) argues, smart people are not merely technologically adept consumers; they are active citizens who shape their environments. Whether NEOM can sustain this participatory ethos within a high-tech cognitive infrastructure remains to be seen.

In summary, NEOM's smart people vision demonstrates a conceptual evolution of the BCSCW dimension from one centred on education and skills to one focused on cognitive co-evolution, global talent ecosystems, and creativity-as-governance. Yet, its success will depend on whether these innovations are matched with inclusive policies that ensure broad-based human development, rather than a technocratic knowledge enclave.

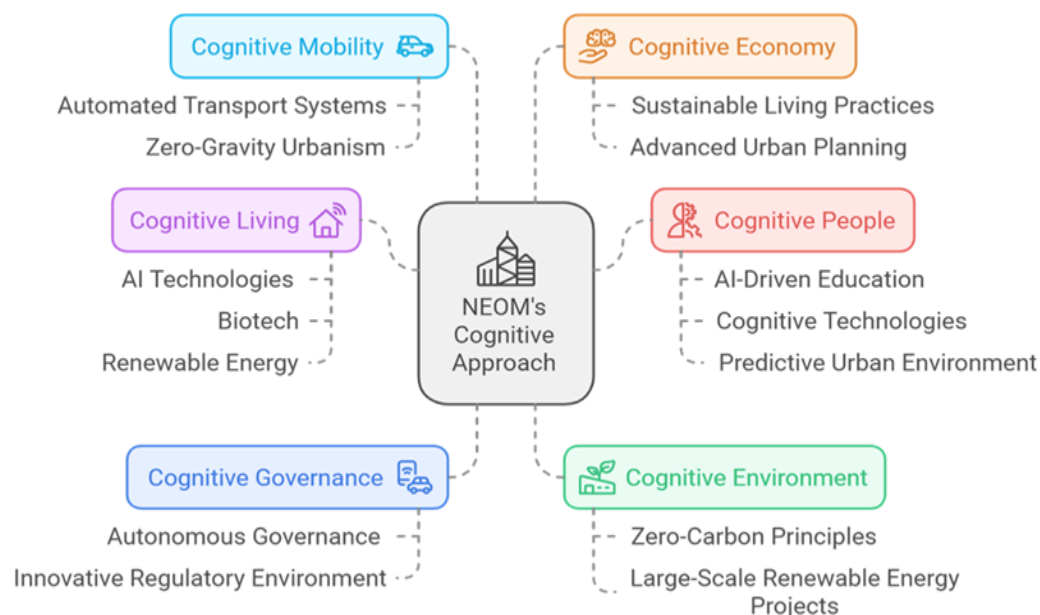
5.2.4. Key Theme 2 Discussion

The findings presented in this chapter reveal that NEOM not only aligns with the six core dimensions of Cohen's (2013) Smart City Wheel Model, smart governance, smart environment, smart mobility, smart living, smart economy, and smart people, but actively extends their conceptual and functional scope through a 'cognitive' layer that redefines smart urbanism for a post-digital era. Interviewees across various leadership roles within NEOM repeatedly articulated that the city's vision is not to imitate existing models but to innovate upon them, embedding AI, predictive systems, and adaptive governance as foundational elements of city-making. As

highlighted by Interviewee 1 (Group 2), the city aims to transform smartness into cognitive responsiveness: “NEOM’s cognitive approach involves a holistic, integrated AI urbanism system that leverages emerging technologies to optimise decision-making, resource allocation, and citizen engagement across all aspects of the city’s operations.” Figure 27 offers an illustrative overview of the interview findings to illustrate the way the cognitive lens is envisaged as transforming smartness in all dimensions.

Figure 27

Mapping interpretation of NEOM's cognitive approach to smart city design as an adaptation of BCSCW based on primary data



Source: Adapted by the author based on expert interviews and secondary data.

I would contend that this deliberate transition from a reactive smart city to a predictive, self-learning system as identified in the interview data marks a conceptual leap from the instrumented city toward what Townsend (2013) describes as the sentient city,¹⁰ towards post-smart urbanism, a domain in which urban systems no longer merely process data but continuously

¹⁰ 'Sentient city' is a concept developed by Townsend (2013) to describe urban environments that are infused with ubiquitous computing and sensor networks, allowing them to perceive, monitor, and respond to real-time conditions. In this framing, the city becomes aware of its own operations, much like a biological organism, capable of "sensing" environmental, infrastructural, and behavioural patterns through digital inputs.

adapt and reconfigure themselves in real time (Cugurullo et al., 2023; Batty, 2018a). Each of Cohen's original six dimensions remains embedded within NEOM's vision, yet they are reconceptualised as sub-layers of a more integrated cognitive infrastructure. For instance, smart governance is reimagined as cognitive governance, incorporating autonomous legal zones and algorithmically enhanced decision-making, allowing the city to function with a level of independence and regulatory agility not seen in most global counterparts (Kitchin, 2014a; Caprotti, 2019).

Similarly, the smart environment dimension, traditionally concerned with sustainable resource use and pollution reduction (Arroub et al., 2016), is expanded into a regenerative paradigm. NEOM's plan for a net-positive ecological footprint, highlighted by Interviewees 1, 3, and 8 (Group 2), underscores a citywide operational model based not on mitigation but on planetary stewardship. These ambitions align with Bibri (2021b), who advocate for closed-loop urbanism and ecological design as the next stage of smart city evolution. The incorporation of circular economy principles into every facet of NEOM's development, renewable energy, water reuse, and waste-to-energy demonstrates a departure from conventional green-washing, seeking instead to institutionalise sustainability through systemic urban infrastructure.

Smart mobility within NEOM is similarly reconceived. Rather than adopting a car-lite or public transport-heavy system typical of many smart cities (Bibri & Krogstie, 2020), NEOM envisions a zero-car city from inception, with hyperloop, drone taxis, and autonomous shuttles forming a core part of its transport infrastructure. Interviewees such as 8 and 10 (Group 2) framed this strategy not merely in terms of environmental impact but as part of a larger rethinking of urban experience, where mobility becomes frictionless, anticipatory, and almost invisible, an ethos aligned with Townsend's (2013) discussion of urban systems that operate ambiently and responsively, embedding intelligence within the urban fabric to shape how infrastructure is experienced in everyday life.

The dimension of smart living, often measured through access to amenities and digital services, is radically elevated within NEOM to include biophilic design that fosters connection to nature, emotional well-being, and digitally mediated spiritual experience. According to Interviewee 9 (Group 2), technologies such as ambient AI and adaptive architecture are being

explored to foster mental and physical wellness, resonating with emerging research on affective urbanism (Degen & Rose, 2024). I would note that NEOM's focus on emotional intelligence within urban systems challenges the purely technocratic logic of most smart living models and proposes a more empathetic, experiential form of urban life.

Meanwhile, NEOM's smart economy vision, described by Interviewees 3, 5, and 14 (Group 2), constructs a future-oriented economic geography predicated on cognitive capitalism, experimental SEZs, and sectoral clustering. This vision strongly aligns with Scott and Storper's (2015) theories of regional innovation systems while pushing the boundaries towards what Mumtaz and Happonen (2023) refer to as economic singularities, where AI, biotech, and green tech converge in dense, digitally networked ecosystems. Yet, we must, I suggest, remain attentive to critiques of enclavic development (Cugurullo et al., 2023), recognising that NEOM's economic innovations must remain accessible to a broader regional population to avoid exacerbating socio-spatial inequality.

Finally, the smart people dimension, traditionally centred on education and digital literacy, is perhaps most significantly rearticulated in NEOM. Rather than focusing narrowly on educational attainment, NEOM's approach prioritises cognitive capacity-building, lifelong learning, and talent incubation. Interviewees 2, 10, and 14 (Group 2) described a deeply immersive, AI-augmented ecosystem of co-creation and personalised learning. This aligns with Greco and Bencardino's (2014) view that smart people must be active shapers of urban innovation, not passive recipients. However, again I would caution that this elite-driven model risks excluding those without the requisite technological access or cultural capital, a challenge also identified by Vanolo (2014).

The alignment between NEOM and BCSCW is not superficial or symbolic; it is foundational. Yet, NEOM's reconfiguration of these six dimensions through a cognitive lens marks a decisive shift in the epistemology of smart cities. NEOM is not merely digitising the city; it is programming it to think, adapt, and evolve, a move with profound implications for how urban futures are conceptualised and contested. Crucially, this evolution aligns with the broader ambition of NEOM to act as a testbed for future urban paradigms, positioning itself within the lineage of experimental cities that seek to advance historical infrastructural legacies (Caprotti, 2019; McFarlane, 2011a).

As such, this research contributes to the growing body of literature calling for a critical re-examination of smart city frameworks and urges scholars and practitioners to engage with emergent models like NEOM not just as case studies of best practice, but as provocations for rethinking the ontologies of urbanism itself, along with invites critical reflection on whether such technologically intensive frameworks are universally replicable or contextually contingent upon high levels of capital, political will, and territorial control.

5.3. Integrated discussion (Group 2; Key Themes 1 – 2)

This discussion presents an integrated analysis of findings derived from semi-structured interviews with internal NEOM stakeholders in relation to global smart city best practices and conceptual alignment with established smart city theory. In addressing the central research question regarding the extent to which NEOM may be regarded as a paradigm for sustainable smart city development, this section situates NEOM within broader international debates in urban geography, smart city scholarship, and environmental urbanism. The discussion synthesises interview insights with relevant literature to critically assess how NEOM both draws upon and departs from earlier generations of smart city models, particularly when examined through the framework of Cohen's Smart City Model.

Interviewees consistently framed NEOM in relation to existing smart city exemplars, including Songdo, Singapore, Amsterdam, Copenhagen, San Francisco, and Brisbane. These cities were widely acknowledged for pioneering the integration of information and communication technologies into urban governance, infrastructure management, and service delivery, particularly in relation to efficiency, automation, and real-time data use (Batty et al., 2012; Townsend, 2013). However, stakeholders emphasised that such precedents were not viewed as templates for replication but as reference points against which NEOM's ambitions could be sharpened and critiqued. As Interviewee 8 noted, the structural limitations of legacy cities, particularly the financial, political, and social costs of retrofitting, constrain the degree to which transformative change can be pursued. NEOM's greenfield context was therefore repeatedly framed as a strategic advantage, enabling planning from a zero-base condition unconstrained by inherited urban form.

Songdo, frequently cited in both interviews and scholarly literature as an archetypal master-planned smart city, was recognised for its advanced infrastructural integration and embedded

digital systems. At the same time, interviewees echoed established critiques that describe Songdo as lacking spontaneity, adaptability, and social vibrancy, qualities often associated with organic urban development (Datta, 2015; Halpern et al., 2013). Similarly, Singapore was praised for its highly integrated governance architecture and data-driven decision-making, yet interviewees suggested that its scale, institutional maturity, and incremental policy culture limit the scope for radical experimentation. Copenhagen, while admired for its leadership in carbon neutrality and non-motorised mobility, was perceived as offering evolutionary rather than transformational change, a distinction that stakeholders considered increasingly inadequate given accelerating environmental and infrastructural pressures.

Amsterdam and Barcelona were referenced as examples of culturally driven smart city approaches that foreground citizen engagement, digital rights, and bottom-up innovation. Nevertheless, NEOM stakeholders argued that the geopolitical, economic, and spatial conditions underpinning NEOM demand a fundamentally different governance logic. NEOM's planners articulated the need for a centralised, AI-enabled coordination model capable of operating at unprecedented scale and speed. This position resonates with Kitchin's (2014b) caution against assuming that smart city frameworks developed in liberal democratic contexts can be seamlessly transferred to state-led development environments, particularly those seeking to reconfigure urban life rather than retrofit existing systems.

This comparative positioning reflects a broader temporal framing of NEOM as a project oriented beyond existing smart city iterations. Several interviewees characterised NEOM as a form of "smart city 3.0", emphasising a shift from ICT-enabled responsiveness towards predictive and anticipatory urban systems. Interviewee 10 described this as a move from real-time reaction to real-time anticipation, in which infrastructure is designed to forecast future conditions rather than merely respond to present demands. This framing aligns with Cugurullo et al.'s (2023) articulation of post-smart urbanism, wherein cities evolve from being instrumented and automated to becoming cognitively augmented systems capable of learning, adaptation, and behavioural simulation.

When examined through Cohen's Smart City Model, NEOM demonstrates strong conceptual alignment across several dimensions, particularly Smart Environment, Smart Governance, and Smart Infrastructure. Interview data repeatedly emphasised the centrality of

renewable energy integration, circular resource management, and AI-driven optimisation as foundational principles rather than supplementary features. This approach aligns closely with Bibri's (2021b) conceptualisation of the smart sustainable city as one that integrates technological intelligence with low-carbon urban metabolism and adaptive environmental systems.

At the same time, NEOM's alignment with Cohen's model is selective rather than comprehensive. The Smart People and Smart Living dimensions, which in much smart city literature emphasise participation, social inclusion, and quality of life, appear subordinated to a predominantly technocratic and top-down planning logic. The absence of clearly articulated participatory frameworks within NEOM's early design phases reflects broader concerns within smart city scholarship. Caprotti (2016) warns that smart cities risk becoming enclaves of technocratic ambition when citizen engagement and social negotiation are treated as secondary to efficiency and control. While NEOM stakeholders framed centralisation as a pragmatic response to scale and complexity, this approach challenges normative assumptions embedded within much smart city theory regarding democratic governance and civic empowerment.

Overall, the findings suggest that NEOM engages with global smart city best practices in a reflexive rather than imitative manner. Its relationship to Cohen's Smart City Model is characterised by strategic alignment and deliberate divergence, embracing technological and environmental dimensions while reconfiguring governance and social assumptions to suit a state-led, future-oriented development logic. In positioning itself not as an iteration of existing models but as their successor, NEOM foregrounds enduring tensions between optimisation and inclusivity, anticipation and adaptability, that remain central to evaluating its long-term sustainability and legitimacy within global smart urbanism.

5.4. Conclusion

This chapter has presented a comprehensive analysis of the strategic vision and conceptual planning frameworks underpinning NEOM, drawing upon the perspectives of internal stakeholders (Group 2). By situating the project within the broader landscape of global smart city development, the findings reveal that NEOM is strategically positioned not as an imitation of existing models, but as a deliberate departure from them. The analysis demonstrates that while global exemplars such as Copenhagen, Singapore, and Amsterdam serve as critical benchmarks,

internal stakeholders view NEOM's "greenfield" status as a unique opportunity to transcend the retrofitting constraints and incrementalism that define legacy urbanism.

Through the application of Cohen's Smart City Model, the chapter has identified a distinct alignment with the dimensions of Smart Environment and Smart Infrastructure, driven by a logic of high-efficiency and predictive governance. However, the analysis also highlights a significant divergence in the dimensions of Smart People and Living, where NEOM adopts a centralized, technocratic approach that prioritizes algorithmic anticipation over the participatory governance often emphasized in Western smart city discourse. This suggests that NEOM is aiming to define a new "post-smart" typology, one that shifts from reactive ICT integration to proactive, cognitive urban systems.

Having established the foundational motivations and the comparative positioning of NEOM against global best practices, the study must now turn to the specific mechanisms of its implementation. While this chapter focused on the why and the where of NEOM's conceptual placement, the following chapter will examine the how and the what. Consequently, Chapter 6 continues the analysis of Group 2 data to explore NEOM's unique operational dimensions, such as the linear urban form and zero-gravity urbanism, to fully address the central research question of whether NEOM constitutes a replicable paradigm for future sustainable cities.

Chapter 6: Conceptualising NEOM as a Paradigm for the Future (Internal Perspectives II)

Extending the analysis of internal perspectives (Group 2) initiated in the previous chapter, chapter 6 addresses the central research question regarding the extent to which NEOM serves as a paradigm for future sustainable smart city initiatives. While Chapter 5 highlighted the strategic vision and conceptual frameworks, this chapter focuses on the operational attributes and distinct paradigmatic elements of the project. The following sections present the findings structured around three of the primary aims of this study (Aims 5 – 7). As illustrated in Figure 28, these aims are analysed based on Group 2 data by unpacking the respective thematic analysis under key themes 3 and 4. First, the chapter explores the third key theme, NEOM's Unique and Innovative Dimensions, which identifies the elements that set NEOM apart from conventional smart cities. It examines the revolutionary urban design of The Line, focusing on sub-themes such as the Cognitive City and AI Urbanism, Zero Gravity Urbanism, Renewable Energy and Zero-Carbon Strategies, and Environmentally Integrated Urban Design.

Finally, the analysis addresses the fourth key theme, NEOM's Planning Between Utopia and Reality: Lessons and Challenges of Future Urbanism. This section synthesizes the lessons learned and challenges encountered during development, covering localized and sustainable mobility solutions, community-centric planning, financial and operational adaptability, and the role of global collaboration. By extracting these insights, the study provides a critical perspective on NEOM's potential as a model for future urbanism.

In engaging with these themes, the chapter directly addresses the central research question by examining the conditions under which NEOM's innovations might generate transferable lessons for future sustainable smart city initiatives. At the same time, it critically reflects on the social, environmental, and governance implications of pursuing radical urban transformation at scale, foregrounding the frictions that arise when speculative planning confronts material, institutional, and human realities.

6.1. Identification of Themes

The thematic analysis presented in this chapter draws on the same methodological framework outlined in Chapter 3 and operationalised in Chapters 4 and 5, following Braun and Clarke's (2014) six-stage approach to thematic analysis. As the coding and refinement processes were conducted holistically across the full Group 2 dataset, the themes discussed here are analytically distinct but conceptually interconnected with those examined previously. Their separation across Chapters 5 and 6 is intended to enhance analytical clarity rather than imply rigid thematic boundaries.

Two key themes (3 – 4) are examined in this chapter. Key theme 3 centres on NEOM's unique and innovative dimensions, encompassing internal narratives surrounding cognitive urbanism, zero-gravity and linear spatial configurations, AI-enabled infrastructure, and the integration of environmental performance into the core logic of urban form. This key theme captures how internal stakeholders frame NEOM as an unprecedented departure from existing urban models and as a prototype for post-carbon, data-intensive, and anticipatory urban systems.

Key theme 4 addresses NEOM's planning between utopia and reality, focusing on how internal actors acknowledge, negotiate, and rationalise the tensions embedded in the project's scale and ambition. This includes reflections on technical feasibility, environmental trade-offs, social and psychological implications of novel spatial forms, governance experimentation, and systemic resilience. Rather than positioning these tensions as failures or contradictions, stakeholders often articulated them as inherent to innovation at scale, emphasising learning, iteration, and institutional flexibility as critical to NEOM's long-term viability.

Together, these key themes provide a deeper understanding of how NEOM's internal stakeholders conceptualise the project not only as a city under construction but as an evolving socio-technical and institutional experiment. The sections that follow analyse each theme and its associated sub-themes in detail, situating internal perspectives within relevant scholarly debates and critically assessing their implications for the future of sustainable smart city development.

6.2. Group 2 (cont.)

Table 10

Themes and Sub-themes that Emerged from Group 2; Key themes 3 - 4

Themes	Sub-themes	Files (how many participants discussed the theme)	References (how many times the theme was mentioned)
NEOM's unique and innovative dimensions	1. Cognitive City and AI Urbanism. 2. Zero Gravity Urbanism and Revolutionary Urban Form. 3. Renewable Energy and Zero-Carbon Strategy.	19	123
NEOM's planning between utopia and reality: lessons and challenges of future urbanism	1. Lessons from NEOM's Planning. 2. Challenges associated with achieving NEOM's goals.	17	47

Source: Semi-structured Interviews, adapted by the author from NVivo 14 software.

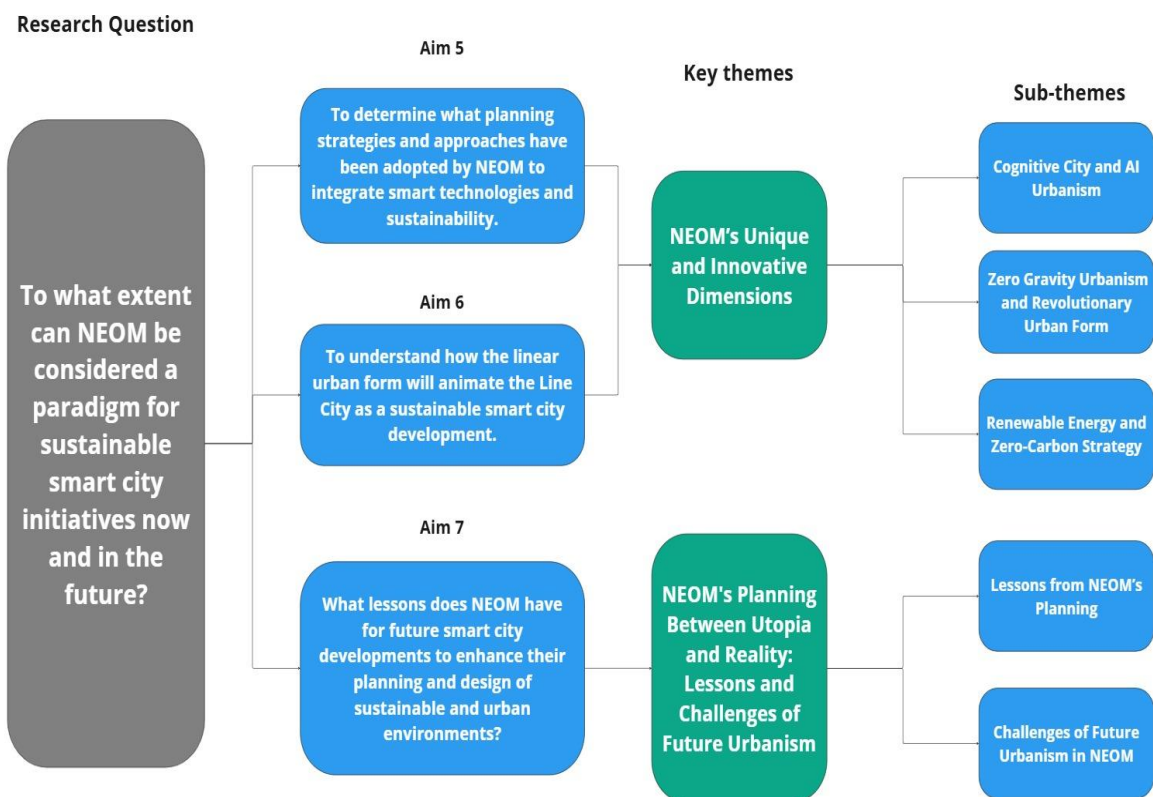
As outlined in Table 10, the third key theme, NEOM's Unique and Innovative Dimensions, explores the distinct elements that set NEOM apart from conventional smart cities. It examines its revolutionary urban design through The Line, focusing on sub-themes such as the Cognitive City and AI Urbanism, Zero Gravity Urbanism, Renewable Energy and Zero-Carbon Strategies, and Environmentally Integrated Urban Design. Finally, the fourth key theme, NEOM's Planning Between Utopia and Reality: Lessons and Challenges of Future Urbanism, synthesises lessons learned and challenges encountered in NEOM's development. This section addresses localised and sustainable mobility solutions, community-centric planning, financial and operational adaptability, and the role of global collaboration. By extracting these insights, the study provides a critical perspective on NEOM's potential as a model for future urbanism. Together, these themes provide a comprehensive analysis of NEOM's development, positioning it within the global smart city discourse while critically evaluating its potential as a sustainable and innovative urban paradigm.

This chapter further demonstrates the value of rich qualitative data to both complexify and illuminate secondary sources.

Figure 28

Key Findings of the Thematic Analysis of Interviews with Internal NEOM Stakeholders (Group 2)

Addressing Aims 5–7 of the Research Study; Key themes 3–4



The following sections in this chapter present the findings structured around the remaining analytical aims of the study (Aims 5 – 7), drawing on internal stakeholder perspectives to deepen the examination of NEOM as a paradigm for future sustainable smart city initiatives. As illustrated in Figure 28, the findings discussed here are organised into Key Themes 3 and 4, which collectively extend the analysis beyond conceptual alignment and innovation to interrogate the practical, institutional, and experiential dimensions of NEOM's planning.

6.2.1. Key Theme 3: NEOM's Unique and Innovative Dimensions

NEOM's vision as a sustainable smart city is built on a foundation of cutting-edge technologies, revolutionary urban forms, and an unprecedented commitment to sustainability. To fully understand the transformative potential of this ambitious project, internal NEOM stakeholders provided their insights and knowledge on the unique and innovative dimensions of the planned smart city. This chapter presents the findings from internal expert interviews, planning documents, feasibility reports, and exhibition visits. The interview data is critically analysed to demonstrate how NEOM aims to surpass existing smart city archetypes with support from secondary sources. Moreover, the potential for NEOM to integrate smart technologies and sustainable urban planning is addressed to outline how proposed innovations could potentially redefine future urban models. This theme aligns with research aims 5 and 6 as outlined in this thesis (see Figure 24), focusing on NEOM as a cognitive city and highlighting its distinct contribution particularly in the terms of The Line.

6.2.1.1 Sub-theme 1: Cognitive City and AI Urbanism

NEOM's cognitive city model introduces a paradigm shift in urban governance, spatial planning, and technological integration, reflecting a radical departure from traditional smart city models. Built around the concept of AI Urbanism, NEOM aims not only to embed AI across its urban systems but to reconceptualise the very ontology of urban space as dynamic, sentient, and responsive. At the heart of this model is the ambition to create a living city that learns, self-regulates, and anticipates human and environmental needs; a vision that sets NEOM apart from other global initiatives like Songdo, Masdar, or Singapore.

It is important to note at this juncture that although NEOM is heavily investing in the technologies to bring the cognitive city to life (Mumtaz & Happonen, 2023), such advanced technologies remain in the testing phases. However, NEOM's intentions in this area are clear from the interview findings. The Executive Director of Digital and Cognitive Solutions – The LINE (Interviewee 10, Group 2) set out what NEOM is seeking to do in becoming a cognitive city:

The [cognitive] dimension, I would say, is going from each of these, going from smart to ... cognitive. Yeah, we do that by moving from being, as I said, reactive

to being predictive, maximising the reuse of data in the public interest while safeguarding privacy and making sure that the technology is serving people's real needs. And we see kind of the city as a kind of cognitive city, the city itself as a concierge that looks after your needs, that understands you. So rather than a smart city which understands one-way data from IoT devices, and then makes a decision based on that, and it understands software, and then if you want to change that algorithm, you have to upgrade. So it's not real-time. Everything we want to do is real-time.

Interviewee 17 (Group 2) also captured this ambition clearly: "NEOM's cognitive city is built to learn and adapt in real-time. The AI systems will monitor everything from energy use to pedestrian flows, continuously optimising resources and services." This vision reflects broader discourses in urban geography around the shift from instrumental smartness to cognitive spatiality, where cities become active agents in their own governance (Batty, 2013; Townsend, 2013; Marvin & Luque-Ayala, 2017). These theoretical developments have urged scholars to rethink the city as more than a container of technologies, but as an assemblage of human-machine-environment relationships in flux.

AI Urbanism, as described by NEOM's Interviewee 4 (Group 2), aims to transcend sensor-driven smartness: "We are not just talking about smart sensors and connected infrastructure. NEOM's buildings, public spaces, and transportation systems will be imbued with AI." This aligns with Cugurullo et al.'s (2023) work on urban AI, which posits that the emergence of AI cities marks the next phase in technocratic urban development. Unlike first-generation smart cities that deployed ICT for efficiency, AI cities function through predictive algorithms and real-time learning environments, blurring the boundary between infrastructure and intelligence.

NEOM's commitment to AI urbanism extends beyond efficiency and optimisation, with plans to integrate AI into the design of public spaces, transportation, and the built environment itself (Nikitas et al., 2020). Interviewee 17 (Group 2) emphasised NEOM's cutting-edge and added, "Our city will be built using intelligent design and fully data-driven, again thanks to the digital twin algorithm, so that we don't have to retrofit solutions afterwards. Sadly, that is currently what happens in every other global city."

The use of digital twins exemplifies this predictive turn. These virtual replicas allow planners to simulate and continuously monitor the physical city in real time. Interviewee 3 (Group 2) stressed this point, describing the digital twin as “a game changer, allowing us to anticipate urban challenges before they arise.” This resonates with urban geography’s growing engagement with geocybernetics,¹¹ which conceptualises cities as cybernetic feedback systems where information processing becomes the key to spatial regulation (Phillips, 2021; Gabrys, 2016; Kitchin, 2014a; Söderström et al., 2014).

Secondary data from PwC (2023) and Shahat et al. (2021) further legitimise this ambition. The PwC report positions cognitive cities as the evolution of smart urbanism, where real-time AI processing replaces traditional command-and-control hierarchies. These developments align with Kitchin’s (2016) critique of the algorithmic city, in which “data-informed urbanism is increasingly being complemented and replaced by data-driven urbanism ... changing how we know, plan and govern cities” (p. 3).

The integration of AI into NEOM’s energy and mobility sectors, two critical urban infrastructures, demonstrates its operational ambitions. Interviewee 5 (Group 2) noted that “AI will enable us to balance energy loads more efficiently than ever before,” particularly important given NEOM’s reliance on intermittent renewable energy sources. Similarly, Interviewee 13 (Group 2) described an AI-led mobility system capable of eliminating congestion. These aims reflect what Sheller (2018) terms mobility justice, where technological systems must be evaluated not only by efficiency metrics but by their capacity to serve diverse urban publics equitably.

Yet, as highlighted by Interviewee 2 (Group 2), these ambitions are not without vulnerabilities. The scale and interdependence of AI systems raise concerns about system failure and cyber resilience. Urban geographers such as Graham and Martin (2001) have long warned about splintering urbanism,¹² where uneven access to resilient infrastructure creates new forms of digital exclusion and systemic fragility. Moreover, the NYC AI Action Plan (2023) underscores

¹¹ ‘Geocybernetics’ is a framework in urban theory that conceptualises cities as cybernetic systems governed by feedback loops among sensors, algorithms, and human activity. It marks a shift from spatial planning to dynamic process-oriented governance (Phillips, 2021).

¹² ‘Splintering urbanism’ refers to the fragmentation of urban infrastructure and access caused by uneven technological integration, often leading to new geographies of inclusion and exclusion (Graham & Martin, 2001).

the need for governance structures that can pre-empt cyber threats in increasingly autonomous urban environments.

Feasibility studies also raised the paradoxical issue of energy-intensive AI systems. While AI optimises urban systems, its operation, particularly training deep learning models and processing real-time data, requires substantial computational energy. As O'Dwyer et al. (2019) argue, the green credentials of smart technologies are often overstated unless the energy consumption of their backend systems is critically assessed. This creates a potential contradiction in NEOM's net-zero ambitions and its AI-driven urbanism, a tension also observed in literature critiquing the ecological modernisation (Mol & Spaargaren, 2000).

In addition to material and technical concerns, the cognitive city model raises profound questions about social experience and spatiality. Interviewee 18 (Group 2) articulated these anxieties, stating, "There's a risk that over-reliance on automated systems could reduce human interactions." The danger, as urban sociologists like Sennett (2012) warn, lies in creating cities that suppress ambiguity and informal social interaction, engineering out the spontaneity and serendipity that underpin vibrant urban life. The NYC AI Action Plan (2023) cautions against technocratic dominance, calling instead for human-centric AI systems that prioritise inclusion, deliberation, and social equity.

Efforts to balance automation with urban conviviality¹³ are not new in the field of urban geography. Concepts such as *smart citizen*¹⁴ (Cardullo & Kitchin, 2019) and *right to the city*¹⁵ frameworks (Harvey, 2015) suggest that urban technological development must be co-produced with citizens, rather than imposed through technocratic logics. Interviewees expressed awareness of this tension, and planning documents from NEOM increasingly reference goals to humanise AI deployment through participatory and experiential design.

¹³ Amin and Thrift (2002) conceptualise cities as relational and affective spaces, where informal encounters and ambiguity resist overly rationalised urban design.

¹⁴ Smart citizen is a concept introduced to critique smart city governance models that favour corporate or technocratic control, advocating instead for participatory and inclusive technological governance frameworks. (Cardullo & Kitchin, 2019).

¹⁵ The right to the city, first proposed by Henri Lefebvre, argues that urban dwellers, especially marginalised groups, should have a say in how urban space is produced, experienced, and governed. In the context of smart and hyper-designed cities, this concept remains a critical counterpoint to top-down, technocratic planning (Isensee, 2013).

Ultimately, the interview data, when read alongside critical urban scholarship, suggest that NEOM's cognitive city is both a technological innovation and a political project. It reimagines the urban as an intelligent infrastructure, yet also opens up new dilemmas around power, agency, and the ethics of automation.

6.2.1.2 Sub-theme 2: Zero Gravity Urbanism and Revolutionary Urban Form

NEOM's adoption of Zero Gravity Urbanism represents one of the project's most provocative departures from conventional urban planning. Rather than reproducing the horizontal sprawl of twentieth-century metropolises, this model proposes a multi-layered, vertically integrated urban form, challenging both spatial logic and socio-technical norms that have long governed city-making. As articulated by Albarqawi (2023), Zero Gravity Urbanism transcends the traditional constraints of horizontal urban sprawl, promoting compact, dynamic environments that make more efficient use of space and natural resources.

The core idea revolves around verticality, not simply as a structural tactic but as a planning paradigm. Residential, commercial, and recreational functions are to be stacked atop each other in precisely engineered layers, radically altering the spatial footprint of the city. Interviewee 3 (Group 2) explained that "Zero Gravity Urbanism is essentially a way to describe this fundamental rethinking of urban planning where we reduce the 'gravity' or burden on residents to access essential services and on the environment." This framing underscores two critical objectives: improving spatial accessibility and alleviating ecological strain. It reflects wider debates in urban geography around compact urbanism¹⁶ and the shift away from car-centric sprawl (Neuman, 2005).

Perhaps the disruptive ethos of Zero Gravity Urbanism is most vividly articulated by Interviewee 17 (Group 2):

Zero gravity urbanism ... means that we've always built cities based on cars based on the ability to travel far and that's generated sprawl [and] social disintegration ... it's generated everything that is wrong with our cities including pollution ...

¹⁶ 'Compact urbanism' promotes dense, mixed-use development as a sustainable alternative to sprawl, though it may risk gentrification and social exclusion (Neuman, 2005).

[If] we create a city with a hundred percent renewable energy ... take out all the cars it's a city without cars ... [W]hat comes after that is height; we know that a linear city creates efficiency it's a single line of infrastructure, ... communication [and] transportation and you move up and down 20 minutes end to end. [In contrast] to cross London is about an hour and a half in public transport, to cross the line is 20 minutes.

This critique aligns with long-standing academic concerns regarding the socio-environmental consequences of post-war suburbanisation and automobile dependence (Newman & Kenworthy, 1999). NEOM's ambition to eliminate cars and decentralise pollution through a linear, vertically layered infrastructure reconfigures these historical critiques into a design intervention. The notion of a city without cars powered by 100% renewable energy resonates with discourses around the 15-minute city but pushes further by compressing urban functionality not only in terms of proximity but also in physical height.

However, while the promise of a city that takes 20 minutes end to end¹⁷ is compelling, the scale and uniformity implied by such efficiency-oriented urban design may raise critical questions about liveability and community identity. Urban scholars have argued that spatial compression, if over-engineered, can limit place-based identity and socio-spatial differentiation, which are key to civic life and cultural vibrancy (Relph, 1976; Zukin, 1998). While NEOM's model is designed to maximise mobility and sustainability, it remains to be seen how these principles will coexist with organic urban rhythms, informality, and the social textures that define cities.

This tension is also indirectly acknowledged by Interviewee 19 (Group 2):

Zero gravity urbanism is assessed to optimise spaces while offering continual connection development through social interaction as well as urban experience.

Therefore, design is seen to exemplify the commitment shown by the planning of

¹⁷ The phrase "20 minutes end to end" refers to NEOM's plan for a high-speed rail system enabling residents to traverse the entire 170 km length of The Line in 20 minutes. This concept is highlighted in NEOM's official materials, stating, "Residents will also have access to all daily essentials within a five-minute walk, in addition to high-speed rail, with an end-to-end transit of 20 minutes" (NEOM, n.d.).

NEOM to innovation and sustainability for managing the people-centric development of urban development in smart cities.

This framing echoes what urban theorists describe as the networked city, where social interaction and experiential quality are mediated by design, infrastructure, and digital systems (Graham & Marvin, 2001). The dual emphasis on space optimisation and people-centricity reflects a familiar smart city dilemma: how to balance technocratic efficiency with human-scale sociality.

The interview findings indicate that central to NEOM's implementation is the spatial and infrastructural integration of its key systems, where vertical and horizontal layering enables seamless coordination between mobility, energy, and digital networks. As the Manager of Urban Planning at NEOM explained, "We are layering functions both vertically and horizontally, so that mobility, energy, and digital systems are all seamlessly connected" (Interviewee 5, Group 2). These include high-speed elevators, subterranean transport, and automated pedestrian flows. Such infrastructure represents the material realisation of what geographers call vertical urbanism,¹⁸ a spatial logic that reconfigures traditional zoning by height rather than horizontal proximity (Graham, 2016; Appert & Montes, 2015). In theory, this layering fosters density without congestion, creating compact communities with seamless interlayer transitions.

Nevertheless, this model's feasibility raises further questions around governance, social equity, and psychological orientation within a vertically ordered space. For example, can vertical communities foster the same neighbourhood ties and informal interactions traditionally nurtured in horizontal layouts? What impact might this spatial order have on perceptions of openness, sunlight access, or mental well-being, issues already identified in high-rise urban settings across the Global North and East Asia (Gifford, 2007; Yuen et al., 2011)?

Moreover, while Zero Gravity Urbanism may offer environmental benefits through reduced land use and renewable integration, its long-term adaptability remains uncertain. If needs or populations shift, it is not clear how flexibly a hyper-structured, vertically bounded city could

¹⁸ 'Vertical urbanism' concerns the social and spatial consequences of stacking city functions across height rather than land area. It introduces new hierarchies and access concerns while reconfiguring traditional ideas of proximity and neighbourhood. In cities like Hong Kong and New York, it has raised debates around sunlight access, social isolation, and vertical segregation (Appert & Montes, 2015).

respond. The rigidity of such a model may hinder informal growth or community-led spatial reappropriation, features that historically contributed to urban resilience (Alexander, 2013; Brenner & Elden, 2009).

In summary, NEOM's Zero Gravity Urbanism embodies a radical rethinking of urban form, mobility, and space. It critiques the failures of car-centric, sprawling cities while proposing a vertically integrated alternative that prioritises efficiency, sustainability, and social connectivity. Yet its realisation will depend on a delicate balancing act between spatial optimisation and urban conviviality, between verticality and diversity, and between control and organic emergence. As with cognitive urbanism, its success will ultimately hinge not only on design ingenuity but on how well it negotiates the social, cultural, and ecological dimensions of city life.

6.2.1.2.1 The Line: The Realisation of Zero Gravity Urbanism

While The Line was a strand of conversation that featured in the Group 2 internal stakeholder interviews, before engaging with the comments that emerged there, this section represents field work undertaken by myself as researcher in terms of direct observation of the design conceptions for The Line at an exhibition in Riyadh in 2023.

The Line, a revolutionary urban city within Saudi Arabia's NEOM development, exemplifies the practical implementation of Zero Gravity Urbanism. Designed as a 500-metre-tall, linear megastructure, The Line integrates diverse functions, residential, commercial, and recreational, within vertically organised environments (NEOM, 2024a). The concept, conceived by the renowned design firm Morphosis, reimagines urban morphology by adapting spatial conditions to create liveable microclimates (Morphosis Architects, 2023). These confined yet meticulously planned vertical spaces foster unique public realms and ensure accessibility to essential services and amenities, thereby redefining urban living. As a narrow, connected linear settlement, The Line represents a radical departure from traditional city planning that more commonly follows a radial or grid-based layout.

The vision for The Line extends beyond mere structural innovation. It emphasises sustainability, mobility, and inclusivity. As a car-free city, it aims to reduce reliance on traditional modes of transportation, instead offering advanced transit systems that connect its vertical layers.

Healthcare, education, and recreational facilities are intended to be distributed within a five-minute walking radius of residents, ensuring convenience and efficiency in daily life. Public parks and retail spaces are to be interspersed throughout the vertical structure, contributing to a vibrant and diverse living environment that blurs the boundaries between nature and urbanisation. This holistic approach underscores the potential of Zero Gravity Urbanism to address the environmental, spatial, and societal challenges of the 21st century.

NEOM's The Line is presented as a groundbreaking urban model not just in form and smart infrastructure, but in its collaboration with twelve global firms (NEOM, n.d.). At the heart of this initiative is the integration of innovative contributions from each firm, collectively shaping the city's vision of a self-sustaining, zero-emission urban environment. These contributions not only complement one another but also reinforce the shared goals of The Line and NEOM, demonstrating a complex interplay of expertise and creativity. However, its feasibility and scalability remain uncertain, requiring an analytical evaluation of its practical challenges.

At The Line Exhibition in Riyadh (2023), these globally renowned architectural firms unveiled their visionary contributions to this urban megaproject, offering diverse approaches to modularity, ecological integration, and human-centred design. I attended the exhibition to collect up-to-date information and gain a deeper understanding of the unique elements that define The Line's innovative urban design. The envisioned outcome presented a transformative urban blueprint that aspires to redefine future cities. The twelve architectural firms were as follows: Fuksas, Tom Wiscombe Architecture, UNStudio, Adjaye Associates, HOK, Sir Peter Cook's, Morphosis, Pei Cobb Freed & Partners, Delugan Meissl Associated Architects (DMAA), Coop Himmelb(l)au, Oyler Wu Collaborative, and OMA. To depict each of these contributions and the way they are intended to work together as a whole concept, the designs from each firm are presented in turn before bringing the discussion together in concert with the perspectives from the interviewees.

Fuksas's design philosophy for The Line drew inspiration from the natural beauty of NEOM's coral reefs, blending architecture and ecology into a seamless harmony. Their vision introduced two key elements: The Coral and The Rocks (Figure 28). According to Fuksas, The Coral represents a continuous public realm that mimics the porous structure of coral reefs, fostering

natural ventilation, passive cooling, and abundant natural light. Meanwhile, The Rocks reimagines residential zones as organic extensions of the landscape, utilising cutting-edge materials like self-healing concrete and environmentally friendly construction methods to ensure durability and sustainability. Together, these elements create a cityscape that merges advanced technology with ecological preservation, emphasising a symbiotic relationship between urban spaces and their surrounding environment.

Figure 29

A rendering by Fuksas, showcasing the organic interplay of natural motifs and modular urban structures for The Line



Source: Exhibition in Riyadh, 2023 (photography by author 07/07/2023)

Tom Wiscombe Architecture presented a bold, futuristic vision for The Line with their concept, Interstellar (Figure 29), which they noted, was inspired by cosmic forms and zero-gravity principles, challenging conventional notions of urban spatial dynamics. Their emphasis seems to be on the engineering aspects of the design. Floating architectural structures, crafted from lightweight composite materials, create layered public spaces that function as hubs for community interaction. These interstitial spaces, supported by innovative tensioning systems, are designed to

adapt dynamically to environmental and social needs. Wiscombe's vision merges cutting-edge engineering with artistic expression that seeks to foster interconnectedness in a way that is both imaginative and functional.

Figure 30

A detailed rendering of Tom Wiscombe's "Interstellar" - The Line's modular urban framework, highlighting its futuristic design and vertically layered functionalities



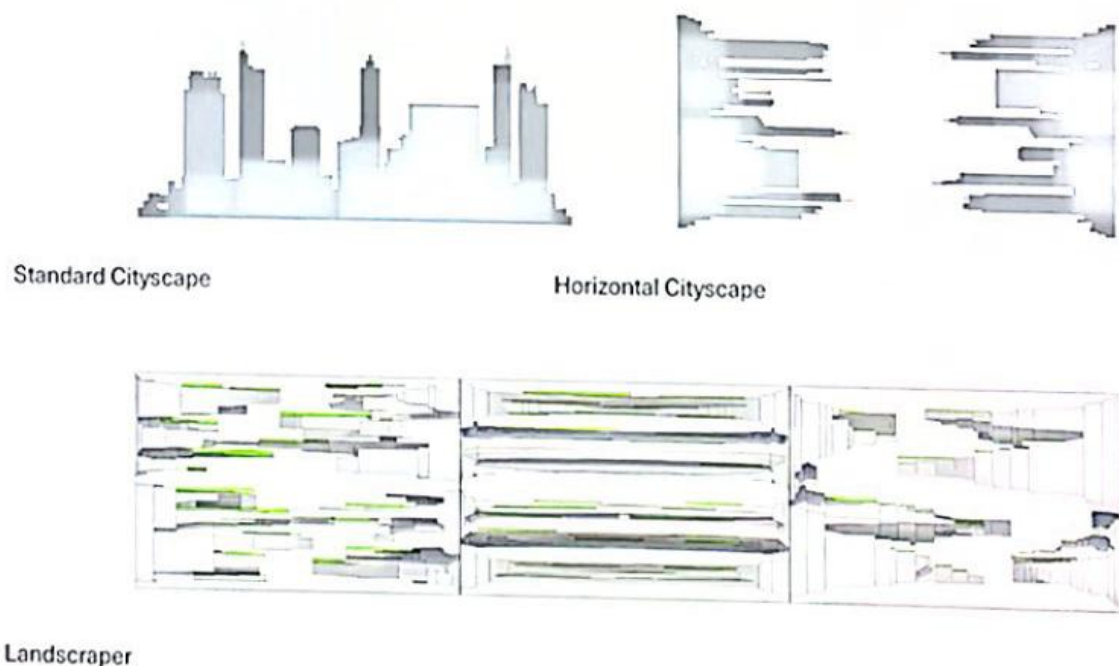
Source: Exhibition in Riyadh, 2023 (photography by author 07/07/2023)

UNStudio's contribution, The Most Walkable Vertical City, prioritised walkability and sustainability within The Line's vertical framework (Figure 30). Their design integrates urban agriculture directly into residential towers, utilising aeroponic systems and advanced lighting technology to produce local food efficiently. Building facades feature kinetic photovoltaic panels that adjust to sunlight angles, optimising energy capture and minimising waste. Public spaces are

designed with biophilic principles,¹⁹ incorporating natural materials, circadian lighting, and lush greenery to promote well-being. By ensuring walkable access to essential amenities and fostering ecological self-sufficiency, UNStudio's vision demonstrates how dense urban environments can remain liveable, resilient, and sustainable.

Figure 31

UNStudio's depiction of a horizontal cityscape as envisioned for The Line



Source: Exhibition in Riyadh, 2023 (photography by author 07/07/2023)

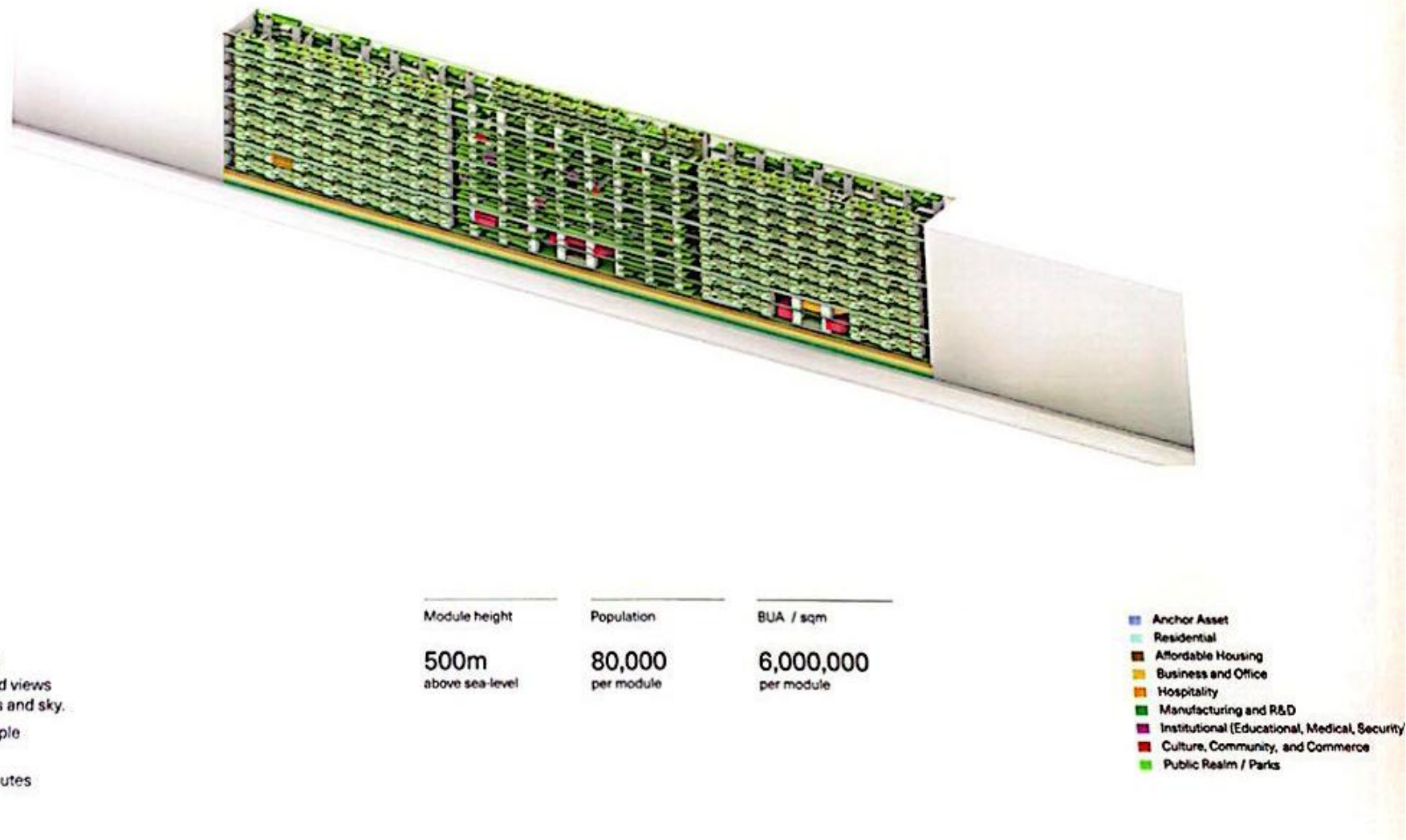
Adjaye Associates envisioned The Line as a self-sufficient ecosystem where urban systems are intricately intertwined with nature (Figure 31). Their design integrates landscaped terraces filled with native flora to support biodiversity and mitigate urban heat. Circular systems for resource management, such as blackwater recycling and urban composting, reduce waste and enhance sustainability. Renewable energy solutions, including decentralised microgrids powered

¹⁹ Biophilic principles are design strategies that integrate natural elements, patterns, and processes into the built environment to enhance human well-being, productivity, and ecological sustainability. Rooted in the concept of biophilia, which suggests an innate human affinity for nature (Wilson, 2017), these principles seek to create environments that foster connectivity with the natural world.

by solar and wind, ensure energy independence. Adjaye Associates also proposed subterranean utility networks, leaving the surface free for green spaces and pedestrian areas while maintaining seamless functionality. This vision underscores the potential for cities to operate as environmentally conscious systems without compromising on human comfort or aesthetic appeal.

Figure 32

A rendering by Adjaye's illustrating their concept of interconnected nature and urban forms for The Line's vertical city

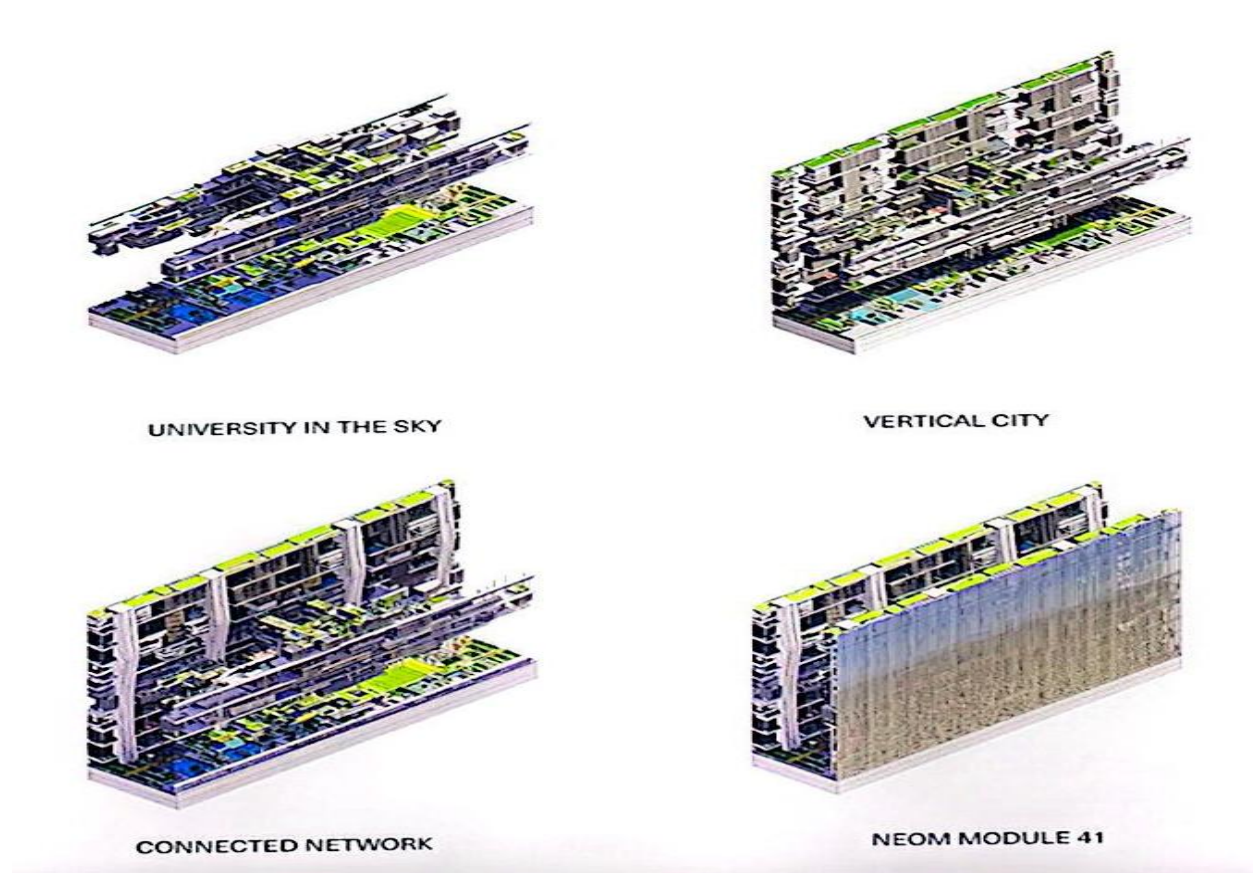


Source: Exhibition in Riyadh, 2023 (photography by author 07/07/2023)

HOK's University in the Sky concept transformed vertical urbanism into a multifunctional environment blending education, commerce, and residential spaces (Figure 32). Their design features high-speed vertical transit systems based on magnetic levitation technology, allowing for seamless movement between levels. High-altitude terraces provide open-air spaces shielded from the wind through advanced deflection systems and weather-resistant materials. By integrating diverse functions into a vertical hub, HOK states that they are seeking to address the challenges of high-density urban living with innovative solutions that ensure flexibility, accessibility, and functionality.

Figure 33

Vertical Urbanism concept as designed by HOK for NEOM's The Line

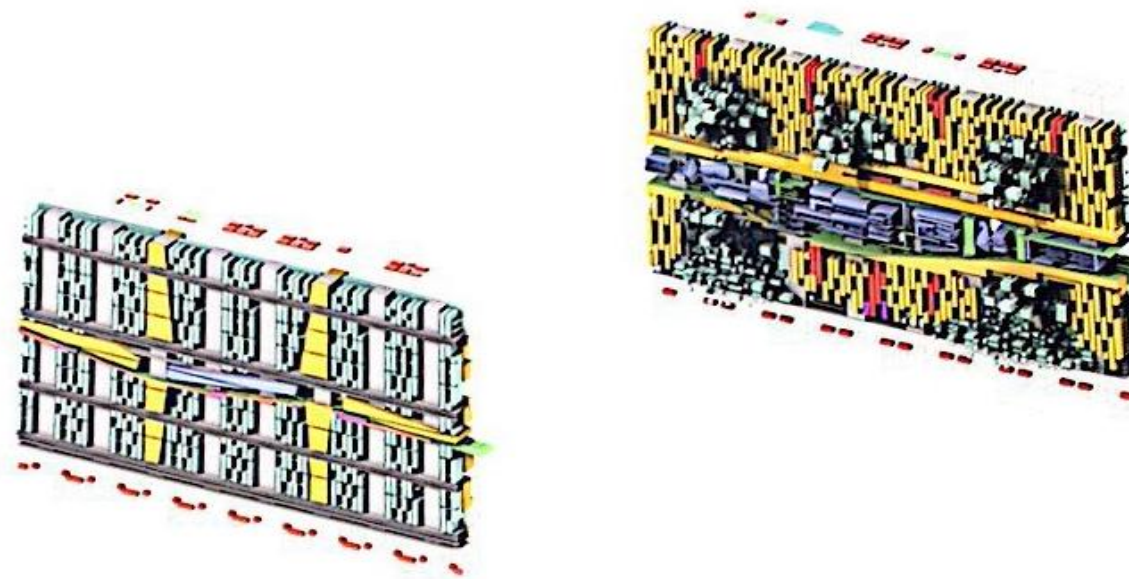


Source: Exhibition in Riyadh, 2023 (photography by author 07/07/2023)

Sir Peter Cook's design proposal for The Line at NEOM presents a visionary approach to urban living, reimagining traditional notions of city density, accessibility, and interaction (Figure 33). The concept celebrates elevated urbanism, creating a vibrant, pulsating cityscape that fosters variety, satisfaction, and dynamic experiences for its inhabitants. By introducing layered, elevated living spaces, Cook states that the design disrupts conventional ground-level layouts, offering a redefined relationship between public and private domains. This visionary cityscape prioritises human-centric design principles, blending advanced technology, environmental consciousness, and architectural innovation to address contemporary urban challenges. Rooted in futuristic functionality, the proposal aims to meet present-day needs while inspiring a new standard of living in cities, making The Line a model for transformative and forward-thinking urban development. The concept of futuristic functionality in NEOM can be understood as the capacity of built environments to sense, predict, and respond to user behaviour and environmental conditions (Bibri, 2021a). However, such speculative integration demands critical scrutiny. As Sennett (2012) argues, overly systematised urban environments risk undermining democratic openness and civic flexibility. In this regard, NEOM's real test lies not in its technological sophistication but in its ability to sustain inclusive participation, governance transparency, and spatial adaptability, dimensions currently underdeveloped in both planning documents and public discourse.

Figure 34

Sir Peter Cook's conceptual design for The Line at NEOM



Key characteristics

The everyday life is elevated, the individual and the social-economic life of the city is composed in a different plain, one that is now dominated by verticality and free of necessity for the ground. The city now offers many other grounds and elaborate domains traditionally belonging revised, relearned, established and even invented. Conditions need to be designed, shaped and constructed as they are not necessarily given. Responsibility for the conditions and intentions of the city is therefore much greater and the responsibility of the designer and the citizen.

Module height

500m
above sea-level

Population

77,000
per module

BUA / sqm

6,420,000
per module

- Anchor Asset
- Residential
- Affordable Housing
- Business and Office
- Hospitality
- Institutional (Educational, Cultural)
- Commercial
- Logistics
- Public Realm / Parks

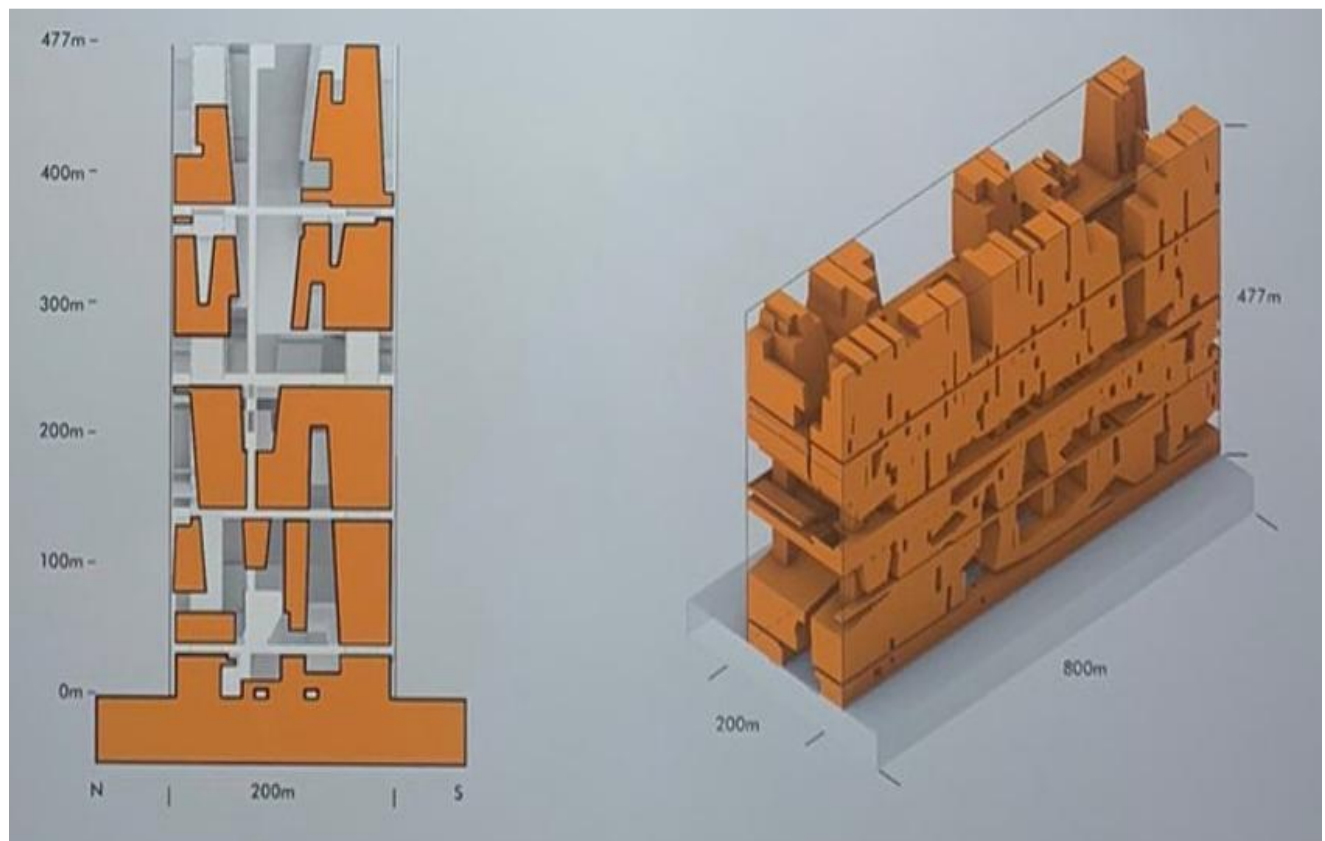
Featuring a 500-meter-high modular structure housing 77,000 people per module across 6,420,000 square metres.

Source: Exhibition in Riyadh, 2023 (photography by author 07/07/2023)

Morphosis Architects, tasked with conceptualising The Line's foundational framework, proposed an adaptable and modular urban structure capable of evolving alongside the city's needs (Figure 34). Their carved morphology embraces prefabrication techniques to reduce material waste and increase construction efficiency. Smart infrastructure, embedded with IoT sensors, monitors structural performance and environmental impact in real-time. Morphosis's emphasis on adaptability ensures that The Line remains responsive to future challenges, preserving its relevance as a sustainable urban model.

Figure 35

Rendering of Morphosis's initial design concept for The Line's carved morphology for spatial flexibility

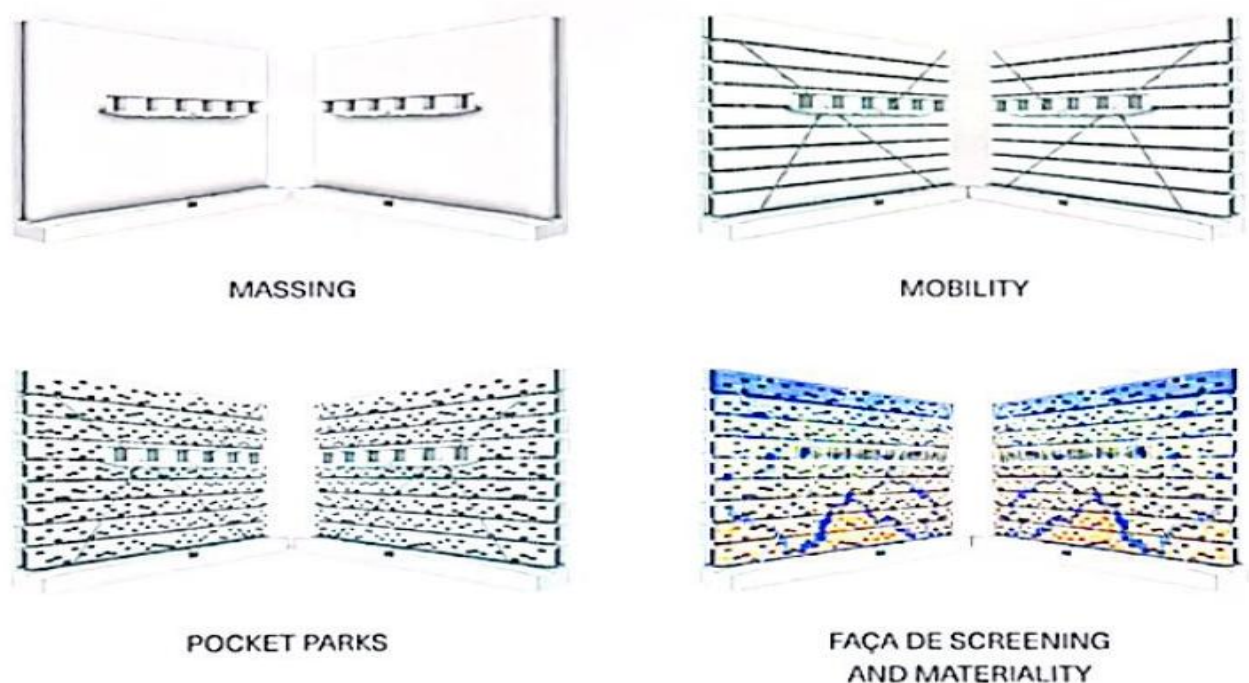


Source: Exhibition in Riyadh, 2023 (photography by author 07/07/2023)

Pei Cobb Freed & Partners envisioned The Line as a vertically folded cityscape designed for compactness and walkability (Figure 35). Their approach prioritised mixed-use neighbourhoods interspersed with pocket parks and rooftop gardens irrigated through greywater recycling systems. By combining compact urban design with abundant green spaces, they demonstrated how dense environments can remain ecologically integrated. Facades optimised for natural ventilation and solar shading further reduce reliance on energy-intensive systems, offering a balance between functionality and sustainability.

Figure 36

Pei Cobb Freed & Partners' design of The Line as a 'folded city'



Showing the vertical stacking of different modules, such as green spaces, for compact and dense neighbourhoods that are highly connected.

Source: Exhibition in Riyadh, 2023 (photography by author 07/07/2023)

DMAA focused on the creation of dynamic interstitial spaces that foster community engagement and human interaction (Figure 36). Their design featured artificial vertical parks, hydroponic greenery, and water-centric features that enhance air quality and liveability. These spaces were conceived as hubs for spontaneous gatherings, cultural events, and social exchange, reinforcing The Line's identity as a human-centred city. DMAA's use of augmented reality

systems within public spaces also blurs the boundary between physical and digital environments, creating interactive and immersive urban experiences.

Figure 37

DMAA's design of the in-between interstitial spaces that foster community engagement and human interaction



Source: Exhibition in Riyadh, 2023 (photography by author 07/07/2023)

Coop Himmelb(l)au presented The Vertical Garden City, a self-sustaining urban ecosystem that combines modular adaptability with controlled microclimates (Figure 37). Their design incorporates renewable energy systems, including photovoltaic glazing and integrated wind turbines, to power the city sustainably. Vertical gardens and urban forests would act as carbon sinks, while climate-controlled zones would ensure comfort in extreme conditions. This vision highlights the potential of architecture to balance ecological responsibility with human comfort, offering a template for future urban ecosystems.

Figure 38

A sketch of Coop Himmelb(l)au's 'Vertical Garden' concept illustrating its different components as envisioned for The Line

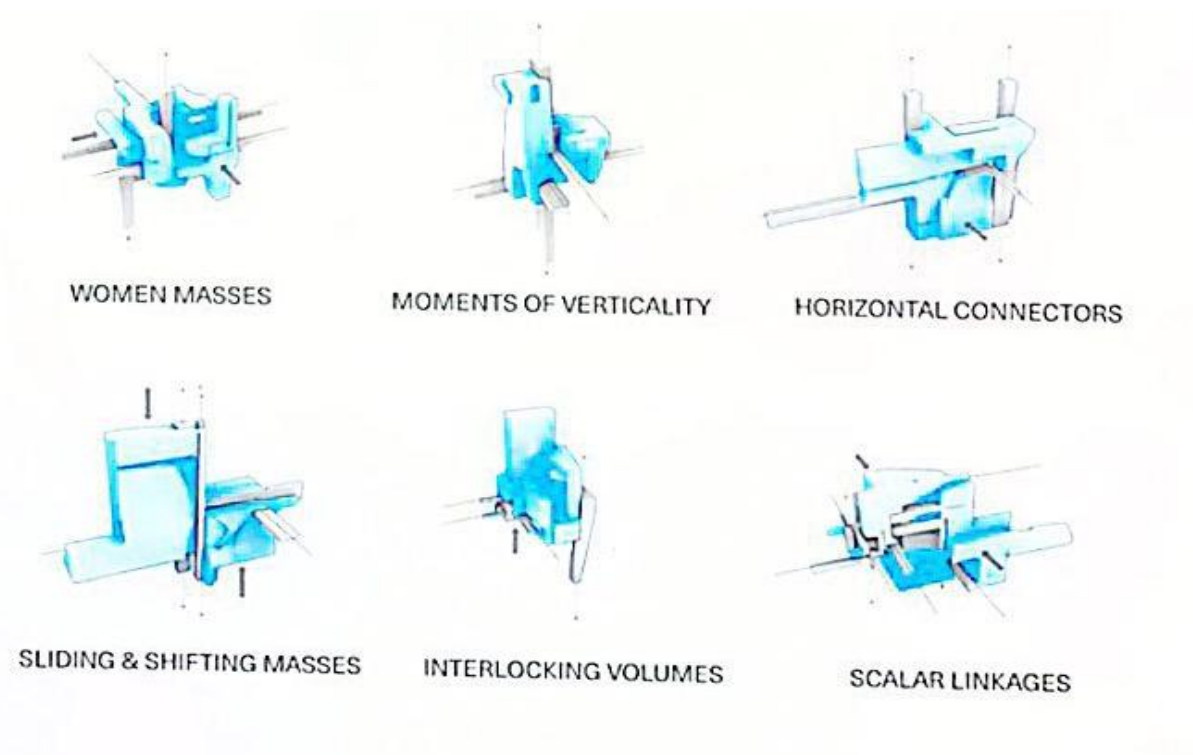


Source: Exhibition in Riyadh, 2023 (photography by author 07/07/2023)

Oyler Wu Collaborative introduced a network of interlocking urban volumes, an integrated spatial framework enabling both vertical and horizontal connectivity (Figure 38). Their design creates neighbourhoods connected by sky bridges and multilevel corridors, fostering a sense of cohesion and adaptability. According to the firm, the modular nature of their structures allows spaces to evolve over time, responding to changing needs and demographics. This flexible approach would ensure that The Line remains dynamic and resilient, capable of adapting to future urban challenges.

Figure 39

A conceptual design by Oyler Wu Collaborative for adaptable urban spaces in The Line



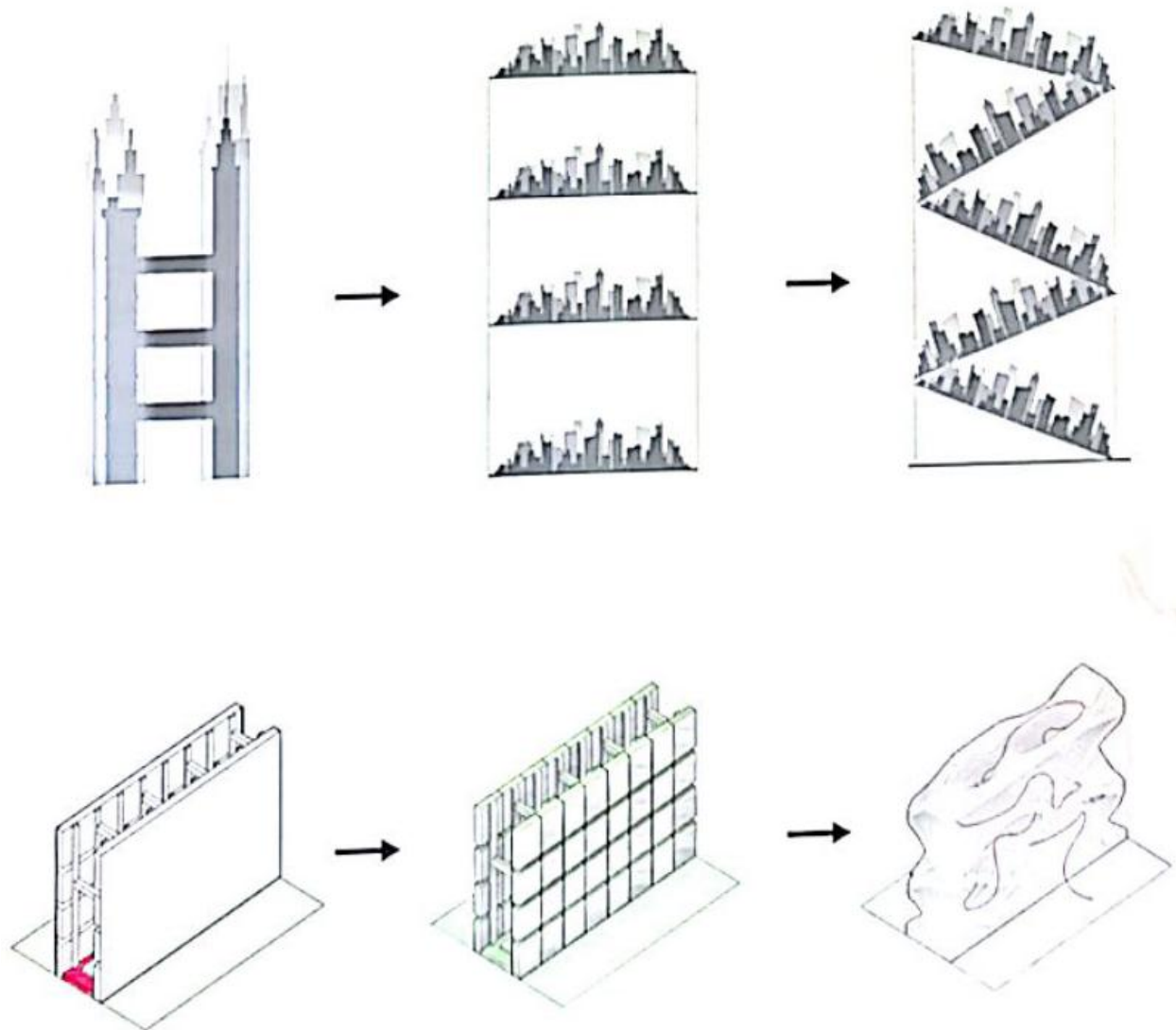
Showcasing interlocking volumes, sliding masses and modular connections.

Source: Exhibition in Riyadh, 2023 (photography by author 07/07/2023)

OMA's vision focused on accessibility and mobility, emphasising five-minute walkability to essential services (Figure 39). Their design incorporated panoramic routes and diagonal pathways to connect vertical layers efficiently. Green spaces were seamlessly integrated into urban structures, creating shaded corridors and natural cooling systems that improve liveability. OMA's commitment to balancing mobility, functionality, and ecological integration underscores the city's focus on creating a harmonious urban environment.

Figure 40

A design rendering of OMA's depiction of a vertical city



Allowing its inhabitants the opportunity to be in close proximity to all essential ingredients of a liveable community.

Source: Exhibition in Riyadh, 2023 (photography by author 07/07/2023)

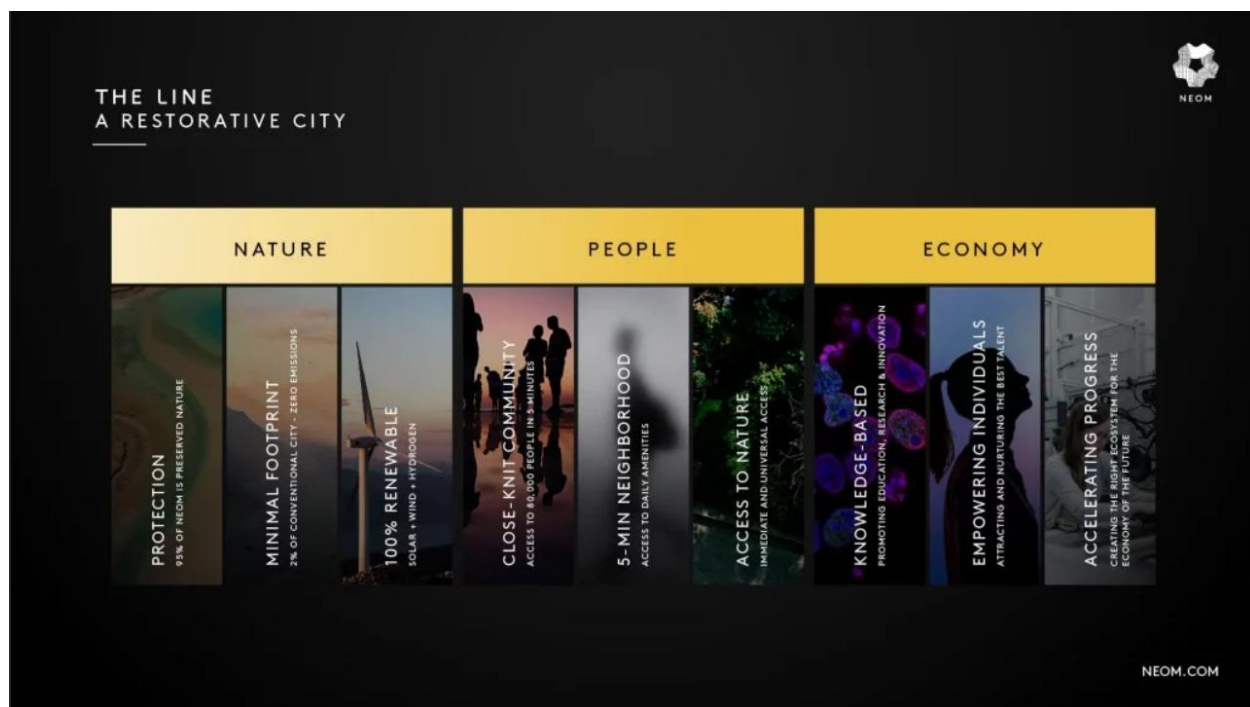
These architectural visions, unveiled at The Line Exhibition, represent a collective effort to rethink how cities of the future can be designed to address the dual challenges of rapid

urbanisation and environmental sustainability. By integrating advanced technologies, modular adaptability, and ecological consciousness, The Line aspires to be more than a city, presenting itself as a transformative prototype for the urban systems of tomorrow.

The two key features that are evident in all the designs is the diversity of forms, spaces, and materials that are needed to achieve a high-density smart urban environment that is liveable and adaptable to future needs circumstances, and the creativity in designing for ecological preservation. The collaborative approach allows for a wide pool of expertise to more fully address these challenges. By merging adaptive designs, renewable technologies, and human-centred urban planning, The Line exemplifies a pioneering approach to urban development, positioning it as a blueprint for the cities of tomorrow (Figure 40).

Figure 41

Overview of The Line's main distinctive features



Source: NEOM.com

Seeing first-hand all the designs presented together served to reinforce the ambitious scale of the project, the futuristic and highly advanced nature of the design concepts and models, the

stated intention across all the various proposals to address the significant pressures of urbanisation as sustainably and creatively as possible, as well as the opportunity afforded by a completely new city in not being restricted by pre-existing structures and configurations. The nature of the challenge to realise the project on the ground, especially with so many collaborative designers, is also evident in the fact that between the exhibition in Riyadh in 2023 and the first official announcement of the phased approach to construction made on November 11, 2024, some of the architects named above have since communicated that they are no longer working on the project, such as Adjaye Associates, HOK, and Coop Himmelb(l)au (Ravenscroft, 2024).

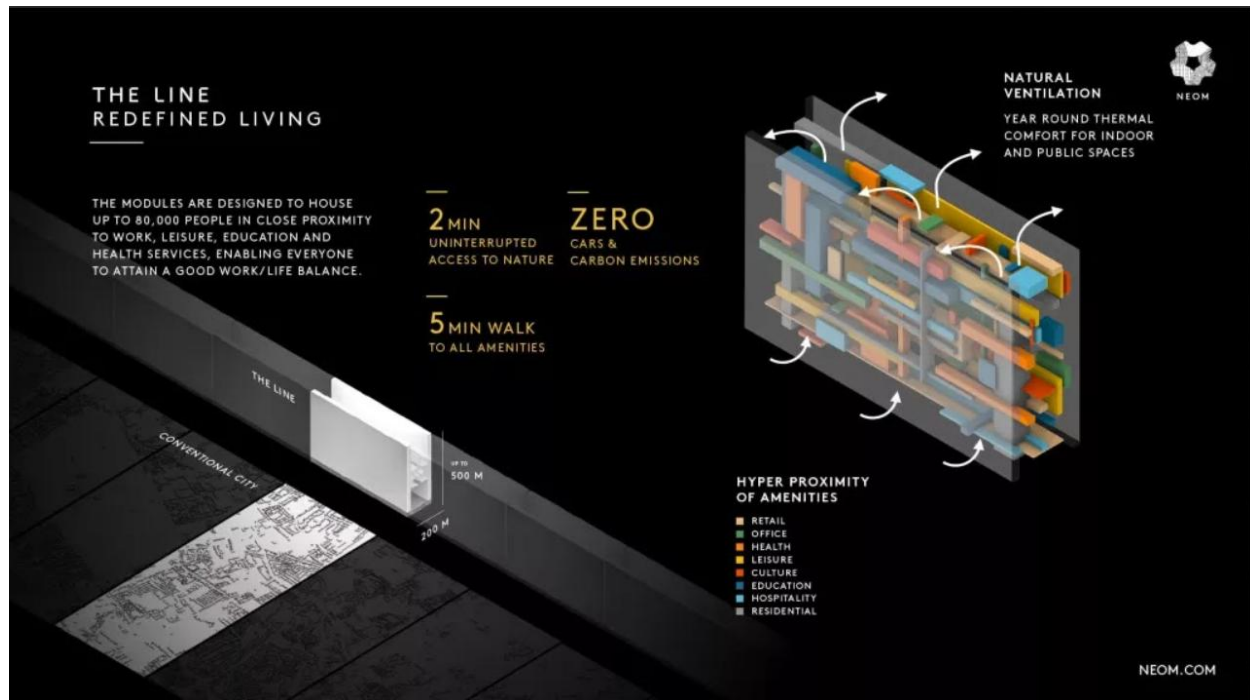
It is valuable to compare the documentary evidence from the exhibition as set out above with the aspects that emerge from the interviews with Group 2 stakeholders as they discuss what they see as the aims and purpose of The Line. One of the key drivers behind this revolutionary urban form, as identified in the interview data is the desire, as Interviewee 5 (Group 2) states, “to minimise the city’s footprint and environmental impact while maximising the efficient use of space.” Reducing the environmental impact includes reducing the need for mass transportation and enabling a more sustainable, low-carbon lifestyle. Interviewee 5 (Group 2) went on to explain how they saw the linear design functioning in this respect:

The Line’s vertical orientation will allow for multi-level transportation networks, with pedestrian walkways, autonomous vehicles, and hyperloop systems stacked on top of one another, reducing the need for sprawling road infrastructure. We [NEOM’s planners] envision a city where residents can access all essential amenities within a 5-minute walk, reducing reliance on private cars and enabling a pedestrian-friendly environment.

Aligning with the emphasis evident in the exhibition and The Line’s own documents, the interviewees also highlighted the way that the linear design not only allows for a more harmonious integration with the surrounding natural environment with construction that does not sprawl outward and encroach on fragile ecosystems (Figure 41).

Figure 42

A diagram depicting the linearity design concept of The Line



Source: NEOM.com

NEOM's population density, particularly within The Line, presents a unique case study in urban planning, and the revolutionary nature of this approach to social organisation was another key feature commented upon by interviewees. While precise figures remain subject to the project's ongoing development, current projections offer a glimpse into the unprecedented scale of this urban experiment. As a 170-kilometre-long, 200-metre-wide, and 500-metre-tall city, The Line is designed to accommodate approximately 9 million residents. This translates to an estimated population density of 264,705 people per square kilometre, a figure nearly ten times greater than that of Manhattan, often cited as a benchmark for high-density urban environments (Musset, 2023; Safarik et al., 2018). Interviewee 17 (Group 2) explained what they saw as The Line's potentially radical paradigm:

The Line also generates ... social proximity which is something that we're reinventing altogether. In five minutes, you can reach about 16,000 people in London, in a five-minute radius walking in New York you can reach about 22,000

... [The Line] poses an incremental change [where you reach] 80,000 people within five minutes ... then start layering the city so people ask why 200 meters wide and why 500 meters tall because we layer these pedestrian villages one above the other so you start moving from a 20,000 neighbourhood up again to another 20,000; do it five times or four times you got 80,000 people within five minutes ... [T]hat's what we do for social cohesion ... we can put the world's population on a line that goes around the equator once and then imagine what the planet will be ... with zero carbon emissions and a carbon-free environment ... This is what the line is about; it's not about just building high and building crazy, it's about revolutionising from the ground up.

The feasibility of such extreme density remains a subject of ongoing discussion. While The Line's vertical design aims to mitigate the potential for overcrowding by the vertical stacking of residential, commercial, and public spaces, the long-term social and logistical implications of this concentrated urban form require careful consideration. The integration of green spaces, AI-powered infrastructure, and efficient transit systems will be crucial in ensuring that this high density fosters a functional and liveable environment. As noted by some urban designers involved in the project, The Line will incorporate AI-controlled facades that respond dynamically to environmental conditions and urban activity, further enhancing the city's adaptability and responsiveness (Yusuf & Abdulmohsen, 2023). This integration of technology is central to NEOM's vision of a self-regulating, sustainable urban ecosystem. However, the potential challenges associated with such extensive reliance on AI, including cybersecurity risks and energy consumption, must be addressed to ensure the long-term viability of this model. Further research and analysis are needed to fully understand the complex interplay of density, technology, and sustainability within NEOM's ambitious urban design. In addition, Phase 1 of The Line is designed to set the stage for its ambitious long-term vision, with an initial focus on constructing a 2.4-kilometre section (NEOM, n.d.). This section includes three 800-meter-long modules, each designed by different architectural studios to create a diverse yet cohesive urban environment. Each module will house approximately 80,000 residents and provide spaces for work, education, healthcare, and leisure activities (NEOM, n.d.). The Hidden Marina, set to be completed by 2030, will serve as a key feature of this phase. It will include a 2.2-km-long canal and a sprawling marina designed to accommodate between 600 and 8,000 yachts. The marina is envisioned as a hub for

recreation and tourism, with a sports stadium located over 350 metres above ground level, potentially serving as a venue for the Fédération Internationale de Football Association's World Cup 2034 (Designboom, 2025).

6.2.1.3 Sub-theme 3: Renewable Energy and Zero-Carbon Strategy

NEOM's renewable energy and zero-carbon strategy is not simply a technical ambition but a foundational redefinition of how cities are planned, powered, and positioned in relation to the planet. At the heart of this vision is a commitment to building a city powered entirely by renewable sources, principally solar, wind, and green hydrogen, with the stated goal of achieving net-zero carbon emissions (Algumzi, 2022). According to Interviewee 1 (Group 2), "Our energy supply ultimately is going to be 100% sustainable or from 100% renewables. So that in itself is almost setting a benchmark at very few places." This declaration underscores how NEOM sees itself not just as an infrastructural innovation, but as a benchmark city in the global discourse on sustainability transitions.

Interviewee 8 (Group 2) reinforced this ethos by stating, "Environmentally, our planning is rooted in sustainability, targeting zero waste and zero carbon. All of these layers are interwoven into a holistic planning strategy that is intended to not just make life convenient but meaningful and sustainable." These perspectives reveal that NEOM's zero-carbon agenda is conceived as an integrated system, linking energy infrastructure, urban form, and lifestyle shifts, an approach that echoes the SSC frameworks advocated by Bibri (2021a).

The city's location, offering abundant solar irradiation and steady wind, presents strategic advantages for clean energy deployment (Yusuf & Abdulmohsen, 2023). The intent is not only to leverage these natural assets to develop one of the world's most ambitious renewable portfolios, but NEOM also seeks to move beyond domestic self-sufficiency: its planners envision the city as a future energy exporter, whereby urban infrastructures are deployed to reshape national influence and regional interdependence (Frey et al., 2020).

An aspect of renewable energy that was not specified by the interviewees but is identified in the secondary data as a central pillar of NEOM's strategy is green hydrogen production. The project is spearheaded by the NEOM Green Hydrogen Company (2023), a joint venture between

Air Products, ACWA Power, and NEOM and aims to produce 650 tons of hydrogen daily by 2026. This facility is not just an energy asset; it is a symbolic declaration of NEOM's leadership in post-carbon innovation. It also addresses decarbonisation challenges in hard-to-electrify sectors, such as freight and heavy industry (Kılıkış & Kılıkış, 2018). However, this vision must also contend with the resource-intensity and environmental demands of hydrogen production, particularly regarding water usage, as noted in recent critiques of hydrogen urbanism (Miller et al., 2021).

Spatially, NEOM's energy infrastructure reflects a shift toward what Interviewee 4 (Group 2), described as the breakdown of traditional, centralised energy models. He explained:

[I]n theory, if you think about cities that are now looking at microgrids or off-grid, it's all about breaking down the granularity of supply so that I don't have massive infrastructure projects, power stations too far away from where I need the electricity ... Think about the UK. We have some nuclear power, big power stations. As soon as you commit to a massive power generation scheme, you're committing to transmit that power within a rate. It's not infinite, it can go quite far, but you have transmission losses, for example, so that's not as efficient as it could be ... With The Line, you have this opportunity to [match] the density of demand with the supply. I've got the demand, which is the people, the population, the facilities.

This insight highlights the unique opportunity afforded by NEOM's greenfield status: the ability to design supply and demand as spatially aligned systems. This matches closely with distributed energy²⁰ theories in urban studies in which energy is generated and consumed locally to avoid loss and improve resiliency (Kavin & Jayakumar, 2025).

Interviewee 5 (Group 2) drew attention to gravity-based storage systems as a key part of NEOM's renewable infrastructure, illustrating a key feature of NEOM's cognitive sustainability model: not only producing renewable energy but integrating it into intelligent, real-time systems

²⁰ 'Distributed energy' is an emerging model of energy infrastructure where decentralised, small-scale, locally integrated energy systems (e.g., microgrids, on-site renewables) are embedded into urban design, minimising transmission loss and improving resilience (Kavin & Jayakumar, 2025).

that allow for storage, optimisation, and load balancing (Bibri, 2021b). Interviewee 5 (Group 2) gave the following description:

You have water and then during the day when you have excess energy, you use it to pump water up from the lower reservoir to the upper reservoir... that consumes the energy through the turbines that are required to pump the water to the higher reservoir. At night, when you need it, then you just let gravity do its work and you release water from the upper reservoir. By virtue of physics, it goes down to the lower reservoir, it generates the energy back and then you push it through the system, through the grid. To do that efficiently, you need smart systems to monitor your consumption.

In tandem with energy production, NEOM's urban design focuses on minimising energy consumption. Buildings will incorporate passive cooling, high-performance materials, and architectural strategies to reduce demand. The Line's infrastructure, for instance, is designed to recycle both energy and water internally. Urban mobility is reimagined around electric rail and pedestrianisation, as Interviewee 4 (Group 2) explained:

From the sustainability aspect, it's to greatly improve the connectivity through transport, access to transport ... You remove the highways, the cars, the heat island effect that you get with a lot of downtown cities, you're removing that because it's all-electric or alternative fuel, it's not combustion fuel. [Due to] the connectivity, fewer journeys [are made], and more journeys happen on foot.

These statements suggest that sustainability is being pursued across all dimensions of daily life: infrastructure, mobility, architecture, and behaviour. This aligns with Townsend's (2013) notion of infrastructure as experience, where urban systems are designed not only for utility but to shape ecological awareness, social relations, and lived experience.

Again, while this was not an emphasis in the expert interviews, NEOM's commitment to environmental restoration, including ecosystem rehabilitation and rewilding, needs to be mentioned as demonstrating an understanding of sustainability that extends beyond mitigation

toward regeneration (NEOM, n.d.). These initiatives signal a shift toward planetary urbanism²¹ (Brenner & Schmid, 2015), where the city is not merely a user of ecological capital but an active agent in its reproduction. By integrating AI into circular systems and environmental governance, NEOM also exemplifies anticipatory urbanism,²² in which environmental feedback loops guide resource management and urban adaptation (Sengers et al., 2019; Anderson, 2010; Phelps et al., 2025).

As already intimated from the above discussion, NEOM's renewable energy and zero-carbon strategies can be argued from both the emphases in the expert interviews and the scholarly literature as not only foundational to its own urban vision but also as a potential global reference point for the future of sustainable cities. As one of the world's most ambitious testbeds for green infrastructure and post-carbon urbanism, NEOM exemplifies what scholars term a planetary laboratory²³ (Evans et al., 2016): a space where experimental models are developed with the intention of informing broader regional and international trajectories. In bringing together the main strands of the discussion so far, some of the wider global implications of NEOM's energy model are engaged with to bring the innovative and expansive nature of this smart city dimension into further focus.

By seeking to integrate renewable generation, smart distribution, and clean mobility into one comprehensive urban ecosystem, NEOM aspires to demonstrate the feasibility, scalability, and replicability of a fully decarbonised urban model. As discussed above, this includes pioneering efforts in green hydrogen production, decentralised microgrids, pumped hydro storage, AI-managed energy networks, and circular resource flows, all configured to operate in real time through digital coordination. In doing so, NEOM offers a blueprint for other urbanising regions,

²¹ 'Planetary urbanism' is a concept that situates urbanisation within global ecological, political, and economic systems. Cities like NEOM are viewed as planetary projects with implications for global climate, biodiversity, and carbon governance (Brenner & Schmid, 2015).

²² 'Anticipatory urbanism' involves designing urban systems that proactively respond to real-time environmental and infrastructural feedback. It often relies on sensors, AI, and predictive analytics to support adaptive governance (Sengers et al., 2019; Anderson, 2010; Phelps et al., 2025).

²³ A 'planetary laboratory' refers to urban or regional-scale experimental projects designed not only to test new technologies or policies locally but to produce globally relevant models, lessons, and templates. These spaces are often framed as pioneering 'testbeds' for socio-technical transitions in governance, energy, or urbanism (Evans et al., 2016).

particularly those in the Middle East, that may face similar pressures to decarbonise rapidly while still expanding basic infrastructure.

This vision is not merely local in intent. NEOM's renewable exports and investment in green hydrogen markets position Saudi Arabia, and the gulf more broadly, as an emergent player in global clean energy geopolitics (Müller et al., 2024). Rather than maintaining influence through fossil fuel exports, Saudi Arabia's strategy with NEOM reflects a pivot toward green statecraft;²⁴ leveraging infrastructure-led diplomacy, technology development, and energy partnerships to shape the global decarbonisation agenda. If successful, NEOM could contribute to the global diffusion of hydrogen infrastructure, driving down production costs and creating new trade corridors based on low-carbon fuels.

At the urban scale, NEOM also reflects what Caprotti (2015) describes in his analysis of eco-city initiatives: highly visible, city-scale experiments that aim to model best practice, attract investment, and reinforce national narratives of innovation. In this context, NEOM joins projects like Songdo (South Korea), Masdar City (UAE), and the Sino-Singapore Tianjin Eco-City as part of a growing trend where cities become both testbeds and symbols of national sustainability commitments. Yet unlike many of its predecessors, NEOM's scale, financial backing, and integration of renewables into the foundational urban fabric distinguish it as potentially more impactful, both materially and discursively.

However, NEOM's model is not without contention. Its technological complexity, resource intensity, and top-down governance model raise important questions about transferability and justice. The sheer capital investment required to replicate NEOM's systems makes it less feasible for less wealthy nations, while its greenfield context avoids many of the infrastructural, political, and spatial constraints that characterise retrofitting efforts in older cities. In this sense, NEOM may function more as an inspiration for long-term greenfield planning rather than an immediately applicable template for global urban sustainability transitions (Acuto, 2020). Moreover, critics argue that showcase projects like NEOM risk fostering smart elitism (Mumtaz & Happonen, 2023),

²⁴ 'Green statecraft' refers to the strategic use of environmental policies, technologies, and infrastructures by states to exert international influence, foster global partnerships, and reposition themselves in emerging post-carbon political economies. It is a form of energy diplomacy embedded in climate action (Burke et al., 2016).

reinforcing techno-utopian narratives that obscure deeper social and environmental contradictions embedded in the global urban system.

Nevertheless, the wider implications of NEOM's approach are considerable. If it succeeds in aligning clean energy generation with urban design and social well-being on a large scale, it could alter the standard expectations for what future cities should strive for. This might speed up the global adoption of net-zero urbanism and redefine sustainability as an overarching urban condition rather than a separate policy goal. Particularly, NEOM's utilisation of AI, cognitive grids, and predictive analytics to manage systems like energy, water, waste, and transport could expand the horizons of what is possible within integrated urban metabolism (Kennedy et al., 2007).

In this regard, NEOM's energy model is not just about powering a city; it is about reimagining the foundational structure of urban life in an age of planetary crisis. The integration of environmental ethics with infrastructural systems represents a paradigmatic shift from cities as engines of carbon and consumption to cities as stewards of planetary limits. Whether NEOM succeeds or falters, it will contribute valuable lessons to the evolving relationship between cities, climate systems, and technological innovation and offer a major reference point for mid-21st-century sustainability transitions.

6.2.2. Key Theme 3 Discussion

This key theme examines NEOM's interdependent planning logic across three core sub-themes: Cognitive City and AI Urbanism, Zero Gravity Urbanism, and Renewable Energy and Zero Carbon Strategy. These elements constitute the backbone of NEOM's radically experimental urban framework. Drawing on expert interviews and scholarly literature, this synthesis explores how AI, vertical urban morphology, and a fully renewable energy system are integrated into NEOM's vision. This section not only unpacks the innovative claims that underlie NEOM's development, but also interrogates the operational contradictions, social implications, and geopolitical dimensions that accompany its realisation.

At the heart of NEOM lies its model of cognitive urbanism, which imagines the city as a continuously learning and adaptive system. Drawing on earlier conceptualisations of the smart or

sentient city (Kominos, 2006; Townsend, 2013), NEOM embeds AI throughout its planning and operational frameworks. Interviewee 17 (Group 2) explained how digital twin technologies are used to eliminate the need for retrofitting, while Interviewee 3 (Group 2) described them as tools to anticipate challenges before they arise. This form of predictive urban governance reflects ideas from recent literature on anticipatory systems (Bibri, 2021a), where AI is not only used for optimisation, but also for forward-planning across infrastructure and services.

However, this technological approach is only effective when paired with NEOM's vertical and compact spatial structure. Zero Gravity Urbanism is more than a novel architectural idea; it is a planning logic that redefines proximity, density, and movement. In The Line, NEOM's flagship development, this verticality is used to layer pedestrian zones, mobility networks, and energy systems. Interviewee 17 (Group 2) noted that these stacked villages are designed to place 80,000 people within a five-minute walking distance of essential services. The goal is to reduce travel, emissions, and land use. But such dense spatial configurations demand highly coordinated systems, managed by AI, to ensure seamless flow and connectivity.

The Line's radical morphology warrants closer analysis. It represents an unprecedented urban form: a 170-kilometre linear city constrained to a 200-metre width and rising 500 metres in height. This urban typology radically departs from concentric or sprawled city models. It aims to compress spatial functions while maximising ecological preservation by concentrating development in a narrow vertical corridor. Interviewee 17 (Group 2) praised The Line's ability to eliminate car dependency entirely and support efficient end-to-end mobility in 20 minutes. However, Interviewee 18 (Group 2) cautioned that "over-reliance on automated systems could reduce human interactions," reflecting concerns echoed by Sennett (2012) and Gifford (2007) that excessive spatial rationalisation may compromise civic life and wellbeing. The integration of stacked neighbourhoods challenges existing understandings of scale and public realm design, demanding careful reconsideration of how vertical space affects community formation and social cohesion.

NEOM's renewable energy systems further extend this idea of integration. Interviewee 1 (Group 2) affirmed that the city will be powered entirely by solar, wind, and green hydrogen. Interviewee 5 (Group 2) described a pumped hydro system that stores energy during the day and

releases it at night. AI will manage these flows to balance energy production and consumption in real-time. This aligns with the concept of urban metabolism (Kennedy et al., 2007), where cities function as systems of circulating energy, water, and materials. However, the energy required to run NEOM's AI systems also raises environmental concerns. Interviewee 2 (Group 2) flagged the risks of cybersecurity and the energy intensity of digital infrastructure; issues raised by O'Dwyer et al. (2019) and Kitchin (2016) in broader critiques of smart cities.

NEOM's designers claim their model promotes social wellbeing alongside sustainability. Interviewee 19 (Group 2) described the planning as "people-centric," with design choices intended to support community interaction. The compactness of The Line, combined with high-frequency transport and biophilic design, seems to echo the logic of the 15-minute city (Moreno et al., 2021). However, translating these ideals into vertical, high-density environments is untested at this scale. Research by Gifford (2007) and Yuen et al. (2011) shows that tall buildings can reduce social interaction and psychological wellbeing unless carefully mitigated through public space design.

NEOM is also positioned as a prototype for future city-making. Yet, its replicability is limited. The city benefits from vast financial resources, a greenfield site, and a centralised governance structure; conditions that are not easily reproduced elsewhere. Scholars such as Caprotti (2015) and Acuto (2020) caution against assuming that showcase cities like NEOM can act as universal models. Despite this, while NEOM is often presented as a prototype for future cities, its planners do not claim to offer a definitive or universally transferable blueprint. Instead, Tarek Qaddumi, Executive Director of Urban Planning at NEOM, described the project during a media briefing in Hong Kong as a 'living laboratory', a place where entrepreneurship, imagination, and technological innovation will guide the development of new urban paradigms (China Daily, 2024). This resonates with the concept of the planetary laboratory (Evans et al., 2016), where cities serve as spaces of experimentation and learning.

In conclusion, NEOM represents a significant step in reimagining urban futures. Its combination of AI-led governance, vertical urbanism, and renewable energy presents a new kind of city; one shaped by integration, prediction, and adaptation. However, the challenges it faces are substantial. Balancing automation with human interaction, ecological ambitions with digital energy costs, and visionary design with everyday urban experience will require careful navigation.

Whether NEOM succeeds or not, its development offers critical insights for planners, urban geographers, and policymakers. It demonstrates the possibilities and pitfalls of attempting to build a sustainable, intelligent city from the ground up and highlights the need for cities to remain flexible, inclusive, and responsive in the face of technological change.

6.2.3. Key Theme 4: NEOM's Planning Between Utopia and Reality: Lessons and Challenges of Future Urbanism

As NEOM aims to redefine urban living by integrating sustainability, technological innovation, and visionary planning, the smart city's development has been met with a myriad of challenges that have captured the attention of experts, the media, and critics alike (e.g., Boretti, 2022; *The Guardian*, 2024; *The Wall Street Journal*, 2024; Fast Company, 2024). Positioned as a city of the future, NEOM aspires to address the pressing challenges of urbanisation while setting a benchmark for global urban development (Fadel & Bhaa, 2024). However, the ambitious scope of the project highlights the tension between its utopian aspirations and practical realities. As Lorinc (2022) argues, many smart city visions function more as “dream states”, technologically driven constructs that reflect elite imaginaries of control, efficiency, and spectacle rather than grounded responses to complex urban realities. As the Kingdom seeks to rebrand its image and establish a testing ground for sustainable planned cities, it must grapple with a range of economic, social, and environmental hurdles. Similarly, the extensive research and development taking place has led to critical insights and lessons that may inform the future of urban planning.

Drawing on insights from primary interviews with urban planners and policymakers, as well as secondary data from academic reports and media coverage, this analysis specifically seeks to understand Research Aim 7 (see Figure 24), examining both the lessons and challenges inherent in the NEOM project thus far to derive actionable recommendations and best practices for future sustainable smart city developments. The exploration is divided into three key sub-themes: recent observations of NEOM's construction progress, lessons from NEOM's planning, and challenges associated with achieving its ambitious goals.

6.2.3.1 Recent Observations of NEOM's Construction Progress

To empirically ground the analysis of NEOM's urban vision and bridge the gap between media narratives and on-ground reality, this section critically examines recent satellite and aerial imagery

documenting construction progress across The Line, Trojena, and Oxagon. Drawing on visual evidence published by *The New Arab Staff* (2025), *Newsweek* (2025a, 2025b), *Bandara* (2025), *Tolentino* (2025) and *Business Insider* (2025a), as well as official imagery shared by project executives (Pendleton, 2025), this analysis offers updated insight into the physical initiation of NEOM's strategic zones. These observations provide some evidence to NEOM's ambitious claims, reinforcing the broader thematic discussion surrounding its planning, execution, and feasibility.

The success of The Line's ambitious vision is supported by world-class firms with distinct roles in its design and planning. The initial concept design of The Line was developed by Morphosis, a US-based architecture studio renowned for its cutting-edge, innovative designs. Morphosis envisioned the 170-kilometre-long megastructure as two parallel skyscrapers, each 500 meters tall and 200 meters wide, with mirrored façades. This iconic design integrates sustainability with high-density urban living, incorporating features such as microclimates, green spaces, and an emphasis on environmental harmony. Morphosis's foundational work set the stage for the subsequent detailed planning and designs undertaken by DMAA, Gensler, and Mott MacDonald. At present, there is limited publicly available information regarding the involvement of additional firms in the project's next phases.

DMAA leads the conceptual and detailed urban master planning for Phase 1. DMAA emphasises sustainability, parametric adaptability, and ecological harmony, focusing on creating dynamic public spaces, vertical parks, and highly connected neighbourhoods. Their vision ensures that the project integrates nature into the urban fabric while fostering a community-oriented environment. Gensler, serving as the city planning consultant, plays a critical role in coordinating city-wide design efforts and establishing governance frameworks. Their work encompasses land-use policies, design compliance, and the integration of mobility and infrastructure systems. Additionally, Gensler is responsible for designing critical city infrastructure, including transport hubs and public spaces, ensuring seamless connectivity and functionality. Mott MacDonald oversees the engineering and management of horizontal and vertical infrastructure systems, focusing on constructability, operability, and sustainability. Their expertise ensures that the utilities, mobility corridors, and public amenities align with NEOM's vision of efficiency and environmental responsibility.

In line with the initial design proposals and concepts, the first phase of The Line exemplifies the principles of vertical urbanism, integrating housing, schools, and hospitals into a compact, walkable environment. By eliminating roads and cars, the city prioritises pedestrian accessibility and reduces its ecological footprint. High-speed transit systems will enable seamless connectivity along the megastructure, enhancing mobility while supporting the city's sustainability goals. Sustainability is further emphasised through advanced energy-efficient systems and minimal environmental impact strategies, ensuring that the city sets new benchmarks for ecological design.

As of November 11, 2024, according to NEOM, Significant progress has been made in laying the foundations for The Line, with over 120 foundation piles being cast weekly. This massive operation, representing one of the largest piling efforts ever undertaken, underscores the scale and complexity of the project. These foundations will support The Line's innovative vertical structure, redefining urban planning by creating a multi-layered system for living, transportation, and logistics.

Phase 1 lays the foundation for The Line's gradual expansion and ultimate completion. Subsequent phases will build upon this groundwork, extending the city's length and capacity while incorporating advanced technologies such as AI-driven city management and autonomous transportation. This is seen as a strategic and promising move, especially in light of the criticism the project faced such as it being referenced as too futuristic and vague (Ravenscroft, 2024). Vertical farming systems and renewable energy infrastructure will further enhance sustainability. Cultural and recreational developments, including tourism hubs, will transform The Line into a global centre for innovation and sustainable urban living.

By May 2025, as reported by the *New Arab Staff*, The Line has indeed demonstrated a discernible shift from speculative visualisations to visible, though localised, construction activity. Notably, satellite images reveal extensive excavation and groundwork near the Hidden Marina zone, a 1.5-mile segment of the linear city expected to accommodate approximately 200,000 residents (*The New Arab Staff*, 2025). Even though progress remains confined to a relatively narrow corridor compared to the original 170-kilometre ambition, the scale of work, however, does seem to confirm a serious commitment to materialising NEOM's Zero Gravity Urbanism. Figures

42–44 from *The New Arab Staff* (2025), Pendleton (2025), and *Tolentino* (2025) depict moderate construction progress in the Tabuk desert, reinforcing that while serious development is ongoing, it remains far from the magnitude and density promised in early marketing.

Figure 43

Satellite image of The Hidden Marina of The Line



Source: The New Arab Staff (2025).

Figure 44

Recent Images (April 2025) of Oxagon and The Line Infrastructure works



Source: Giles Pendleton's (Chief Operating Officer, The Line at NEOM) public LinkedIn Profile, 2025.

Figure 45

Image Showing Early Stages of the Construction of The Line



Source: Tolentino (2025).

Yet, despite these milestones, the slow pace and spatial limitation of visible construction expose the tension between NEOM's transformative rhetoric and its delivery timelines. In its early vision, the linear megastructure was projected to house nine million people by 2030 (NEOM, 2024a). However, as the project has progressed, both the timeline and implementation strategy appear to have been recalibrated in recognition of the significant engineering, environmental, and logistical complexities associated with constructing such an unprecedented urban form in an arid, remote context. As Tolentino (2025) notes, even foundational logistics present unprecedented engineering challenges. Moreover, the planned reliance on new and untested technologies adds further uncertainty to implementation.

In parallel, progress in Trojena and Oxagon reveals a similarly cautious but incremental development trajectory. Trojena, NEOM's mountain resort and future host of the 2029 Asian Winter Games, has seen preliminary work commence, including road construction and land clearing (Newsweek, 2025b). Given its rugged topography, the site presents substantial engineering and ecological challenges. The transformation of high-altitude terrain for large-scale tourism infrastructure introduces risks of habitat fragmentation and biodiversity loss, raising ethical questions about the compatibility of mega-resort development with environmental

sustainability principles. This tension reflects broader academic concerns that rapid urbanisation, even when cloaked in green rhetoric, can result in significant ecological disturbances if not coupled with rigorous environmental assessments (Beatley, 2020; Otto, 2024).

Oxagon, meanwhile, has begun to manifest its industrial identity through the construction of port infrastructure and manufacturing zones along the Red Sea coast (Figure 45) (Pendleton, 2025; Bandara, 2025). Positioned as NEOM's economic and logistical nucleus, Oxagon is intended to operate as a floating city that exemplifies circular economy principles. Satellite imagery confirms the early establishment of coastal platforms, suggesting some momentum in foundational development. Nevertheless, the scale of current activity remains modest, especially when evaluated against NEOM's sweeping economic targets. As observed in comparable projects such as KAEC, the danger of underutilised infrastructure and investor fatigue looms if development outpaces market demand or is undermined by regional geopolitical uncertainties (Yusuf & Abdulmohsen, 2023). Moreover, building a major industrial hub in an ecologically sensitive coastal region necessitates careful regulation to avoid marine degradation, particularly given the Red Sea's importance as a biodiversity hotspot (Michelson, 2024).

Figure 46

Aerial image of infrastructural progress of Oxagon port along the Red Sea



Source: Pendleton (2025); Bandara (2025).

Alongside physical development, NEOM has advanced preliminary stages of its renewable energy infrastructure. Figure 46 confirms the installation of over 60 wind turbines and the early implementation of large-scale water pipeline systems to service its sustainability goals (Bandara, 2025; Pendleton, 2025). These developments reflect NEOM's declared ambition to operate entirely on renewable energy and to serve as a model of carbon neutrality. However, critics have pointed out that the energy and resource intensity of desalination, steel-reinforced concrete, and hydrogen production infrastructure could offset short-term sustainability gains (Gielen et al., 2019; Sovacool et al., 2021). The visual spectacle of The Line's mirrored façade and vertical compactness, while architecturally striking, has also triggered conservationist concerns regarding migratory bird disruptions along the Red Sea flyway, generally deemed the second most important flyway for migratory birds globally (Michelson, 2024). This underscores the contradiction between NEOM's environmental branding and the material footprint of its construction practices.

Figure 47

Image Showing the Installation of Wind Turbines in Designated Areas for the Project



Source: Pendleton (2025).

Additionally, recent developments at Sindalah Island offer a noteworthy example of NEOM's staggered implementation strategy. As of early 2025, construction progress on Sindalah appears to be more advanced than in other regions of NEOM, with satellite imagery and promotional material showing the near completion of key marine infrastructure, including its 86-berth marina, helipads, and beachfront villas (Figure 47) (Arab News, 2024; NEOM, 2024b). Unlike The Line or Oxagon, Sindalah operates within a more conventional tourism model, relying on established luxury branding rather than untested urban prototypes. Its accelerated progress suggests that NEOM's phased rollout prioritises commercially viable, short-to-medium term projects to build credibility and revenue streams ahead of more experimental endeavours. However, the focus on ultra-luxury tourism raises questions about inclusivity and social value, echoing wider critiques of megaprojects that privilege elite consumption while sidelining local socioeconomic development (Caprotti, 2014). While Sindalah may function as a symbolic gateway

into NEOM, its long-term significance will depend on whether it integrates meaningfully into the broader ecosystem of the project or remains an isolated enclave of spectacle and exclusivity.

Figure 48

Aerial Image Showing Construction and Development Progress of Sindalah and Its Different Facilities



Source: NEOM (2024c).

In conclusion, the satellite and photographic evidence gathered reveals that while NEOM has begun implementing select components of its vision, the uneven pace and geographically localised nature of this development highlight a widening gap between conceptual ambition and material delivery. The emergence of foundational elements such as the Hidden Marina, friction pile works, and early utility systems provides a visual anchor for NEOM's future trajectory, yet also underscores the formidable logistical, environmental, and temporal constraints associated with building a hyper-modern city from scratch. Notably, Sindalah Island stands out as the most

advanced of NEOM's regional components, with its luxury marina and hospitality infrastructure completed or nearing completion. This suggests a tactical phasing strategy that privileges commercially viable, short-term successes while flagship components such as The Line and Oxagon remain at earlier stages. From a critical urban geography perspective, NEOM offers an instructive example of the limits of large-scale urban imaginaries which risk becoming detached from spatial justice, ecological stewardship, and delivery feasibility. As this empirical analysis demonstrates, while NEOM continues to operate as a powerful symbolic project of national reinvention, its long-term credibility will depend on whether it can meaningfully reconcile visionary urbanism with inclusive governance, pragmatic planning, and the lived realities of its terrain. These emerging tensions between visionary ambition, ecological impact, and technological feasibility form the basis of the subsequent section. The following thematic discussion critically unpacks key lessons and challenges arising from NEOM's early-phase implementation, highlighting broader implications for future SSC initiatives.

6.2.3.2 Sub-theme 1: Lessons from NEOM's Planning

Returning to the analysis of the primary data derived from the expert interviews, the current sub-theme explores the principal lessons that have emerged from NEOM's urban planning and development trajectory in engagement with the relevant literature. Figure 48 synthesises six key dimensions that collectively capture NEOM's distinct planning logic and strategic orientation: namely, Starting from Scratch, Sustainability and Eco-Innovation, Community-Centric Urbanism, Global Collaboration, Strategic Branding, and Resilience and Adaptation. Together, these elements summarise how NEOM's urban model attempts to move beyond conventional planning constraints by leveraging a semi-blank-slate approach, integrating cutting-edge technologies, and aligning itself with global urban development discourses. Each component of the diagram represents an interconnected theme that not only guides NEOM's physical and infrastructural layout but also informs its narrative positioning, environmental aspirations, and institutional partnerships.

Figure 49

Diagram Presenting Key Lessons Learnt from NEOM's Research and Development Phases



Source: Adapted by the author based on expert interviews and secondary data.

The first lesson highlighted is the advantage of starting from scratch. NEOM's planners often refer to the project's location in northwest Saudi Arabia (Tabuk Province) as a *tabula rasa*, a vast 26,500 km² expanse of largely undeveloped desert and coastline (Human Rights Watch, 2024; Yusuf & Abdulmohsen, 2023). Promotional materials have described it as "virgin land,"²⁵ suggesting an untouched canvas for futuristic urban development (Human Rights Watch, 2024). Though not entirely uninhabited, the scale and density of human presence were minimal relative to the site's massive footprint, and no substantial urban centres or complex infrastructure predated NEOM. This situates NEOM's location as a unique case of near-greenfield development, offering

²⁵ While this portrayal simplifies the region's demographic reality, it holds partial accuracy. Historically, the land has been sparsely inhabited, primarily by nomadic tribes whose estimated population of around 20,000 maintained a pastoralist presence through scattered settlements and seasonal movement across the area (Human Rights Watch, 2024).

a practical blank slate for planners while diplomatically acknowledging the need for careful engagement with the region's historical inhabitants.

From an urban planning perspective, one of NEOM's most strategic advantages lies in its freedom from the legacy infrastructure that often impedes innovation in established cities. Urban theorists frequently highlight the concept of path dependency, wherein prior infrastructural and spatial arrangements constrain future developments (Kitchin, 2016). In NEOM's case, the absence of any aged roads, outdated utilities, or fragmented zoning systems allows for a holistic design approach. As Frost & Sullivan (2024) emphasise, cities burdened with historical infrastructure face challenges in adopting smart technologies, whereas greenfield projects like NEOM can integrate advanced systems such as autonomous mobility, fibre optic networks, and renewable energy grids from the outset.

This 'starting from scratch' approach, praised by NEOM's Development Lead (Interviewee 8, Group 2), "enables a fully integrated urban form, free from the inefficiencies and retrofitting costs common in legacy cities". Indeed, planned cities in the Global South, such as Abuja or Brasília, were similarly constructed with a view to bypassing infrastructural bottlenecks, though their outcomes were mixed, as noted by Prieto-Curiel and Kondor (2023). NEOM's master plan attempts to learn from these precedents by embedding flexibility and sustainability from inception. The project's flagship initiative, The Line, exemplifies this ambition, where its 170 km city structure will have no roads or cars, and where high-speed transit and AI-managed services promise a zero-carbon, highly accessible lifestyle (Prieto-Curiel & Kondor, 2023; Yusuf & Abdulmohsen, 2023).

Moreover, NEOM's infrastructure is designed to operate entirely on renewable energy, incorporating green hydrogen production, smart water desalination, and digital systems for service optimisation (Yusuf & Abdulmohsen, 2023). The city's spatial density and minimal land take are also intended to conserve surrounding ecosystems, aligning with broader sustainability goals. Urban geographers often stress that retrofitting sustainability into existing cities is costly and politically fraught; NEOM circumvents this by integrating environmental performance indicators into the initial blueprint (RBC Wealth Management, n.d.). While criticisms of techno-utopianism and community relocation remain relevant (Human Rights Watch, 2024), NEOM offers a unique

planning case: a megaproject that leverages its near-blank terrain to push the boundaries of urban design. If its ambitious goals are realised, NEOM may serve as a high-profile experiment in whether building a sustainable, technologically integrated city from the ground up can offer a viable model for future urbanism.

The second key lesson concerns what might be described as ‘branding’ that acts as a strategic tool. NEOM’s branding plays a pivotal role in positioning the project as a beacon of future-oriented urbanism, sustainability, and technological leadership. The strategic articulation of NEOM’s identity is not merely promotional but forms a critical mechanism for attracting foreign investment, skilled labour, and global political interest. As Interviewee 10 (Group 2) explained, NEOM’s vision is framed as “an accelerator of human progress,” a phrase that encapsulates both its technological ambitions and its alignment with global development narratives. This deliberate positioning situates NEOM as not just a smart city, but a transformative urban model aimed at redefining what cities can achieve in the 21st century.

Branding in this context serves both symbolic and material functions. It constructs NEOM as a global hub of innovation and economic dynamism, while also performing as a policy instrument to galvanise international support. The Environment Compliance Management Manager (Interviewee 3, Group 2) emphasised that “NEOM’s branding has been very effective in showcasing its ambitious vision and capabilities,” underscoring the role of image-building in advancing its urban and geopolitical agenda. This is in line with Harvey’s (1989) theorisation of urban entrepreneurialism, whereby cities actively rebrand and market themselves to secure investment and position themselves within the competitive global urban hierarchy.

This strategy echoes the theoretical framing provided by Kavaratzis (2004), who contends that city branding is not just about visual identity, but the communication of a city’s purpose, values, and aspirations to a global audience. NEOM’s brand articulates a compelling narrative of a post-carbon, AI-integrated, human-centric metropolis; a narrative that resonates with current discourses in urban sustainability and innovation. Abdelhady (2024) argues that NEOM’s branding deliberately fuses futurism with national ambition, creating a hybrid image that is at once utopian and strategically pragmatic. Similarly, Aly (2019) situates NEOM within a lineage of gulf urban

branding exemplified by Dubai, where image construction operates in tandem with infrastructural and economic development to manifest state-led visions of modernity.

From the perspective of NEOM's leadership, branding is not ancillary but foundational to the project's advancement. As Interviewee 10 (Group 2) reiterated, the project's identity as an "accelerator of human progress" inspires global audiences and provides a unifying ethos across sectors and stakeholders. This performative aspect of branding functions as what Peck and Theodore (2015) describe as policy boosterism: a way of using symbolic capital to project credibility, legitimacy, and desirability. Interviewee insights further suggest that branding plays a crucial role in internal alignment as well. Interviewee 6 (Group 2), for example, commented that "the branding creates a sense of shared purpose, especially when dealing with international consultants and partners."

The effectiveness of this branding strategy is evident in public opinion metrics. According to the Ipsos Public Perception Report on NEOM (2019), 90% of Saudis believe that NEOM will improve the country's global standing, while 60% expect it to outperform Dubai in sectors like business, tourism, and technology. However, the same report highlights a measure of scepticism, with 18% of respondents concerned about the project's economic feasibility. This ambivalence reflects a broader pattern in ambitious urban projects, where visionary branding must continually negotiate between aspiration and deliverability.

In summary, NEOM's branding exemplifies the evolving role of strategic communication in 21st-century urbanism. More than a superficial label, it constitutes a core mechanism of governance and development, shaping perceptions, aligning stakeholders, and mobilising resources. As the empirical data suggests, branding in NEOM is embedded within a complex interplay of national ambition, global competition, and urban theory. By marrying futuristic aesthetics with substantive policy narratives, NEOM's brand aspires not just to attract investment but to redefine the global discourse on what a future city can be.

Thirdly, NEOM's development strategy is characterised by a profound commitment to visionary thinking and transnational collaboration. As Interviewee 6 (Group 2) observed, "NEOM is trying new things on a scale that's probably never been seen before," highlighting not only the

project's scale but its role as a testing ground for globally unprecedented urban ideas. This approach aligns with contemporary urban governance models that prioritise experimentalism, international expertise, and knowledge transfers as pathways to competitive advantage in the global urban hierarchy (Peck & Theodore, 2015).

NEOM's model of global collaboration is exemplified through its strategic partnerships with leading architects, engineering firms, technology developers, and research institutions. These alliances are not merely contractual but co-productive, enabling NEOM to shape its urban form in dialogue with the world's foremost experts. This reflects what Sassen (2018) terms the global circuits of expertise that increasingly define elite urban developments, whereby urban innovation is cultivated not solely through local capacity but through access to international networks of knowledge and capital.

From the standpoint of NEOM's internal leadership, this global collaborative ethos is viewed as integral to achieving the project's ambitious goals. As Interviewee 3 (Group 2) explained, "NEOM is bringing together the best minds and technologies from around the world to create a truly innovative city." This strategy reinforces the notion that the challenges of sustainable urbanisation, climate resilience, resource efficiency, and technological integration are best addressed through cosmopolitan coalitions that pool diverse capabilities and perspectives (Acuto, 2020; Hodson & Marvin, 2009).

Crucially, NEOM's collaborative model is underpinned by a particular mode of visionary leadership. This vision is not limited to technical solutions or master plans but extends to the imaginative redefinition of what urban life can be. The project seeks to operate at the intersection of speculative urbanism and actionable planning, embodying what Su (2023) refers to as aspirational urbanism, a mode of city-building that attempts to leapfrog current limitations by drawing on symbolic futures and global imaginaries. Such a stance allows NEOM to simultaneously act as a locus of innovation and a platform for soft power, positioning Saudi Arabia as a key actor in the discourse of future cities.

Yet this visionary approach is not without precedent. It mirrors the strategies adopted in urban megaprojects such as Songdo in South Korea or Masdar City in the UAE, which similarly

mobilised global expertise to materialise new paradigms of urban development. However, NEOM's distinguishing factor lies in its integration of global collaboration into the very architecture of its governance and delivery model. Rather than outsourcing innovation, NEOM curates and embeds it through sustained partnerships, effectively creating a 'living lab' for urban experimentation at scale.

From an urban geography perspective, NEOM illustrates a synthesis of global urban policy mobility and place-specific aspiration. It is both shaped by and is shaping the international knowledge economy of city-making. This reflexive interplay between local ambition and global collaboration suggests a novel form of urban agency, one that transcends traditional North–South binaries and offers a decentralised model of innovation leadership. As the empirical data suggests, NEOM's success is not solely the product of funding or national willpower but of its ability to convene and coordinate a constellation of visionary thinkers, practitioners, and institutions toward a shared future-oriented agenda.

The fourth area to emerge as a key lesson is the intentionality to make sustainability and eco-innovation foundational and integral. Sustainability is a core tenet of NEOM's planning, with a strong emphasis on renewable energy, eco-friendly infrastructure, and green urban design. The project aims to showcase the feasibility of planned cities that are economically, socially, and environmentally sustainable. Interviews with urban planners and policy experts indicate that NEOM has been designed with a strong commitment to sustainability, with the goal of becoming a global leader in this domain. As Interviewee 5 (Group 2) notes, "NEOM begins with sustainability as a foundational pillar, which sets it apart from many other cities that are retrofitting sustainable solutions." The nature of NEOM's development allows for the seamless integration of sustainability principles. For instance, given that urban areas account for over 70% of global CO₂ emissions (Intergovernmental Panel on Climate Change, 2023), designing a city with net-zero ambitions from the beginning is a significant advantage. NEOM's commitment to 100% renewable energy, smart urban mobility, and a circular economy model aligns with global sustainability goals, such as those outlined in the UN's SDGs (United Nations, 2015b).

NEOM's vision for sustainability includes achieving 100% renewable energy and a zero-carbon footprint, providing insights for sustainable city planning. Interviewee 4 (Group 2)

highlights that “future smart cities should prioritise renewable energy sources, energy efficiency, and low-carbon technologies to reduce environmental impact.” Furthermore, NEOM’s commitment to integrating green hydrogen technologies illustrates its effort to align energy innovation with ecological goals (Wouters, 2024). To leverage solar, wind, and green hydrogen to establish a net-zero energy system, the NEOM Grid of the Future report highlights the integration of advanced High-Voltage Direct Current transmission and AI-driven energy management systems, ensuring efficient, decentralised energy distribution (ENOWA Water, 2023). By 2030, all of NEOM’s operations will be powered exclusively by renewable sources, setting a new benchmark for carbon-neutral urban development.

In alignment with NEOM's sustainability goals, Oxagon’s development will take a phased approach, with phase one, backed by an initial investment of 5 billion USD, expected to be operational by 2028 (NEOM, 2025a). The planned 1.5-gigawatt facility will integrate a wide range of computing densities and energy-efficient architectures to mitigate the growing energy demands of AI-driven data centres (Business Insider, 2025b). According to the International Energy Agency (2023), data centres currently consume between 1% to 1.3% of global electricity demand, and with the rise of generative AI, power consumption is expected to increase exponentially. Given the energy-intensive nature of these infrastructures, the transition to clean and sustainable energy solutions is imperative. Oxagon’s design reflects NEOM’s proactive approach to addressing these global sustainability challenges through innovative, energy-efficient industrial ecosystems (NEOM, 2025b).

Additionally, NEOM is investing in the world’s largest green hydrogen facility, designed to produce 600 tonnes of zero-emission hydrogen fuel per day. This initiative underscores NEOM’s ambition to become a global leader in green energy production, contributing to a future where cities operate without reliance on fossil fuels (NEOM, 2024d). In academic discourse, hydrogen is increasingly seen as a keystone in decarbonisation strategies for energy-intensive sectors (Ameli et al., 2024). However, some scholars urge caution, citing the high costs and infrastructural demands associated with scaling green hydrogen (Boretti, 2022; Sovacool et al., 2021). NEOM’s initiative thus places it at the frontier of this debate, simultaneously showcasing ambition and exposing itself to the technological and economic uncertainties of emergent energy systems.

NEOM's water sustainability strategy embodies circular economy principles, ensuring zero waste, full resource recovery, and water recycling. ENOWA Water, the city's water utility, has implemented zero-liquid discharge desalination, ensuring that no brine waste is discharged into the Red Sea (ENOWA Water, 2023). The Water Sustainability Implementation Plan incorporates smart water grids, AI-based monitoring systems, and aquifer recharge initiatives to minimise water wastage and enhance long-term sustainability (ENOWA Water, 2023). These innovations align NEOM with UN Sustainable Development Goal 6 (Clean Water and Sanitation) while ensuring resilience against climate change. Within urban sustainability scholarship, such an integrated approach to water management is increasingly cited as essential, particularly in arid regions where water scarcity intersects with urban growth (Bakker, 2012).

The integration of cutting-edge technologies, such as autonomous mobility, AI and the IoT, further enhances NEOM's sustainability credentials and serves as a blueprint for future urban development. The Line's design challenges traditional urban paradigms by proposing a linear, hyper-dense urban framework while maintaining accessibility to surrounding natural landscapes. This hybrid approach aligns with sustainable urban planning principles that emphasise high-density living with integrated green spaces (Dempsey et al., 2011; Register, 2006). Notably, however, there is academic debate over whether such "compact utopias" can achieve liveability alongside environmental performance. Critics of hyper-density argue that urban quality of life may be compromised if social and spatial diversity is not carefully planned (Williams et al., 2010).

Several lessons can be drawn from NEOM's sustainability-focused approach, including the importance of establishing clear sustainability targets and incorporating multiple innovative sustainability technologies simultaneously to maximise impact and results. This also sheds light on the advantages and potential of setting integrated and comprehensive sustainability standards at the outset of urban planning, rather than retrofitting solutions. This pre-emptive integration, often referred to in planning literature as design-led resilience²⁶ (Davoudi et al., 2012), enables a

²⁶ Design-led resilience describes a forward-looking planning strategy where resilience to environmental and socio-economic shocks is embedded through anticipatory design choices. Unlike reactive or engineering-based resilience models, this approach focuses on systemic integration, considering spatial form, infrastructure, governance, and community dynamics from the outset. It is particularly influential in discussions of climate-adaptive cities, where multifunctional and flexible urban systems are required to deal with complex and uncertain futures (Davoudi et al., 2012; Meerow et al., 2016).

system-wide coherence between energy, water, mobility, and spatial design. NEOM serves as a rare empirical case where regenerative design, circular economy principles, and zero-carbon aspirations are not merely performative but structurally embedded into the city's governance and physical fabric. This contrasts sharply with the incremental retrofitting efforts seen in many legacy cities, which are often constrained by political, spatial, and infrastructural path dependencies (Frantzeskaki et al., 2017). As such, NEOM could inform a new paradigm for large-scale urban sustainability that moves beyond “low-hanging fruit” interventions toward whole-system reconfiguration. Such radical transformation is described by Hodson and Marvin (2009) as climate urbanism, where cities become experimental platforms for sustainability transitions. However, the project must also be evaluated in terms of social and ecological equity. As scholars such as Anguelovski et al. (2016) warn, sustainability interventions in planned cities can sometimes lead to exclusion or the relocation of existing communities if not accompanied by inclusive governance mechanisms.

At the same time, NEOM's approach reveals tensions between technological determinism and holistic urbanism. While its emphasis on AI, automation, and green infrastructure signals progressiveness, it raises important questions about socio-spatial equity, ecological limits, and the political economy of sustainability transitions. Scholars caution that a sustainability agenda driven predominantly by elite technological solutions may reproduce existing inequalities or overlook lived urban experiences (Sharma et al., 2023). NEOM's ambition to model a zero-carbon urban future must therefore be accompanied by adaptive governance structures capable of addressing evolving environmental, economic, and social dynamics. Future cities drawing lessons from NEOM must ask not only how to embed sustainability, but also for whom these sustainable futures are being designed, and who is empowered to shape them. These questions remain essential as the discourse on post-carbon urbanism moves from vision to implementation.

In sum, I would argue that NEOM's sustainability agenda represents a significant and ambitious attempt to embed eco-innovation within every layer of urban life. While it aligns with best practices in energy, water, and spatial planning, it also invites scrutiny regarding its feasibility, adaptability, and inclusivity. The project thus provides a powerful case study in both the promise and complexity of sustainability-led urban transformation in the 21st century.

The fifth lesson identified from NEOM's planning relates to community-centric and walkable urbanism. NEOM introduces the concept of 5-minute urbanism within The Line, aiming to promote walkability, accessibility, and reduced environmental impact. Interviewee 3 (Group 2) explains that "The Line ensures everything residents need is within a five-minute walk, promoting walkability and reducing carbon emissions." This principle places NEOM within a broader global discourse on reorienting cities away from car dependency and towards human-scaled, community-centric environments.

Walkability and local accessibility are increasingly seen as critical to sustainable urbanism, not only for their environmental benefits but for their social and public health outcomes (Gehl, 2010; Nieuwenhuijsen & Khreis, 2016). By positioning essential services within a short walking distance, NEOM seeks to reduce the need for motorised transport, lower emissions, and promote active mobility. This approach resonates with what has been called the '15-minute city' model, popularised by Carlos Moreno and implemented in cities such as Paris, Melbourne, and Portland, Oregon (USA) (Moreno et al., 2021). However, NEOM adapts and intensifies the model into a more compact five-minute radius, presenting a unique case of extreme spatial efficiency in planned urban design.

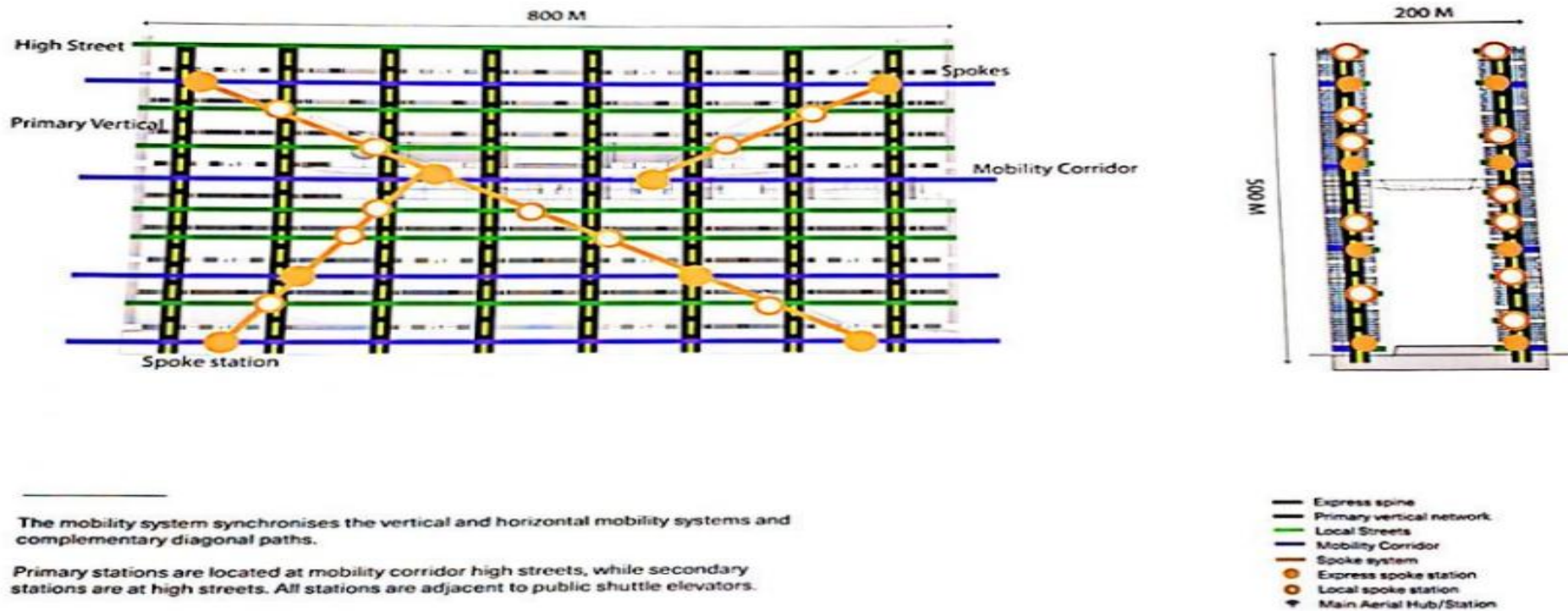
Contrary to NEOM's positioning of this framework as novel, the '5-minute city' is already being explored in other international contexts, most notably in the Nordhavn district of Copenhagen. There, urban planners have explicitly designed the neighbourhood to ensure that residents can access schools, shops, transit, and green spaces within a five-minute walk from their homes (Ramboll, n.d.). This reveals that while NEOM innovates through scale and integration, it is participating in, rather than originating, a broader movement in sustainable urban restructuring. I would nevertheless suggest that NEOM's adaptation represents a valuable evolution of this trend, particularly through its vertical layering and integration with autonomous transport systems, but it should be situated within this wider genealogy of compact urbanism.

NEOM's urban mobility system reinforces this community-centric philosophy through a multi-layered, decentralised transport grid (Figure 49). It comprises mobility corridors, vertical transit networks, and diagonal spoke pathways, all designed to minimise congestion and enhance user efficiency. Strategically placed transit stations serve as anchor points within this framework.

Express spoke stations enable high-speed travel across longer distances, while local stations facilitate neighbourhood-level access. A main aerial hub acts as the city's central interchange, enabling seamless multimodal integration. These features reflect a deliberate application of equilibrium principles in urban structure, as described by Batty (2022), in which movement patterns are dynamically balanced through decentralised yet interconnected nodes.

Figure 50

Grid-Based Mobility System in NEOM



Source: Exhibition in Riyadh, 2023 (photography by author 07/07/2023)

From a theoretical perspective, NEOM exemplifies the shift from mono-centric, car-oriented development to polycentric, transit-oriented design. Its mobility strategy aligns with concepts of spatial equilibrium and accessibility equity, where mobility infrastructure does not simply move people more efficiently, but redefines spatial relations across the city (Bertolini, 1999; Cervero & Sullivan, 2011). The blending of vertical and horizontal urban logics in The Line represents a hybrid model of transit-oriented development, pushing the conventional boundaries of transit-oriented development by incorporating autonomous systems, layered urban functions, and AI-managed flows.

However, the success of such models hinges not only on technological execution but also on social outcomes. Scholars have warned that overly rigid spatial planning in walkable cities can inadvertently produce socio-spatial segregation or exclude vulnerable groups if not designed with equity at the forefront (Allam & Jones, 2020; Anguelovski et al., 2018). NEOM's "walkable utopia" must therefore be viewed through a critical lens. Its promise of equitable access depends on whether it can translate design efficiency into lived inclusivity, especially across income levels, ages, and physical abilities.

Furthermore, the psychological and cultural dimensions of walkability should not be overlooked. Research in urban studies highlights that perceived safety, comfort, and aesthetic value play significant roles in residents' willingness to walk (Ewing & Handy, 2009). While NEOM's infrastructure may meet formal accessibility criteria, the lived experience of walkability will require soft urbanism interventions, such as public art, shaded pathways, and diverse street interfaces that encourage a vibrant pedestrian culture. These elements remain under-articulated in NEOM's current narrative and merit attention in implementation.

Ultimately, NEOM's approach offers a compelling case study in fusing advanced mobility technology with the spatial logics of walkable urbanism. It proposes a city where accessibility is not an afterthought but an organising principle. However, its success as a replicable model will depend on how it resolves the tensions between efficiency and inclusivity, central planning and local experience, vertical integration and horizontal community life. As the researcher's findings suggest, NEOM's model must be seen not only as a technical prototype but as a social experiment in reshaping urban life around accessibility, sustainability, and cohesion.

Finally, comes what can be described as planning for resilience and adaptation. A defining lesson of NEOM's urban development strategy is its commitment to preserving 95% of its land and marine ecosystems for nature conservation, aiming to establish a balance between urbanisation and ecological sustainability (NEOM, 2024a). This large-scale conservation effort is not only an environmental commitment but also a fundamental pillar of NEOM's resilience and adaptation strategy. By integrating vast ecological reserves into its urban framework, NEOM positions itself as a climate-resilient, resource-efficient development capable of responding to long-term environmental challenges. This aligns with the growing academic consensus that nature-based solutions (NbS) should form a core element of urban resilience frameworks, both as climate buffers and as enablers of ecosystem services in dense urban contexts (Beatley, 2020; Pauleit et al., 2017).

The integration of NbS into NEOM's planning includes coastal restoration, green-blue infrastructure, and buffer zones designed to mitigate the effects of sea-level rise and extreme weather events. Such strategies reflect a shift from reactive adaptation towards anticipatory resilience, where environmental systems are treated not as passive landscapes but as dynamic infrastructures that support urban form and function (Ahern, 2011). From an urban geography perspective, this reinforces the idea that resilience should be spatialised; that is, designed into the city's physical, ecological, and institutional systems from inception, rather than retrofitted after risk materialises.

NEOM also emphasises adaptability in its urban design process. As Interviewee 5 (Group 2) stressed, "thinking creatively about solutions that reduce footprints and encourage densification" is essential to addressing the complexity of contemporary urban challenges. This reflects a wider recognition in planning theory that compact, adaptable urban forms are better equipped to manage uncertainty, particularly when supported by real-time data and spatial intelligence (Godschalk, 2003; Meerow et al., 2016). NEOM's use of geomatics-based spatial modelling exemplifies this approach. These techniques allow planners to simulate future urban growth scenarios and climate stressors, enabling iterative design responses that can evolve alongside environmental and demographic changes (Alogayell et al., 2024).

The broader lesson here is that resilience must move beyond shock absorption to embrace transformability. As urban environments face accelerating pressures from climate change, population growth, resource depletion, and technological disruption, the capacity to

adapt not just infrastructure but governance, land-use, and urban behaviour becomes central to future-readiness (Davoudi et al., 2012). NEOM's strategy embodies this forward-looking orientation, combining advanced spatial tools with ecological foresight to build adaptability into the DNA of the city.

Yet, the challenges of implementing resilience at this scale should not be underestimated. While NEOM's ambitions are laudable, scholars have noted that large-scale resilience strategies often risk privileging environmental performance over social equity, unless supported by inclusive planning mechanisms (Ziervogel et al., 2017). NEOM's extensive conservation zones and density-driven design imply a certain model of urban containment, which if not managed carefully, could lead to socio-spatial exclusion or uneven access to ecological amenities. It is worth noting that resilience should not be measured solely in technical metrics but also in its capacity to support wellbeing, equity, and adaptive governance across diverse populations.

In addition, NEOM's model raises important questions about the replicability of such approaches in less resource-rich contexts. The application of high-resolution geomatics, AI-led spatial planning, and mega-scale NbS is feasible within the framework of a US\$500 billion state-backed project but may be less accessible to municipalities operating under budgetary and infrastructural constraints. This reinforces the need for tiered models of resilience planning, where the principles of anticipatory design and ecological integration are adapted to suit varied institutional and financial capacities.

NEOM's development plan provides significant insights into emerging best practices in resilient urbanism. By preserving natural ecosystems, embedding spatial adaptability, and leveraging advanced planning technologies, the project illustrates how cities might proactively design for uncertain futures. Interviewee reflections confirm that compact, flexible urban design and ecosystem stewardship are central to NEOM's adaptive model. As such, NEOM contributes to a growing field of urban experimentation, testing the limits and possibilities of pre-emptive resilience in the face of global environmental transformation.

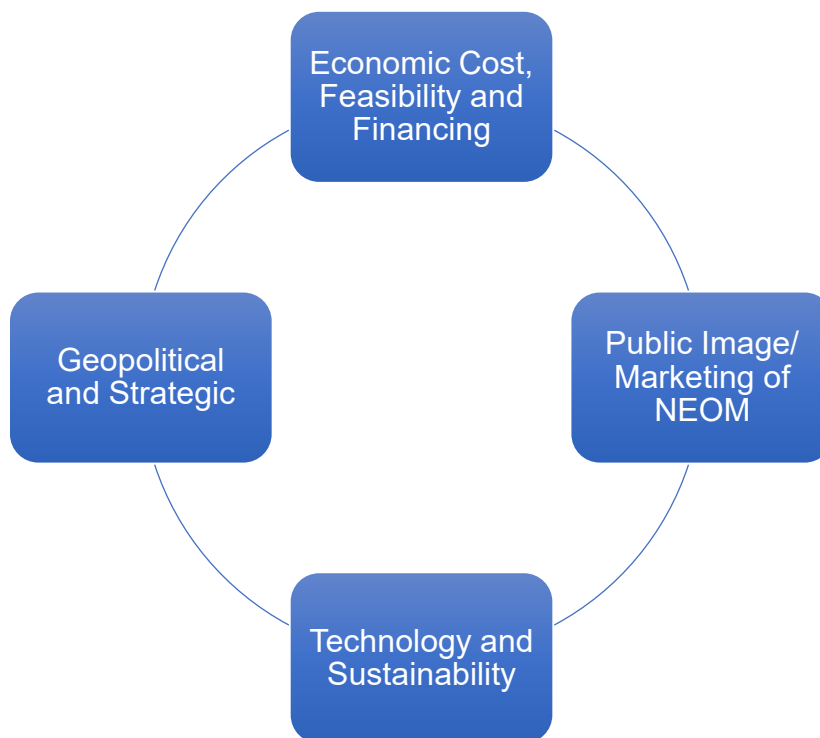
6.2.3.3 Sub-theme 2: Challenges associated with achieving NEOM's goals

Although NEOM's vision for a sustainable, smart, and resilient city is ambitious and forward-thinking, the project has faced several challenges that threaten to undermine its lofty goals. The

challenges presented below are a combination of insights from experts, criticism from the media, and other relevant sources. The challenges are grouped as follows: economic cost, feasibility and financing; public image/ marketing of NEOM; technology and sustainability; and geopolitical and strategic challenges (Figure 50).

Figure 51

Main Challenges Facing NEOM's Development and Achievement of Goals



Source: Adapted by the author based on expert interviews and secondary data.

In terms of economic cost, feasibility, and financing, NEOM's financial sustainability is among the most pressing challenges facing the project. As one of the most ambitious and capital-intensive urban developments in modern history, with an estimated budget exceeding US\$500 billion, its long-term viability depends on Saudi Arabia's capacity to secure continuous financing and manage systemic economic risks. The project is currently underpinned by the Saudi PIF, supported in part by efforts to attract foreign investment, including urban bonds and green finance mechanisms. While this multi-tiered financial strategy reflects a diversification effort, it also underscores the vulnerability of megaprojects that depend heavily on state funding and commodity-linked revenues.

Recent reports have highlighted significant financial and managerial challenges facing NEOM. An internal audit suggested that certain project executives may have presented adjusted financial forecasts that downplayed escalating costs, potentially limiting full visibility for senior leadership, this raises important questions regarding transparency and governance within the project's financial management structure (Nissenbaum & Parkinson, 2024). Additionally, the sacking of NEOM's former CEO, Nadhmi Al-Nasr, reportedly due to scheduling failures and an abrasive management style, points to deeper leadership issues that could affect project continuity and investor confidence (Walters, 2024). These developments underline the institutional risks embedded in state-driven megaprojects, where top-down decision-making structures may hinder open feedback and adaptive responses to complex challenges.

NEOM's green finance mechanisms, such as sustainability-linked bonds and climate-conscious investment instruments, are designed to appeal to investors aligned with global environmental, social, and governance (ESG) priorities (Ben Jenana & Elkharmany, 2024). These align with the broader movement toward sustainable urban financing, where cities increasingly leverage climate agendas to unlock capital (Shand & Colenbrander, 2018). However, as Abdelhady (2024) notes, geopolitical risk perceptions and macroeconomic uncertainties in the Middle East remain significant deterrents for many institutional investors. The region's volatile energy markets, ongoing socio-political transformations, and historically opaque regulatory environments collectively raise concerns about long-term capital security and return on investment.

Saudi Arabia's own track record with megaprojects compounds this scepticism. The case of KAEC is instructive: despite its ambitious targets, the project fell short of economic performance benchmarks, resulting in underutilised infrastructure and limited investor returns (Yusuf & Abdulmohsen, 2023). NEOM, which dwarfs KAEC in scale and complexity, must avoid similar pitfalls. The academic literature on megaprojects repeatedly warns of the planning fallacy, a systemic underestimation of costs, timelines, and complexity, often driven by optimism bias and political pressures (Flyvbjerg, 2014; Siemiatycki, 2009). NEOM's viability will depend on its ability to resist these tendencies through transparent governance, staged development, and continuously rigorous cost-benefit assessments.

The risks of cost overruns and delays are further amplified by NEOM's reliance on oil-linked revenue streams.²⁷ While Vision 2030 seeks to diversify Saudi Arabia's economy, oil remains a critical source of state income. Alnaser et al. (2024) argue that fluctuations in oil prices could directly constrain NEOM's funding pipeline, particularly in the event of prolonged downturns or reduced global demand for fossil fuels. This economic fragility complicates the country's attempt to pivot from hydrocarbon dependence while concurrently financing a US\$500 billion experimental city.

Comparative insights from other megaprojects reinforce these concerns. Dubai's World Central Airport and Egypt's New Administrative Capital have faced similar issues related to overcapacity, underutilisation, and capital scarcity during economic slowdowns (Ben Jenana & Elkharmany, 2024). Even China's Belt and Road Initiative, while framed as a model of infrastructural ambition, has triggered debates over debt sustainability and risk exposure, particularly in emerging markets (Hurley et al., 2018). These cases highlight that the scale of investment is no guarantee of long-term economic value unless projects are closely aligned with market demand, spatial logic, and institutional capacity.

While NEOM presents itself as a future-proofed, smart, and sustainable city, its path to financial sustainability remains ambiguous. Touri (2024) observes that without clear, measurable revenue-generation mechanisms, the project risks becoming a prolonged fiscal burden. Current plans rely heavily on aspirational sectors such as AI, biotech, and green hydrogen, industries that are either nascent or not yet commercially viable at scale. As such, the financial strategy must go beyond branding and innovation narratives to articulate grounded pathways for economic productivity and private-sector value capture.

Nonetheless, there are lessons NEOM could draw from international best practice. The Songdo International Business District in South Korea, while facing criticism for a lack of vibrancy, illustrates a successful deployment of public-private partnerships to distribute financial risk and attract sector-specific investment (Ahsan & Park, 2024). Similarly, a phased development approach, where infrastructure and services are rolled out in tandem with real

²⁷ NEOM's reliance on oil revenue poses a structural risk, as Saudi Arabia's economy remains dependent on petroleum exports. This exposes project funding to global oil price fluctuations, geopolitical tensions, and the shift toward decarbonisation. Scholars warn this dependence may cause fiscal instability and limit non-oil investment (Albassam, 2015; Van der Ploeg & Venables, 2011). Growing climate commitments, such as the Paris Agreement, further threaten oil's long-term viability as a funding source.

demand, could mitigate risk exposure and avoid the sunk-cost trap often seen in megaprojects with front-loaded capital expenditure (Flyvbjerg, 2023).

NEOM's economic vision remains aspirational rather than empirically grounded. While the project's scale and symbolism are central to the Saudi state's soft power and post-oil rebranding, its actual capacity to yield sustainable economic returns will hinge on adaptive financial governance, credible market analysis, and risk-sharing with private stakeholders. The emphasis should shift from speculative urbanism to pragmatic economic planning, where ambition is matched by institutional capacity and evidence-based fiscal strategy.

NEOM is a high-stakes financial experiment in post-oil urban development. Its outcome will provide either a new benchmark for sustainable megaproject financing or a cautionary tale of overextension and fiscal risk. By learning from comparable initiatives, enhancing financial transparency, and structuring investments around realisable market opportunities, NEOM may yet demonstrate how transformative urban visions can be made economically viable in uncertain global contexts.

Secondly, while promotion of the project and high levels of communication are important, the public image and marketing of NEOM come with their own challenges. International media coverage has increasingly shaped global perceptions of NEOM, contributing to a more fragmented and contested narrative around the project. While initial promotional campaigns positioned NEOM as a revolutionary smart city project, a symbol of post-oil transformation and technological futurism, recent reporting reflects growing tension between visionary ambition and operational reality. For instance, *The Guardian* reported that NEOM's The Line development is now expected to extend only 1.5 miles out of its original 105 miles (170 km) by 2030, citing budgetary constraints and declining cash reserves (Beaumont, 2024). Similarly, *The Economic Times* highlighted concerns over the project's feasibility, noting that satellite images and internal documents suggest a significant scale-down (ET Online, 2025). Likewise, the *Mail Online* also discussed the potential reduction in scope, emphasising the challenges faced in constructing such an ambitious megastructure in the desert (Hashmi, 2024). Although NEOM officials maintain that this phasing approach was always intended (Al Arabiya English, 2025), recent developments suggest that NEOM is undergoing a period of serious reassessment. External consultants have reportedly been engaged to appraise the project's financial and logistical feasibility, raising questions about whether the original

vision, especially for The Line, remains achievable under current conditions (*CNBC*, 2025; *GulfNews*, 2025; *Metro*, 2025). The contrast between early promotional messaging and current construction progress has fuelled public scepticism.

This shift in the media narrative illustrates what scholars of urban development identify as the discursive politics of megaprojects: the idea that large-scale infrastructure projects gain and maintain legitimacy not solely through material progress but also through their mediated representations and narrative framing (Flyvbjerg et al., 2003; McNeill, 2019). Headlines such as “End of the Line?” (Beaumont, 2024) or “Saudi Arabia’s 100-mile skyscraper is turning into a disaster (Cameron, 2024) encapsulate the narrative pivot, reframing NEOM as a speculative undertaking, increasingly scrutinised for its financial feasibility, socio-political implications, and environmental trade-offs. While some publications, such as *The Sunday Times* (Bennett, 2024), continue to portray NEOM as an ambitious model of urban innovation, the overall tone of international coverage has become more tempered and critical, increasingly highlighting the gap between its visionary ambition and material progress. Such portrayals complicate NEOM’s branding efforts, which continue to promote it as a leading-edge prototype for the city of the future, despite mounting evidence of delays and internal recalibrations (Walker, 2024).

In response to mounting external scrutiny, NEOM’s leadership has made visible efforts to manage its public image through strategic communication. Initiatives such as aerial site imagery and public statements accompanied by phrases like “drawing a line in the sand” have been used to reaffirm the project’s symbolic momentum and ongoing commitment to its long-term vision (The Friendly Urbanist, 2023). Articles in, for example, the *Economic Times* (ET Online, 2025) highlight how NEOM’s communications have been increasingly shaped by the need to counter claims of delays and scaling back. In a media interview, senior leadership reiterated that phased implementation, aligned with population growth, was always intended: “We never intended or expressed our view that we could build the whole 170 km right away, that is like building New York or London in five years” (Al Arabiya English, 2025). However, the disjunction between early promotional narratives and subsequent clarifications reveals a broader challenge: aligning public expectations with infrastructural timelines in a hyper-visible, global media environment.

Further complicating the project’s public image are ongoing ethical concerns related to community resettlement and indigenous rights. Investigative reports from *BBC News* (2024)

and the United Nations Human Rights Office (2023) have raised serious questions regarding the relocation of local populations from construction zones. These incidents stand in tension with NEOM's sustainability and inclusivity branding, highlighting the socio-political costs embedded within rapid state-led urban transformation. Although the Saudi government has cited the role of the National Programme for Community Development (Tanmia) and pointed to compensation and support measures (Saudi Press Agency, 2020; *Arab News*, 2020), such responses have been met with varied reactions. These developments reinforce existing critiques of flagship projects that promote eco-innovation while externalising social risk (Shatkin, 2011; Anguelovski et al., 2016).

Environmental criticism has further challenged the coherence of NEOM's green image. While the project claims to pursue a zero-carbon urban model, its reliance on carbon-intensive materials such as concrete and steel has attracted scrutiny. Analysts estimate that the construction of The Line could result in approximately 1.8 gigatonnes of CO₂ emissions (Oldfield, 2024). This figure places NEOM in a paradoxical position: one where the creation of a so-called 'sustainable city' contributes significantly to global emissions, raising questions about the viability of net-zero targets under current construction methodologies (Broto & Bulkeley, 2013).

Additional concern has emerged around the project's mirrored façade, which although visually striking, may pose a threat to biodiversity. Conservation experts warn that the reflective surfaces could endanger migratory bird populations along the Red Sea flyway, one of the world's most critical avian migration corridors (Michelson, 2024). From the perspective of urban environmental governance, this case illustrates the conflict between architectural spectacle and ecological integrity, an issue frequently observed in speculative urban developments, where form often precedes ecological function (Joss et al., 2019; Rapoport, 2015).

Viewed through the lens of urban geography, NEOM exemplifies what Flyvbjerg (2014, p. 11) terms the "performance paradox" of megaprojects: the notion that the same characteristics which generate public excitement, like visionary scale, radical form, and symbolic value, also introduce disproportionate risk, delay, and controversy. In the case of The Line, this paradox is intensified by the project's physical and epistemological departure from conventional urban planning models. The ambition to design and inhabit a continuous vertical

city in desert terrain raises questions not only about construction feasibility, but also about governance, liveability, and sociocultural adaptability.

In this context, NEOM operates across multiple temporalities: on one hand, a fast-paced media cycle driven by spectacle and performance; on the other, the slow and complex reality of infrastructural development and institutional negotiation. This divergence contributes to a growing legitimacy gap, where the distance between public narrative and material progress becomes increasingly difficult to reconcile. Addressing this requires more than strategic communication; it demands institutional transparency, regular progress benchmarks, and an ongoing commitment to assessing and mitigating social and environmental trade-offs.

As well as being a significant area from which lessons can be learnt regarding NEOM's planning, technology and sustainability also represent the third area of major challenge. NEOM's vision represents a bold attempt to fuse technology and sustainability, positioning itself as a testbed for advanced AI-driven systems, autonomous mobility, and renewable energy integration. While this framing signals an aspirational departure from traditional urban development models, it simultaneously introduces complex operational, environmental, and ethical challenges that require critical examination. Interviewee 8 (Group 2) observed that "the level of technological integration that NEOM is aiming for is unprecedented and untested," highlighting a central concern echoed in academic literature: namely, the absence of mature frameworks for managing city-wide, interdependent systems on this scale (Abdelhady, 2024; Karvonen et al., 2019).

Managing such complexity will require not only technological solutions but also governance innovation. The interoperability of systems developed by diverse global partners, ranging from AI and mobility platforms to decentralised renewable energy grids, raises critical questions around standardisation, infrastructure compatibility, and the potential for institutional fragmentation (Alogayell et al., 2024; Söderström et al., 2014). Moreover, the cybersecurity vulnerabilities introduced by hyper-connected environments demand continuous oversight. Alnaser et al. (2024) argue that large-scale smart infrastructure projects must embed data security and privacy protections within their design from inception, especially when deploying real-time surveillance, predictive analytics, and automated public services.

As has already been said, NEOM's commitment to 100% renewable energy through solar, wind, and green hydrogen technologies has been positioned as one of its core

sustainability pillars. However, there is a tension between these ambitions and their material execution. Renewable energy systems require rare earth elements and high-carbon inputs during production and construction phases, challenging the net sustainability of the transition if not managed holistically (Gielen et al., 2019). Additionally, the intermittency of wind and solar generation in arid climates necessitates sophisticated energy storage and grid balancing mechanisms that are still evolving globally (Sovacool, 2021).

Environmental implications extend beyond energy infrastructure. As Yusuf and Abdulmohsen (2023) argue, the transformation of desert and coastal terrain into dense urban zones risks habitat fragmentation, loss of endemic species, and, as noted already, the disruption of migratory bird corridors along the ecologically sensitive Red Sea flyway. These concerns highlight the paradox between NEOM's sustainability discourse and the ecological consequences of its construction footprint.

Water scarcity presents another critical area of concern. NEOM plans to rely on desalination and water recycling to meet its needs, yet desalination remains an energy-intensive and environmentally problematic process, particularly in terms of brine discharge and marine biodiversity impacts (Abdelhady, 2024). While emerging innovations such as zero-liquid discharge systems and AI-optimised water networks offer mitigation pathways (ENOWA Water, 2023), the scale of application required in NEOM will demand continuous monitoring and adaptive management.

From an urban governance perspective, the success of NEOM's technological strategy hinges not only on engineering prowess but also on institutional agility, regulatory transparency, and stakeholder inclusion. Literature on smart urbanism increasingly emphasises the importance of participatory design and socio-technical adaptability (Kitchin, 2014a; Datta, 2018). In avoiding technocratic lock-ins, that is, situations where rigid, top-down technological systems become entrenched, limiting future flexibility, democratic input, and the ability to adapt to changing social or environmental conditions (Savini & Raco, 2019). In this regard, NEOM's top-down governance structure may pose challenges to meaningful engagement and responsiveness. The project must therefore move beyond technology as an end in itself and demonstrate how these systems will enhance equity, access, and urban resilience over time.

Interviewee insights affirm this complexity, with multiple respondents highlighting the need for flexibility, accountability, and learning-oriented governance. The capacity to respond

to unanticipated challenges, whether technological, ecological, or socio-political, will be fundamental to NEOM's long-term relevance. As Winkel (2024) contends, smart cities that treat innovation as linear or pre-determined often fail to account for the plural and contested nature of urban life. NEOM, by contrast, has the opportunity to evolve as a site of experimentation and institutional learning, provided it is willing to interrogate and adapt its own assumptions.

While NEOM has featured prominently in global smart city discourse, its more futuristic elements, such as The Line's mirrored 'square-scraper', have attracted both acclaim and scepticism. At the 2024 Smart City Expo World Congress, *The Times* identified NEOM's vertical city design as one of the 15 smartest innovations but also raised questions about the environmental and technical viability of implementing such infrastructure in a desert context (Wallace, 2024). These concerns reflect broader tensions between the spectacle of innovation and the grounded realities of ecological constraints, material costs, and implementation feasibility.

Ultimately, NEOM offers a case through which to interrogate the possibilities and limits of technologically enabled sustainability in the 21st century. Its approach to renewable energy, smart mobility, and digital governance provides important insights into the material demands and ethical considerations of future urbanism. Whether NEOM becomes a pioneering prototype or a cautionary tale will depend not on its technological vision alone, but on its ability to balance ambition with realism, innovation with responsibility, and progress with ecological care.

As already referenced in the sections above, these tensions come particularly to the fore regarding The Line, NEOM's flagship initiative that is frequently positioned as a radical reimagination of the urban form: a linear city embedded with advanced technologies and promising zero-carbon operations, seamless AI integration, and a complete break from car-based mobility. Framed within Saudi Arabia's Vision 2030 agenda, The Line is intended to embody a futuristic, liveable, and sustainable model of urban life in arid climates. However, the project has attracted considerable scrutiny from academics, urban planners, environmental experts, and human rights observers who question both the feasibility and ethics of its proposed form and function (Fallatah, 2019; Otto, 2024; Al-Qst, 2023).

NEOM's design narrative emphasises hyper-density, vertical zoning, and the total elimination of traditional vehicular networks. The vision draws upon current debates in urban sustainability that advocate for walkable, compact cities, reduced carbon emissions, and decentralised services (Moreno et al., 2021; Gehl, 2010). Yet, The Line diverges from established urban morphology by attempting to compress city life into a continuous mirrored corridor, raising fundamental questions about spatial experience, psychological well-being, and socio-cultural adaptability in extreme environments. Critics argue that this pursuit of novelty risks prioritising architectural spectacle over liveability and socio-spatial coherence (Rapoport, 2015; Graham & Marvin, 2002).

Technologically, the project claims to offer seamless AI-managed logistics, autonomous public transport, and real-time data regulation. While these systems resonate with emerging smart city frameworks, the scale and simultaneity of such integration are largely untested. Interviewee insights and reports suggest that even NEOM's internal teams are struggling to deliver on these technological aspirations due to limited expertise and unrealistic timelines (Al-Qst, 2023). This aligns with broader patterns observed in other high-tech megaprojects, where top-down visions often falter in translation to operational practice (Cugurullo, 2018; Söderström et al., 2014). As referenced in previous sections, the project has also come under criticism for its environmental contradictions as a sustainable eco-city that stands at odds with the embodied carbon of such large-scale construction of steel and glass, coupled with the disruption of delicate desert ecosystems (Gielen et al., 2019; Otto, 2024).

Comparative analysis with other planned eco-cities such as Masdar City in the UAE and Songdo in South Korea offers cautionary insights. Despite their advanced technologies and branding as climate-resilient cities, these projects have failed to meet original targets in terms of resident numbers, carbon neutrality, and urban vitality (Caprotti, 2014; Joss et al., 2019). Like NEOM, they demonstrate the pitfalls of relying on technocratic optimism and architectural novelty without accounting for political, cultural, and ecological realities. As Fallatah (2019) observes, NEOM may risk reproducing these failures unless it adopts a more grounded, transparent, and community-oriented planning approach.

Ultimately, The Line represents both a provocative design experiment and a critical case study in 21st-century urbanism. Its long-term relevance will depend less on whether it can materialise in line with its glossy renderings, and more on how it responds to the complex

interplay of governance, environmental stewardship, social justice, and technological resilience. As with other megaprojects, the gap between vision and delivery remains wide; NEOM's challenge lies in narrowing that gap without reproducing the ecological degradation and social inequity it claims to transcend.

The final area clearly identified regarding potential difficulties is that of geopolitical and strategic challenges. NEOM's strategic location in the northwestern corner of Saudi Arabia, adjacent to Jordan and Egypt, situates it near historically volatile geopolitical borders. While this proximity theoretically enables cross-border collaboration and trade, it also exposes the project to regional instability. Recent developments in the Middle East, such as escalating tensions between Israel and its neighbours, have amplified security concerns for gulf initiatives and may influence investor sentiment (*The Wall Street Journal*, 2024). Saudi Arabia's own complex relations with Iran and Yemen further complicate the regional outlook, introducing unpredictability into the long-term viability of megaprojects like NEOM (Carnegie Endowment for International Peace, 2023).

Political instability is a key consideration for foreign investors. As Winkel (2024) and Yusuf and Abdulmohsen (2023) argue, megaprojects in conflict-adjacent zones often require additional financial and logistical resources to ensure security, increasing overall risk and reducing financial appeal. Saudi Arabia's reliance on centralised military control offers a degree of protection, but this militarisation can deter private sector involvement and limit international partnerships (Stimson Center, 2025).

Beyond political volatility, NEOM faces acute environmental constraints. Located in an arid, water-scarce desert region, the project depends heavily on large-scale desalination and climate engineering initiatives. These technologies are both energy-intensive and ecologically controversial (World Bank, 2024). As Gielen et al. (2019) emphasise, the long-term sustainability of such projects depends not only on renewable generation but also on the availability of advanced storage solutions and resource-efficient technologies capable of operating under extreme environmental stressors. Furthermore, efforts to implement green landscaping, afforestation, or large-scale solar farms are hindered by the extreme heat and saline soil conditions (Alwafi, 2025).

NEOM also operates within a highly competitive gulf landscape. Cities such as Dubai, Abu Dhabi, Doha, and Manama have already established themselves as innovation and

investment hubs, with projects like Masdar City and Lusail City serving as benchmarks in the smart city arena (Stimson Center, 2025; Wilson Center, 2024). To compete, NEOM must distinguish itself not only through scale but through meaningful differentiation in its technological offerings and governance structures. As Winkel (2024) notes, relying solely on spectacle and ambition without demonstrable pathways for implementation may risk replicating the shortcomings of past gulf mega projects.

Media coverage of NEOM has reflected mounting scepticism regarding not just its feasibility, but also its intent. Critics have labelled it a vanity project, suggesting that its primary function is to enhance Saudi Arabia's global reputation rather than respond to domestic socio-economic needs (Klean Industries, 2024). The project's scale and ambition have prompted some commentators to suggest that its highly centralised planning model may risk overlooking the everyday experiences and needs of broader segments of the Saudi population (Algumzi, 2022). Comparisons with projects such as Telosa²⁸ in the United States, highlight common challenges associated with speculative smart cities, particularly regarding governance, public trust, and unrealistic timelines (Elhag, 2024).

The reliance on futuristic and often fantastical imagery, such as flying taxis, AI-managed cities, and autonomous infrastructure, has generated international intrigue but also scepticism. Abdelhady (2024) cautions that without the foundational legal and regulatory frameworks needed to support these systems, such promises remain aspirational. These visions may distract from more urgent priorities, such as affordable housing, education, and climate resilience.

Investor confidence is further threatened by the disconnect between marketing and measurable returns. As Yusuf and Abdulmohsen (2023) show in their evaluation of Masdar City, overpromising technological revolutions without clear return on investment pathways has historically led to stalled development. NEOM's emphasis on speculative technologies may alienate cautious investors who favour staged returns and regulatory certainty (Alnaser et al.,

²⁸ Telosa is a proposed smart city conceptualised by American billionaire Marc Lore, envisioned as a sustainable, inclusive urban development to be built from scratch in the western United States. Marketed as a city "rooted in community and equity," Telosa aims to incorporate renewable energy, autonomous transport, and a new model of land ownership called "equitism." While still in its early conceptual phase, Telosa has drawn both praise for its ambitious vision and criticism for its lack of concrete governance mechanisms, funding guarantees, and feasibility assessments. Comparisons with NEOM are frequently drawn due to their shared emphasis on futuristic technologies, idealistic branding, and top-down planning frameworks (Elhag, 2024).

2024). In this context, the success of NEOM depends not only on attracting global capital but on establishing transparent, phased, and credible development frameworks that can survive political shifts and market fluctuations.

6.2.4. Key Theme 4 Discussion

The planning of NEOM, and particularly the Line, encapsulates a profound tension between utopian ambition and the realities of contemporary urbanism. Drawing on interviews with internal stakeholders, the project emerges not as a traditional spatial intervention, but as a multi-scalar ideological, technological, and political experiment. These stakeholders view NEOM as a unique opportunity to pioneer future-oriented models of governance, infrastructure, and sustainability. However, a close examination of its conceptual underpinnings and material circumstances reveals the conflict between speculative design and practical feasibility.

NEOM's development is driven by a techno-futurist logic rooted in what scholars have termed 'algorithmic urbanism', a model of city-making reliant on data-intensive technologies and automated governance systems (Kitchin, 2014a; Mattern, 2021). AI, predictive modelling, and real-time surveillance are expected to displace conventional urban planning and bureaucratic management, with the promise of hyper-efficiency and systemic optimisation. As observed in similar initiatives such as Songdo in South Korea or Sidewalk Toronto, such technological determinism often marginalises the lived experiences of urban residents and overlooks the inherent complexity of urban life (Datta, 2015; Leszczynski, 2016). NEOM, rather than retrofitting existing conditions, proposes an entirely new epistemology of urbanism, one seemingly abstracted from social history, environmental constraints, and geopolitical context.

Stakeholders interviewed as part of this research largely expressed confidence in NEOM's ability to overcome these constraints, citing the project's access to capital, centralised decision-making, and Saudi Arabia's geopolitical clout. However, their emphasis on perfection, symmetry, and linearity in the urban form of the Line reflects a discomfort with the messiness and plurality inherent to urban development (Connolly, 2018). Interviewees noted the desire to create a city with "no roads, no cars, no pollution." This claim not only presumes a technological maturity that is yet to be realised but also ignores the engineering and infrastructural complexities of sustaining a 170-kilometre urban corridor in a seismically active

(Kahal, 2020; Klinger et al., 2000) and ecologically fragile zone. These conditions pose structural challenges that cannot be overcome solely through speculative design, raising concerns regarding long-term structural viability.

This environmental fragility is further complicated by NEOM's sustainability claims. While the project is marketed as a post-carbon utopia reliant on solar and wind power, and validly celebrated for its commitment to renewable energy and decarbonisation, the construction process itself, particularly the mirrored façade of the Line, requires substantial energy, water, and material input. Desalination for water supply, reliance on rare-earth minerals for energy storage, and the ecological disruption caused by large-scale construction render the sustainability narrative highly contested. The paradox of ecological modernisation, wherein technologically advanced sustainability solutions simultaneously accelerate environmental degradation, looms large over the project. Stakeholders acknowledged the contradictions but often rationalised them as transitional costs necessary for system-wide transformation. This echoes critiques of sustainability as a legitimising discourse that obscures the political economy of environmental harm (Swyngedouw et al., 2002). Concerns regarding the tension between environmental branding and ecological impact remain unresolved.

At the social level, NEOM's presentation as a visionary project built on a blank slate tends to understate the longstanding presence of communities and the cultural significance of the landscape. While official narratives focus on innovation and opportunity, concerns have been raised by human rights organisations regarding the relocation of local populations; an aspect that receives limited visibility in public discourse (Human Rights Watch, 2024; Al-Qst, 2023). These developments echo what Nixon (2011, p. 2) describes as "slow violence," referring to gradual, often invisible processes that may affect vulnerable communities over time. Rather than being an uninhabited expanse, the NEOM site can be understood as a culturally and ecologically layered environment. Urban scholars have suggested that 'tabula rasa' planning approaches, while offering space for bold experimentation, should also be attentive to issues of place, memory, and inclusivity (Porter, 2010; Yiftachel, 1995).

Internally, NEOM operates through a governance structure that fuses state-led authority with corporate managerialism. Interviewees described a centralised planning model reliant on international consultancies, private sector metrics, and top-down mandates. This model reflects Harvey's (1989) notion of the entrepreneurial city, where urban governance becomes oriented

towards capital attraction rather than democratic participation. The result is a post-political urban condition, in which public deliberation is substituted by performance dashboards and algorithmic systems (Swyngedouw, 2009). While such efficiency may be seen as a strength in the eyes of NEOM's promoters, it risks alienating citizens and undermining the very sense of community that makes cities resilient.

The concept of resilience was raised by many stakeholders, but often framed in technocratic terms: infrastructure hardening, system redundancy, and predictive response mechanisms (Davoudi et al, 2012; Bruneau et al., 2003). This limited reading of resilience neglects the social, cultural, and institutional dimensions that enable urban systems to adapt and regenerate in the face of crisis (Davoudi et al., 2012). Without participatory governance, civic institutions, or social accountability, NEOM's model may prove brittle rather than adaptive. Resilience is not simply the ability to bounce back, but to learn, transform, and democratise power relations. This is particularly important in the context of megaprojects, where scale and spectacle often overshadow social needs.

Financial sustainability also presents a significant risk. With costs reportedly exceeding initial budgets and a growing gap between construction pace and vision delivery, NEOM confronts the same overrun risks that have plagued other global megaprojects (Flyvbjerg et al., 2003; Ansar et al., 2014). While stakeholders remain optimistic about long-term returns, particularly from tourism, logistics, and clean tech sectors, these projections rely on volatile global markets and speculative economic modelling. If unmet, the consequences may include stagnation, debt burdens, and reputational damage.

Taken together, NEOM reflects both the potential and the paradoxes of 21st-century future urbanism. It is at once an experimental laboratory and a site of political, ecological, and ethical contestation. The empirical findings reveal a project driven by conviction, visionary in scope, but constrained by the very logics, such as speed, control, perfection, that it seeks to transcend. Whether NEOM endures as a liveable, inclusive, and sustainable urban entity, or is remembered primarily as a symbolic artefact of techno-futurist ambition, will depend on its willingness to embrace complexity, plurality, and institutional humility.

6.3. Integrated Discussion (Key Themes 3 – 4)

This discussion examines findings related to NEOM's unique and innovative dimensions and the tensions inherent in its planning between utopian ambition and practical realisation. Drawing on insights from Group 2 interviews with internal stakeholders and relevant literature, the discussion explores how NEOM is conceptualised not merely as a smart city but as a cognitive, spatial, and governance experiment that seeks to redefine urbanism itself. In doing so, it critically reflects on the social, environmental, and institutional implications of NEOM's unprecedented scale and ambition.

What emerges from the interviews is not a singular narrative of progress but a dense and often paradoxical field of overlapping ambitions, cautions, and calculated experimentation. Stakeholders consistently described NEOM as an epistemological shift in urban thinking, moving away from the city as a static container of infrastructure towards a dynamic system of anticipatory governance and algorithmic optimisation. NEOM was framed not as a smart city in the conventional sense but as a cognitive city, one that learns, adapts, and evolves in real time. This ambition reflects a speculative orientation towards urbanism as a programmable and self-regulating system, capable of responding to both predicted and unforeseen challenges.

Central to this vision is NEOM's spatial ideology, most prominently articulated through the concept of Zero Gravity Urbanism and The Line. Interviewee 19 described this model as a radical compression of space designed to maximise proximity and intensity of experience while minimising land consumption. This approach resonates with Appert and Montes' (2015) theorisation of vertical urbanism as a response to land scarcity and climate constraints, though NEOM adapts this logic from a position of abundance enabled by sovereign financing and the absence of pre-existing urban constraints.

Unlike earlier vertical urban experiments, such as Tokyo's high-density towers or New York's mixed-use skyscrapers, The Line treats verticality not as a skyline phenomenon but as the core structure of urban metabolism. Interviewee 17 emphasised that this design choice is deeply political, intended to reduce ecological pressure by limiting NEOM's physical footprint. This aspiration aligns with regenerative design principles that advocate for preserving ecological land cover through spatial intensification rather than horizontal expansion (Mang & Reed, 2012).

Crucially, these spatial arrangements are inseparable from NEOM's cognitive infrastructure. The Line is conceived as a spatial interface for AI-driven governance, with digital twins enabling real-time simulation and forecasting of energy use, mobility flows, water systems, and behavioural patterns (Interviewee 3). Architecture and infrastructure become data-producing and data-responsive systems, blurring boundaries between built form and governance (Gabrys, 2016; Kitchin, 2014a). In this model, the city is imagined first as code and only subsequently translated into material form.

While this approach promises unprecedented efficiency and environmental performance, it also raises significant concerns regarding social adaptability and lived experience. Critics of vertical utopias have long warned that stacked space may optimise surveillance and mobility while undermining social encounter and emotional well-being (Graham, 2016). Some interviewees acknowledged these concerns explicitly. Interviewee 18 questioned how community and belonging might be experienced within a highly automated environment located hundreds of metres above the desert, highlighting potential psychological and cultural disconnection from both land and fellow inhabitants.

These tensions extend to NEOM's environmental ambitions. Stakeholders repeatedly expressed pride in NEOM's commitment to operate entirely on renewable energy, including large-scale solar, wind, and green hydrogen systems. This ambition aligns with Saudi Vision 2030 and international frameworks such as the United Nations' SDGs, particularly SDGs 7, 11, and 13 (United Nations, 2015b). From an ecological urbanism perspective, NEOM reflects an effort to embed environmental performance into the core logic of urban systems (Bibri, 2021b). However, the realisation of these ambitions presents substantial challenges. Green hydrogen production requires significant water and energy inputs, posing particular difficulties in NEOM's arid context. Similarly, solar-powered desalination and zero-liquid discharge systems remain largely untested at the scale proposed and carry ecological risks related to brine disposal and energy intensity (Gude, 2016). These challenges illustrate the tension between visionary environmental ambition and the technical complexity required to sustain it.

Governance emerges as a further critical dimension of NEOM's experimentation. Designed as a Special Economic Zone, NEOM operates under a bespoke regulatory framework intended to facilitate innovation, attract global expertise, and enable policy experimentation. This approach aligns with global SEZ best practices, where semi-autonomous governance

structures serve as platforms for regulatory innovation (Farole, 2011; Akinici & Crittle, 2008). Scholars increasingly interpret such zones as laboratories for state-led experimentation (Ong, 2006; Su, 2023), a framing that resonates strongly with NEOM's ambitions.

Stakeholders described governance not as a background condition but as an active infrastructure enabling ecological, technological, and economic transformation. This reflects Kitchin's (2016) conception of governance as facilitative rather than merely regulatory, as well as Carstensen's (2017) notion of institutional bricolage, whereby practices from multiple jurisdictions are selectively assembled to support novel futures.

Ultimately, NEOM emerges from the interview data and observational data from The Line exhibition in Riyadh, as both a city and a concept, a physical environment and an ideological proposition. Its significance lies less in flawless execution than in its capacity for reflexivity, learning, and adaptation. Whether NEOM becomes a replicable model, a symbolic gesture, or an adaptive ecosystem will depend on how effectively it navigates the tensions between technological anticipation and social resilience, environmental ambition and systemic robustness, and global futurism and local coherence. In this sense, NEOM's value lies not only in whether it works, but in how it evolves, and what it reveals about the possibilities and limits of future urbanism.

6.4. Conclusion

This chapter has provided a critical analysis of the internal perspectives (Group 2) regarding NEOM's potential as a paradigm for future sustainable smart city initiatives. Through the thematic interrogation of data derived from senior planners, architects, and strategic leads, the findings reveal that NEOM is conceptualised not merely as a progression of existing smart city models, but as a distinct epistemological rupture, a shift from the reactive 'smart city' to the predictive 'cognitive city.' The analysis has demonstrated that this paradigm is constructed around four interconnected pillars: the transition to AI-driven cognitive urbanism; the spatial reimagining of density through Zero Gravity Urbanism; the implementation of a post-carbon, renewable energy metabolism; and the utilisation of a bespoke regulatory SEZ framework to facilitate rapid innovation.

Collectively, the internal narratives portray NEOM as a "living laboratory," where the limitations identified in legacy smart cities, such as retrofitting constraints, fragmented governance, and incremental sustainability measures, are addressed through a radical clean-slate approach. The findings highlight that for internal stakeholders, the "NEOM paradigm" is defined by its attempt to harmonise technological omnipresence with ecological restoration. However, the analysis also uncovers significant tensions between the project's utopian aspirations and the practical realities of implementation. The data indicates that while the technological and environmental visions are robust, critical challenges remain regarding the social adaptability of vertical living, the resilience of hyper-connected digital infrastructures, and the translation of high-level concepts into lived human experiences.

Ultimately, this chapter concludes that internal stakeholders view NEOM as a prototype for planetary urbanism, an exportable model designed to test the limits of what is technologically and ecologically possible. Yet, as the analysis has shown, the validity of this paradigm rests heavily on the project's ability to navigate the friction between algorithmic optimisation and organic social complexity. Having established the internal strategic and operational visions of NEOM, it is now necessary to situate these findings within a broader critical framework. Consequently chapter 7 draws together the findings of the study to answer the research question, reflect on the contributions and limitations of the research, and consider the wider implications of NEOM's planning model for future smart sustainable city development.

Chapter 7: Conclusion

Introduction

This concluding chapter synthesises the aims and key findings of the research. In doing so, it outlines the practical and theoretical implications of the findings, particularly regarding urban governance, policy planning, geopolitical factors, and the adaptability of global best practices in non-Western contexts. The chapter also addresses the limitations encountered during the research process, including methodological, temporal, and contextual constraints, which inevitably shape the interpretive scope of the conclusions. Finally, it closes with a set of forward-looking recommendations for future research, emphasising the need for longitudinal, comparative, and interdisciplinary studies as NEOM continues to evolve from speculative ambition to on-ground reality.

7.1. Research Aims and Main Findings

This thesis has been guided by seven interlinked aims, each designed to explore a specific facet of NEOM's planning, design, and strategic geographic, political, social, and environmental positioning as a smart sustainable city. Together, these aims contributed to a comprehensive understanding of whether, and to what extent, NEOM can be considered a global paradigm for future urbanism. Each aim is revisited below, drawing out the key points and arguments derived from the findings of the empirical analysis and analytical reflection.

1. Aim 1: To understand the motivations for building NEOM.

The first aim of the research was to understand the motivations behind building NEOM, and the findings reveal a complex convergence of economic, geopolitical, and strategic drivers. At its core, NEOM emerges as a flagship initiative of Saudi Arabia's Vision 2030, designed to shift the Kingdom from an oil-dependent economy toward a diversified, innovation-led future. Both interview insights and planning documents indicate that NEOM is intended as a catalyst for structural transformation through attracting foreign investment, fostering high-tech industries, and creating new employment opportunities.

These economic goals are closely linked to broader political ambitions, positioning Saudi Arabia as a global leader in technological innovation and urban sustainability, while experimenting with distinctive and unconventional models of development. NEOM also seeks to address mounting urban pressures in existing cities such as Riyadh and Jeddah, offering a strategic alternative to issues of overcrowding, rising population density, and infrastructural strain.

Moreover, its strategic location along the Red Sea aims to leverage international trade routes and strengthen global connectivity, reinforcing NEOM's role in regional and global urban development. Aligned with international priorities such as the SDGs and climate action agendas, the project also carries a clear geopolitical message, signalling Saudi Arabia's readiness to shape the future of global urbanism. In this light, NEOM represents not merely a new city but a deliberate rebranding of national identity, marking a decisive break from the past and advancing a vision of a future-ready, knowledge-based society.

2. Aim 2: To identify existing sustainable smart city initiatives for best practices between cities.

The literature review conducted for this study found that globally recognised smart city initiatives, for example, in Singapore, Songdo, Masdar, Barcelona, Amsterdam, and Curitiba, offer a diverse yet complementary set of best practices that inform the evolving paradigm of smart sustainable urbanism and, through comparison with its stated aims and the secondary data from this research. These cities illustrate how digital infrastructure, environmental ambition, and governance models intersect in varied configurations, depending on context and intent. In particular, Singapore exemplifies a highly centralised and integrated model, where state-led digital systems support efficient service delivery and long-term planning. In contrast, Barcelona and Amsterdam champion participatory governance, open data ecosystems, and citizen co-production, offering a more democratic and socially inclusive approach to smart innovation.

Greenfield developments like Songdo and Masdar provide important lessons on the limits of technocratic planning. While Songdo demonstrates excellence in sensor-driven infrastructure and automated systems, it also reveals challenges related to liveability and community engagement. Masdar, though celebrated for its carbon-neutral vision and circular economy principles, has faced issues around implementation scale and user

adaptation. Curitiba, often overlooked in high-tech narratives, contributes an essential counterpoint, emphasising low-tech, high-impact innovations in transport and urban management that align with sustainability goals through pragmatic governance and social inclusion.

Overall, the study concludes that best practices across these cities include the integration of ICT with sustainability objectives, inclusive governance frameworks, data-driven but human-centred services, and strategic long-term vision. These cases do not offer templates to replicate but rather serve as comparative reference points for assessing NEOM's development. By engaging with these diverse models, the thesis establishes a foundational baseline for evaluating how NEOM aligns with, adapts from, or diverges from existing global paradigms of smart and sustainable urbanism.

3. Aim 3: To ascertain how the conception and planning of NEOM is a product of learned best practices from extant sustainable smart city initiatives.

This research set out to explore the extent to which NEOM's planning draws upon lessons from existing smart sustainable city models. The findings demonstrate that NEOM is not emerging in isolation but rather as a product of global urban learning, an intentional effort to synthesise best practices from internationally recognised cities and adapt them to the unique environmental, cultural, and economic context of north-western Saudi Arabia.

As in Copenhagen, Singapore, Barcelona, and Amsterdam. The emergence in the interview data of these particular cities from the many effective smart city examples evidenced in the literature review is notable in terms of the areas they highlight as being of significance for the internal stakeholders. These cities were repeatedly referenced across interviews as benchmarks for specific aspects of smart and sustainable urbanism. For example, Copenhagen's commitment to carbon neutrality, bicycle infrastructure, and open data platforms has strongly influenced NEOM's approach to non-motorised transport, urban greenery, and digital transparency. However, rather than replicating Copenhagen's model, NEOM has adapted these strategies to suit its arid climate and desert ecology, introducing innovations such as smart irrigation systems, vertical gardens, and adaptive shading.

Singapore's influence is particularly evident in NEOM's land use strategy. The constitutional decision to preserve 95% of NEOM's natural territory resonates closely with

Singapore's model of ecological preservation amidst urban growth. Singapore's success in real-time environmental monitoring, through digital twins, sensor networks, and AI-enabled systems, has also informed NEOM's cognitive infrastructure and environmental governance frameworks. Barcelona provided a further layer of insight, particularly in terms of pedestrian-oriented design and micromobility. The city's celebrated superblock model, which reclaims street space for public life and drastically reduces car traffic, inspired NEOM's ambition to create walkable, human-centric districts. Interviewees described how this approach aligns with NEOM's goal of promoting active transportation and designing for liveability, with the added integration of smart mobility technologies and AI optimisation.

Amsterdam's progressive modal shift, from car-centric planning to a multimodal transportation system prioritising cycling and public transit, served as yet another key point of reference. NEOM draws on Amsterdam's infrastructure strategies and collaborative innovation ecosystem, particularly in its Oxagon industrial zone, which aims to embed sustainable transport, green industry, and stakeholder-led co-creation from the outset. Additional references to Curitiba, Masdar, and several UK cities offered insights into integrated transit systems, carbon neutrality ambitions, and the risks of fragmented service delivery. These comparative cases were not treated as templates but as cautionary and inspirational reference points, affirming NEOM's commitment to learn globally while acting locally.

What emerges clearly from the findings is that NEOM is conceived, in McFarlane's (2011a) terms, as a learning city, absorbing trans-local knowledge but filtering it through local imperatives, and experimenting with hybrid strategies that push beyond existing models. Rather than merely mimicking global pioneers, NEOM aspires to synthesise and scale best practices, using its greenfield status to test advanced technological, environmental, and spatial configurations from the ground up.

In summary, NEOM is undeniably a product of transnational urban knowledge circulation. It has borrowed technologies, planning typologies, and policy logics from leading smart cities around the world. Yet it has also repackaged and rescaled these elements to fit a uniquely ambitious and authoritarian model of urban futurism. This approach highlights both the possibilities and the limits of learning from global best practices. While

NEOM integrates advanced systems thinking and environmental innovation, it does so without replicating the participatory, institutional, and civic frameworks that underpin the success of the cities it emulates. As such, NEOM represents an original but asymmetrical synthesis, simultaneously inspired by and divergent from global urban paradigms.

4. Aim 4: To identify the dimensions of NEOM to specify which attributes are new and potential future best practice.

The study identified a set of core dimensions, or thematic pillars, that define NEOM's approach, many of which parallel classic smart city domains while introducing novel elements. According to NEOM's planning documents, the city is structured around 15 key sectors encompassing energy, water, mobility, biotechnology, food, manufacturing, culture, tourism, health, education, technology and digital, liveability, and more. These broadly correspond to recognised dimensions of smart and sustainable cities (as in Boyd Cohen's Smart City Wheel model or similar frameworks), indicating that NEOM's foundation is comprehensive. However, the research found that certain attributes of NEOM push beyond current best practices, potentially setting new benchmarks. The BCSCW was employed as an evaluative lens to ensure NEOM addresses all key dimensions of smart urbanism (economy, governance, environment, mobility, living and People). The thesis findings indicate that many of these align closely with recognised smart city frameworks, confirming that NEOM draws heavily on global theoretical frameworks in areas like governance, mobility, sustainability, and innovation. Using BCSWM as a reference point, the study found that NEOM's sectoral pillars demonstrate a holistic attempt to address all major domains of smart and sustainable urbanism and surpass them with NEOM's 'cognitive' dimension. This cognitive augmentation transforms the smart city from a system of digital services into an adaptive, AI-driven, and continuously learning urban ecosystem, as follows:

- **Cognitive Economy:** NEOM incorporates predictive analytics, autonomous logistics, and digital twin economies, particularly within Oxagon, enabling real-time optimisation of economic performance. Here, the economy becomes self-regulating, data-informed, and anticipatory.
- **Cognitive Environment:** AI-powered ecological monitoring systems and digital twins of NEOM's natural terrain support continuous environmental feedback loops.

The city's capacity to measure, model, and predict ecological change marks a significant evolution in environmental governance.

- **Cognitive Governance:** NEOM's proposed 'cognitive operating system' integrates decision-making across domains using AI and real-time citizen feedback. Governance shifts from reactive policymaking to proactive, data-driven management that evolves in synchronisation with urban behaviours and needs.
- **Cognitive Mobility:** The elimination of cars and the design of a walkable, linear city is supported by AI-managed transit, dynamic routing, and predictive mobility systems. This approach not only optimises flow and energy use but also transforms urban spatiality through real-time adaptability.
- **Cognitive People:** Through personalised learning environments, participatory data platforms, and behavioural analytics, NEOM fosters a citizenry that is both shaped by and shapes the city's cognitive infrastructure. This feedback-rich ecosystem elevates residents from users to co-creators.
- **Cognitive Living:** Smart homes, adaptive infrastructure, and digital health monitoring systems create living environments that respond to individuals' needs in real time, enhancing well-being through ambient intelligence and predictive service delivery.

This move to be not just a 'smart' city but a 'cognitive' city across all dimensions, from energy and digital infrastructure to health, education, and culture, is striking. The alignment with the BCSCW core aspects of an effective smart city indicated that NEOM is not being planned in isolation from global thinking but is intentionally designed to reflect it. However, what sets NEOM apart is not just its breadth, but the scale and ambition with which these elements are being combined and advanced. The research revealed that NEOM is not content with meeting existing benchmarks; it is attempting to leap several steps ahead. Many aspects of the project, from its push for full renewable energy, AI-led governance, to experimental urban forms, signal a desire to create a new kind of smart city altogether. Interviewees consistently described NEOM as a living laboratory, where bold ideas can be tested and scaled in ways that existing cities may not be able or willing to attempt.

This approach presents both opportunities and challenges. On one hand, NEOM's innovations could redefine what is possible in urban design, governance, and sustainability, if successful. On the contrary, the lack of precedent means that many of these systems

remain unproven and any unanticipated shortfalls will be difficult to solve. The city's extreme level of integration, its reliance on technology, and its highly centralised decision-making model all depart from conventional planning norms. While these features may enable efficiency and coherence, they also raise questions about adaptability, inclusiveness, and long-term resilience. NEOM's planning vision sits at the intersection of imitation and invention. It builds on familiar smart city principles but amplifies them into something altogether more experimental. Whether this model becomes a blueprint for others will depend not only on its technical success but on how well it delivers a genuinely liveable and inclusive urban experience and lifestyle.

5. Aim 5: To determine what planning strategies and approaches have been adopted by NEOM to integrate smart technologies and sustainability.

The research demonstrates that NEOM's planning strategies are defined by a high degree of integration between technological innovation and environmental sustainability. Rather than pursuing these as separate or parallel objectives, NEOM adopts an integrated smart-sustainable approach, wherein every major technological deployment is explicitly coupled with sustainability goals. This strategic integration is visible across multiple domains of NEOM's planning, most notably in its flagship project, The Line.

A central concept driving NEOM's model is what this study terms AI Urbanism, a paradigm in which cognitive infrastructure, modular AI systems, and real-time data analytics are embedded throughout the urban environment. These technologies are designed not as standalone features but as part of a unified system for ecological optimisation, enabling continuous monitoring and adaptive management of energy, mobility, waste, and resource flows. Planning documents and interview data confirmed that NEOM is developing a 'cognitive operating system'; a city-wide digital platform that uses machine learning to harmonise data streams from across sectors to enhance performance, efficiency, and resilience.

The Line, in particular, exemplifies this approach through its ultra-dense, linear urban form, which challenges conventional urban models. Designed to eliminate cars and reduce carbon emissions, it promotes compactness, walkability, and transit-based mobility, including high-speed underground rail. The strategic objective to preserve 95% of NEOM's natural surroundings by concentrating development within a narrow footprint reflects a rare

alignment between land-use planning and environmental conservation. While these ambitions are forward-looking, the model remains untested at scale and raises important questions about liveability, adaptability, and social cohesion in a tightly regulated urban environment.

NEOM's broader planning strategies reinforce this integrated model. Massive investments in renewable infrastructure, including solar and wind energy, green hydrogen production, and smart grids, are complemented by circular systems for water, waste, and materials management. These include advanced desalination and recycling technologies, echoing the ambitions of earlier initiatives like Masdar but executed at a much greater scale. The industrial zone of Oxagon illustrates another dimension of innovation through modular floating platforms and global partnerships aimed at advancing green manufacturing and clean technologies.

On the digital front, ubiquitous computing is embedded throughout NEOM's design, with sensors in infrastructure, AI in governance, and automation in logistics and mobility. These elements are oriented toward maximising sustainability metrics, such as emissions reduction and adaptive energy use, in real time. Importantly, NEOM's strategy is not solely state-led; it is underpinned by public-private partnerships and global collaborations to ensure access to frontier technologies and expertise. One of the key operational tools in this cognitive model is the digital twin; a continuously updated virtual model of the city that allows planners to simulate urban scenarios, optimise energy flows, and anticipate environmental pressures. This anticipatory planning paradigm enables NEOM to test and refine infrastructural interventions before implementation, significantly reducing the risks of retrofitting which is common in legacy cities. The interviews reveal that this capacity is seen internally as transformative, enabling proactive rather than reactive governance.

In sum, NEOM's planning approach represents a tightly woven synthesis of smart urbanism and environmental stewardship. Its integrated strategies, from AI-based management systems to regenerative design and land preservation, reflect an ambitious attempt to transcend siloed thinking and produce a city that is both a technological prototype and an ecological benchmark. Whether this model can succeed in practice, particularly in the extreme environmental and political context of northwestern Saudi Arabia, remains to

be seen. Yet, if successful, it could serve as a paradigmatic shift in smart sustainable city thinking, moving beyond efficiency toward holistic, adaptive urban ecosystems.

6. Aim 6: To understand how the linear urban form serves to animate The Line City as a sustainable smart city development.

One of the most radical interventions NEOM introduces to contemporary urbanism is its conceptualisation and implementation of Zero Gravity Urbanism, a vertically layered, high-density model that reconceptualises proximity, accessibility, and environmental stewardship. This research finds that The Line, NEOM's flagship development, operationalises this model through a linear megastructure. The project's form disrupts the dominant paradigm of horizontal urban expansion, replacing it with a compressed, synchronised urban logic aimed at maximising efficiency and minimising environmental impact. This layout enables all essential services to be accessed within a five-minute walk, removing the need for personal vehicles and reclaiming ground-level space for ecological preservation. If realised as planned, The Line could represent a new benchmark for compact, transit-oriented urban development.

The findings also suggest that The Line's innovation lies not only in its physical form, but in its capacity to reorganise urban social life. By combining vertical density with real-time, AI-enhanced mobility systems, the project aims to foster new forms of social proximity, cohesion, and hyper-connectivity. Cognitive infrastructures, including underground transit, high-speed elevators, and digital governance platforms, are intended to enable seamless flows of people, goods, and information. In theory, this model could accommodate over nine million residents while upholding rigorous standards of sustainability and human wellbeing.

Yet, the study also reveals significant tensions and unresolved questions. While The Line's uniformity and efficiency offer sustainability advantages, its unprecedented density and controlled structure raise concerns regarding social diversity, psychological wellbeing, and long-term adaptability. Experts interviewed for this research highlighted the potential risks of over-programmed verticality, including the loss of organic spatial practices, diminished civic identity, and challenges in fostering informal community life; factors long considered vital to resilient urban environments.

The Line emerged throughout this research as perhaps the most striking and controversial embodiment of NEOM's broader vision. It was found to reflect a bold attempt at reimagining how cities can be organised, focusing on compactness, walkability, and environmental preservation in ways that challenge traditional methods of urban planning. In theory, it represents a deliberate move away from sprawl and car dependency, aiming to integrate mobility, density, and sustainability into a single, unified system. Yet while its ambition is clear, the challenges it presents are clearer. The findings revealed ongoing tensions between its futuristic design and the realities of everyday urban life. What stands out most is how The Line encapsulates both NEOM's promise and its uncertainty. It is a clear symbol of innovation, but also a reminder that radical design must be grounded in lived human experience. As such, it serves as a critical test for NEOM's paradigm: whether it can truly redefine urban sustainability, or whether it will remain a speculative vision disconnected from the complexities of real urban life.

Analysis from an exhibition in Riyadh that brought together all the collaborative designs for the city and of data from stakeholder interviews further reinforced the project's global ambition, revealing a concerted effort by twelve leading architectural studios during the initial design phase. Their concepts emphasised modularity, ecological integration, and embedded technologies. Fuksas's coral-inspired urban landscapes, UNStudio's vertically walkable city, and Morphosis's carved morphological strategies collectively reflected a shared vision: that technological innovation, spatial efficiency, and ecological harmony must be mutually reinforcing.

Importantly, NEOM's phased implementation strategy adds operational credibility to its visionary narrative. Phase 1, currently underway, includes three 800-metre urban modules and a 2.4-km hidden marina. With over 120 foundation piles being cast weekly and technical oversight from engineering firms such as DMAA, Gensler, and Mott MacDonald, NEOM is actively transitioning from speculative ideal to engineered reality.

In conclusion, The Line represents both the most ambitious embodiment of NEOM's smart-sustainable aspirations and a pivotal test of its paradigm. Its vertical organisation, Zero Gravity Urbanism, is not merely a design tactic but a strategic reconfiguration of urban space, where density meets accessibility, and innovation serves sustainability. As this research has shown, The Line's success or failure will significantly influence future

discourse on whether smart cities can genuinely reconcile technological, ecological, and human imperatives within radically new spatial frameworks.

7. Aim 7: What lessons does NEOM have for future smart city developments to enhance their planning and design of sustainable and urban environments?

This final research aim considered the wider implications of NEOM's planning strategies for global smart city practices, particularly the potential lessons it offers for the planning and design of future sustainable urban environments. Drawing on extensive expert interviews, internal planning documents, and comparative analysis, the findings suggest that NEOM provides not only a bold reimagination of urban form and governance but also critical insights, both exemplary and cautionary, for future smart city initiatives.

A key lesson lies in NEOM's ability to advance an integrated urbanism, where digital infrastructure, ecological stewardship, and spatial planning are woven into a single vision. Unlike many smart city prototypes that pursue technological and environmental goals as parallel tracks, NEOM conceptualises technology and sustainability as mutually reinforcing. The city's deployment of AI governance systems, renewable energy platforms, and cognitive infrastructure is not just for efficiency but is explicitly designed to serve broader sustainability objectives, such as reducing emissions, conserving land, and enabling adaptive energy management. This suggests that future cities should move beyond fragmented or siloed planning toward interdisciplinary and systems-based approaches.

Second, NEOM's radical urban morphology, especially The Line's linear form and Zero Gravity Urbanism, reflects a significant shift in how planners conceptualise spatial relationships. The compression of urban life into a walkable, car-free corridor that prioritises vertical integration demonstrates how future cities might reconcile high density with ecological sensitivity. While ambitious, this model could inform transit-oriented development and land-use policy in regions facing urban sprawl and ecological degradation.

Third, the cognitive layer of NEOM's planning stands out. By embedding digital twins, real-time data flows, and AI-enhanced management systems across all dimensions of urban life, from energy and water to mobility and citizen services, NEOM transcends the traditional 'smart city' model. It introduces the concept of the cognitive city, one that not only collects and responds to data but evolves dynamically through machine learning and

predictive analytics. This model, though untested at scale, encourages future urban developments to think beyond automation toward adaptive, learning-based governance systems. However, the findings also caution that such cognitive infrastructure demands robust ethical frameworks, especially around surveillance, privacy, and algorithmic accountability.

Importantly, this research also highlighted the significance of global-local hybridity. NEOM's planning integrates global expertise from world-class architectural and engineering firms while tailoring solutions to the regional context of Saudi Arabia's Vision 2030. This alignment between global best practices and national strategic agendas underscores the value of context-sensitive innovation. Future cities should learn from NEOM's capacity to mobilise global networks while maintaining cultural and geographic specificity.

Nevertheless, the study also identifies significant risks. NEOM's top-down governance model, rapid implementation timelines, and reliance on techno-optimism raise questions about inclusivity, adaptability, and long-term resilience. While the ambition to significantly advance urban development through greenfield innovation is commendable, participatory planning, social equity, and informal urban dynamics appear less prioritised in NEOM's current framework. In the thesis, a major challenge that was emphasised was the tension between sustainability goals, or full sustainability via technology, and the potential environmental costs in the very construction, needs of the AI systems, and risks to location. This presents a crucial lesson: that even the most technologically advanced cities must be grounded in human-scale values and democratic processes to ensure legitimacy and inclusiveness.

In sum, NEOM offers future smart cities a number of transformative lessons. It demonstrates the potential of integrating smart technologies with sustainability goals through a systems-based approach. It introduces new paradigms of urban form and cognition that challenge conventional planning logics. It also exemplifies how national ambition can drive large-scale innovation in urban governance and design. At the same time, NEOM reminds us that technological innovation must be complemented by social innovation, ensuring that smart cities remain not only efficient and resilient but also just, liveable, and responsive to the complexities of real human life.

7.2. Contributions of the Research

This thesis makes a series of significant contributions to the academic literature on smart cities, sustainable urbanism, and urban geography, using NEOM as both an empirical and conceptual case study of unprecedented scale and ambition. NEOM is a city where cutting-edge technology, sustainability principles, and economic diversification strategy converge within a single state-led megaproject. Unlike incremental smart city transformations in existing urban contexts, NEOM represents one of the few globally visible attempts to construct a smart sustainable city entirely from the ground up, embedding its technological and environmental paradigms from the outset. Through a focused analysis of NEOM as a paradigmatic and experimental urban prototype, this research offers a set of original contributions that are both empirical and theoretical, with broader implications for the understanding of cognitive urbanism, global best practices, and regionally adapted innovation globally.

Firstly, this study represents one of the earliest comprehensive academic investigations into the planning, development, and paradigmatic potential of NEOM as a smart sustainable city within the framework of Saudi Arabia's Vision 2030. While much of the discussion surrounding NEOM has been speculative or promotional, this research offers an empirically grounded and theoretically informed analysis. In doing so, it establishes the foundation for future academic inquiry into the unique urban, environmental, technological, and socio-political dimensions of NEOM and similar large-scale greenfield smart city projects in the Middle East.

Secondly, this study presents a literature review of global smart city initiatives, with in-depth analyses of 14 key case studies such as Singapore, Songdo, Masdar, Amsterdam, and Barcelona. Importantly, the review also traces the evolution of smart city discourses, from early technocentric models to more holistic, citizen- and sustainability-focused frameworks, highlighting critical debates around surveillance, data ethics, inclusivity, and environmental resilience. This enables the research to situate NEOM within a broader intellectual trajectory and to identify where NEOM extends, replicates, or deviates from established global practices.

Thirdly, this research provides a novel empirical database derived from 39 semi-structured expert interviews with NEOM's internal planners, consultants, and external urban professionals. This dataset facilitates a critical assessment of how NEOM's planning incorporates global best practices, pushes technological boundaries (e.g., AI urbanism, digital twins, green hydrogen), and adapts to its regional context. It delivers actionable insights for decision-makers regarding strategic urban planning, sustainable development, and governance reform.

Fourthly, this study contributes to the academic literature by applying and extending existing smart city evaluation frameworks, especially BCSCW, to a non-Western, greenfield megaproject. It proposes an adaptation of the BCSCW model that includes a 'Cognitive dimension', reflecting NEOM's ambition to implement anticipatory, AI-driven urban systems. This theoretical innovation enables a more nuanced understanding of how emerging cities can exceed or diverge from conventional smart city criteria.

Fifthly, the thesis offers a dual contribution to urban geography and spatial innovation, as well as to the practical understanding of megaproject planning under uncertainty. NEOM's unique spatial morphology, epitomised by The Line, a 170-km linear city with a car-free, vertically stacked, modular design, challenges traditional urban geography by rejecting horizontal expansion, embracing ecological limits, and positioning itself as a post-spatial prototype. NEOM also functions as a space of exception, governed by special legal and economic regimes and situated at the tri-border region of northwestern Saudi Arabia. These characteristics make NEOM a valuable case for understanding territorial experimentation, post-national urbanism, and competitive city-making within global urban networks.

Simultaneously, the research captures valuable real-time lessons from the early implementation stage, including phased construction adjustments, scope revisions, delays, and geopolitical shifts. These insights highlight the dynamic and adaptive nature of planning at this scale, revealing the gap between visionary rhetoric and material delivery. NEOM thus becomes both a living laboratory and a cautionary case, offering nuanced guidance for policymakers, scholars, and planners working on future-oriented smart cities in complex political, economic, and environmental contexts.

Finally, this research contributes an analytical and reflective lens to the ongoing global discourse on the future of cities and urban life, positioning NEOM not only as a case of urban innovation but also as a paradigmatic testbed that challenges prevailing assumptions about smart and sustainable urbanism. It underscores how NEOM blurs the boundaries between urban planning and geopolitical ambition, technological experimentation and nation branding, and environmental vision and socio-economic exclusivity. As such, the study enriches theoretical debates by illustrating what happens when smart city ideals are taken to their radical extreme, offering both promise and challenge.

In sum, these contributions help reframe prevailing assumptions in smart city, sustainability, and urban geography scholarship by positioning NEOM as both a radical departure from conventional urban models and a conceptual frontier for future city-making. Rather than merely extending existing frameworks, this research interrogates their limits, highlighting how projects like NEOM require scholars and practitioners to reconsider definitions of success, legitimacy, and sustainability in an age of rapid technological change, environmental urgency, and geopolitical ambition. By analytically engaging with NEOM's ambitions, spatial innovations, governance structures, and implementation realities, this thesis not only advances theoretical understanding but also offers practical insights for designing, evaluating, and governing next-generation urban environments.

7.3. Implications for Policy and Direction for Future Studies

7.3.1. Implications for Policy and Practice

The findings of this research carry several significant implications for policymakers, urban planners, and strategic leaders involved in the development of NEOM and similar smart and sustainable city initiatives, particularly within gulf states and Middle East and North Africa regions pursuing post-oil urban futures. Drawing on the NEOM case study, this section outlines key insights related to regulatory design, governance, risk management, and international policy transfer.

First, NEOM demonstrates the importance of establishing a comprehensive, adaptive, and future-oriented regulatory framework at the inception of large-scale urban projects. While NEOM has benefited from strong top-down political support and a special governance regime, its continued momentum relies on targeted regulatory mechanisms, such as policies promoting renewable energy, incentivising high-tech investment, and guiding environmental conservation. For Saudi Arabia and comparable contexts, this implies the necessity of embedding sustainability criteria, innovation incentives, and interdepartmental coordination mechanisms from the earliest planning stages. However, as this research emphasises, policy frameworks must be context-sensitive; while NEOM's legal and institutional architecture may offer reference points, it should not be replicated wholesale. Instead, transferable principles include early integration of environmental and technological goals, creation of legal sandboxes as safe regulatory spaces for urban experimentation, and establishment of flexible governance instruments capable of evolving with new data and realities.

Second, the research underscores a fundamental tension between rapid implementation and inclusive governance. NEOM's highly centralised planning model has enabled rapid mobilisation of resources, land, and expertise. However, this approach raises critical questions about transparency, accountability, and citizen participation. In pluralistic or democratic settings, NEOM's model may appear at odds with participatory planning ideals. The key implication is that future smart city initiatives should pursue both efficiency and inclusivity, leveraging stakeholder consultations, public transparency, and feedback mechanisms to ensure long-term legitimacy. Even NEOM, as it transitions from design to inhabitation, may need to institutionalise channels for resident engagement and co-creation to sustain social trust and civic resilience.

Third, from an urban development perspective, NEOM exemplifies how megaprojects can be used as catalysts for national transformation, aligning infrastructure development with broader economic diversification strategies. However, such projects also concentrate risk, economic, ecological, and social, within a single venture. For policymakers, this highlights the importance of robust oversight, continuous risk assessment, and adaptive planning. Lessons from NEOM's evolving implementation, such as the recalibration of The Line's timeline and scale, demonstrate that policy flexibility

should be seen as a strategic asset rather than a sign of failure. Policymakers should establish institutional arrangements to monitor sustainability indicators, track fiscal accountability, and manage social impacts over time.

Fourth, NEOM's development offers insights for international urban policy and global sustainability agendas. If NEOM achieves its ambitious targets, ranging from 100% renewable energy and circular economy integration to climate-responsive architecture and AI-driven governance, it could become a benchmark for future climate-adaptive urban policy. This would influence global dialogues on sustainable urbanisation, including frameworks shaped by entities such as UN-Habitat, the World Bank, or regional development banks. However, even if NEOM fails to fully deliver on its promises, the experimental nature of the project ensures its relevance as a case study of ambition, innovation, and uncovers some of the limits of techno-utopian planning. Either outcome provides vital learning for future cities being planned in ecologically vulnerable or politically ambitious contexts.

Finally, the NEOM case contributes to a recalibrated understanding of policy transfer in smart and sustainable city-making. Its unique mix of ecological foresight, digital innovation, and geopolitical strategy underscores the need for cities and states to engage with NEOM not as a blueprint, but as a conceptual laboratory. The implication is that urban policies drawn from NEOM should be translated not through replication, but through critical interpretation and contextual adaptation, especially regarding urban governance, environmental thresholds, and the ethics of surveillance and automation.

7.3.2. Directions for Future Studies

This thesis represents a foundational academic engagement with the NEOM project, offering an early analytical framework for understanding its ambitions, design logics, and broader implications. Yet, by its very nature, the study is an early-stage intervention into a dynamic project still in motion. As NEOM shifts from conceptualisation to construction and, eventually, to inhabitation, the need for sustained, critical, and interdisciplinary research will only intensify.

One of the most immediate and compelling directions for future inquiry is longitudinal research. NEOM's developmental arc, from blueprints and renderings to physical infrastructure and daily life, presents a rare opportunity to observe a smart sustainable city as it is being built in real time. Tracking the evolution of key components such as The Line's car-free verticality, Oxagon's circular industrial logic, or Trojena's high-altitude environmental design will offer essential insights into the feasibility of such radical urban visions. Longitudinal studies will be vital for testing whether NEOM's ecological, technological, and governance claims translate into measurable outcomes over time.

Another promising avenue lies in comparative smart city research. NEOM does not exist in isolation but emerges within a growing ecosystem of globally imagined cities. Comparative studies between NEOM and established projects like Masdar City, Songdo, or even emergent proposals such as Telosa could help illuminate different development logics such as state-led versus private, greenfield versus retrofitted, or authoritarian versus participatory. These comparative exercises would sharpen our understanding of how governance structures, cultural context, and funding models shape urban innovation and sustainability outcomes. They would also highlight what makes NEOM uniquely situated within the urban imaginary of the Middle East.

While this thesis offered a broad, multi-thematic overview, future studies might delve into more targeted dimensions. There is opportunity for conducting ethnographic research on the labour force building NEOM, interrogating the working conditions, socio-economic stratification, and migration patterns involved. Environmental scientists could focus on NEOM's biodiversity, water stress, and carbon emissions, particularly as the city's footprint expands. Technologists and digital ethicists may examine the city's AI-driven infrastructure and assess the transparency, security, and ethical dilemmas of its data regimes. Likewise, urban designers and human geographers could in the future explore how residents experience The Line's linear spatiality: Does vertical stacking generate a new kind of community, or does it risk alienation and fragmentation?

Simultaneously, researchers must consider the human and lived experience of NEOM as it becomes populated. Who will choose to live in this city, and how will their identities, expectations, and practices shape its evolution? Will NEOM support diverse forms of community life, or will it remain an elite enclave disconnected from broader socio-

cultural realities? These are not only empirical questions but theoretical ones, probing into themes of place-making, identity, and affect in artificially constructed urban environments.

Finally, NEOM's broader impact on global urban discourse and policy warrants close attention. Already, the project has entered the vocabulary of planners, investors, and policymakers across the Middle East and beyond. Whether cited as a model, a provocation, or a cautionary tale, NEOM is influencing how the future of cities is imagined and strategised. Researchers may explore how NEOM's planning logic is adapted, or resisted, in other national contexts, and whether its model of regulatory exceptionalism, technological experimentation, and symbolic architecture gains traction elsewhere.

In sum, NEOM is far more than a blueprint. It is an unfolding process, a site of contestation, and a discursive object that challenges how we think about cities, sustainability, and governance. Future researchers have a rare opportunity to study this project not as a static artefact but as a dynamic and evolving landscape; one that will continue to raise new questions, redefine boundaries, and test the limits of urban possibility in the decades to come.

7.4. Research Limitations

While this study offers substantial insights into NEOM's planning strategies and its paradigmatic potential for future smart sustainable cities, it is equally important to acknowledge the methodological, empirical, and contextual limitations that shape the interpretation of its findings. These limitations do not detract from the research's contribution but provide necessary transparency and underscore areas where caution and reflexivity are warranted.

Firstly, the study's qualitative orientation, centred on semi-structured expert interviews and document analysis, has both strengths and inherent limitations. This methodological approach enabled the collection of rich, context-specific insights from planners, consultants, and strategic actors closely engaged with NEOM and comparable global smart city initiatives. However, as with all interpretive research, there is the potential for researcher bias and subjective framing (Queirós et al., 2017). While efforts were made to triangulate data across multiple sources, including planning documents, academic

literature, and critical media reports, the interpretive nature of qualitative analysis necessitates a degree of caution in generalising the findings.

Secondly, the selection of interview participants introduces a degree of selection bias (Chenail, 2011). The research focused on elite and institutional actors with privileged access to NEOM's strategic and technical planning processes. While this provided valuable insight into top-down perspectives and project rationale, it also meant that grassroots voices, community stakeholders, and civil society actors were largely absent. This exclusion is partially structural: NEOM, at the time of writing, remains under construction with no permanent population. Nonetheless, the absence of public or dissenting perspectives limits the study's ability to assess NEOM's social legitimacy, distributive impacts, or the lived experience of those who may one day inhabit the city or be affected by its regional footprint.

Thirdly, data availability and transparency posed significant challenges. Detailed technical data on NEOM's planning and governance structures, as well as comparable data from cities such as Songdo, Masdar, or Singapore, were at times obscured by commercial confidentiality, proprietary restrictions, or fragmented public communications. Although a wide range of secondary literature, grey documents, and public policy materials were analysed, much of the granular and internal decision-making data, particularly on feasibility reviews, budget allocations, and implementation constraints, remained inaccessible. This constrains the extent to which this study could fully evaluate how NEOM's design reflects or diverges from established global best practices.

A fourth and major limitation is temporal. NEOM is a fluid and evolving megaproject. Throughout the research (2022–2025), significant revisions occurred in leadership structures, project phasing, and architectural designs, most notably in The Line. Consequently, this thesis captures a snapshot in time: the findings reflect the project's status up to mid-2025. Given NEOM's dynamic development trajectory, some conclusions, particularly those concerning implementation feasibility or anticipated societal impact, may become outdated or require revision. This underscores the importance of longitudinal research that can assess NEOM's outcomes over time and evaluate whether its ambitions are met, reconfigured, or abandoned.

Lastly, practical and political constraints affected the possibility of conducting field-based empirical observation. Due to the sensitive political environment, NEOM's status as

a closed construction site, and limitations on foreign researcher access, it was not possible to undertake ethnographic fieldwork or environmental site assessments. As a result, the study relied on publicly available imagery, corporate press releases, and third-party accounts. The absence of on-ground verification limited the researcher's ability to observe informal dynamics, assess environmental impacts, or engage with affected communities in the Tabuk region.

In sum, the limitations of this research fall into four interconnected categories:

1. **Methodological** – the interpretive nature of qualitative research and reliance on elite perspectives.
2. **Data-related** – limited access to proprietary planning materials and restricted media coverage.
3. **Temporal** – the rapidly evolving status of NEOM as an ongoing experiment.
4. **Practical** – barriers to field access, direct observation, and grassroots engagement.

These limitations are not unusual for research focused on large-scale, high-profile, and state-led urban projects, particularly in closed governance contexts. Indeed, they reflect the broader condition of studying “speculative urbanism” (Sood, 2019, p. 1) and future-oriented planning imaginaries (Gunder & Hillier, 2009), where cities are conceived as aspirational prototypes rather than empirically settled realities. NEOM, as a city yet to be fully realised, sits at the intersection of vision, experimentation, and uncertainty. Therefore, the findings presented in this thesis should be read as provisional yet meaningful contributions to the evolving discourse on smart and sustainable urbanism. Future research, especially when on-the-ground access becomes viable, will be essential to validate, challenge, and extend the insights developed in this study. NEOM's transition from blueprint to lived reality will provide new empirical ground from which many of these current knowledge gaps can be addressed.

7.5. Coda

NEOM stands as a bold narrative about the future of cities, a narrative written in glass, steel, and silicon in the deserts of northwest Arabia. It is, at once, a utopian dream and a complex

reality. This thesis has traced NEOM's trajectory from conceptual inception to early-stage implementation, interrogating how it embodies some of humanity's most ambitious aspirations for sustainable, technologically integrated living, while also reflecting the persistent challenges of governance, environmental resilience, and technological feasibility. In its scale, ambition, and speculative ethos, NEOM represents a paradigmatic shift in how cities are imagined, designed, and promoted in the 21st century.

In closing, NEOM may be read as a parable of contemporary urbanism: a project that illuminates the tensions between innovation and constraint, vision and viability, spectacle and substance. It suggests that building the 'city of the future' involves not only projecting radical possibilities but also confronting the social, environmental, and ethical imperatives of the present. As an unfolding case, NEOM invites continual scholarly engagement with what might be termed 'cities of information', those emergent urban forms that test the boundaries of technological imagination and spatial design, while also surfacing the epistemological limits of control, prediction, and linear planning.

The ultimate legacy of NEOM will not be determined in the pages of master plans or architectural renderings, but in the realities of what is eventually built, inhabited, and governed. It may evolve into a model city that others emulate, or a cautionary tale about the risks of overreach in the age of megaproject urbanism. Most likely, it will reside somewhere between these poles: a hybrid experiment that yields significant breakthroughs while also revealing the structural limits of planning certainty in a volatile, interconnected world.

Either way, NEOM has already fulfilled one essential function: it has catalysed a global dialogue on the possibilities and perils of smart, sustainable, and speculative urban development. It compels scholars, practitioners, and policymakers to grapple more deeply with questions that lie at the heart of 21st-century urban futures: How can cities be intelligent and equitable? How can technological innovation coexist with environmental stewardship? How can ambition be balanced with accountability?

In this sense, NEOM is not an endpoint but a provocation, a living prompt for ongoing inquiry, critical reflection, and transdisciplinary learning. Its unfolding narrative will continue to shape and be shaped by the broader quest to imagine and implement cities that are not only technologically advanced and ecologically sound but also socially just, culturally meaningful, and resilient for generations to come.

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Appendices

Appendix 1: (Participant Consent Form).

Project Title: NEOM – Lining up a new smart city.

Contact Details:

Student Researcher: Abdulaziz Alqasem: Email: [REDACTED] | WhatsApp: [REDACTED]

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Please initial box

1. I () confirm that I have read and understand the information sheet for the above study (dated/...../.....) which is attached to this form. ☐
2. I understand that my participation is voluntary and that I am free to withdraw at any time, without giving any reasons. ☐
3. I understand what my role will be in this research, and all my questions have been answered to my satisfaction. ☐
4. I understand that I am free to ask any questions at any time before and during the study. ☐
5. I have been informed that the information I provide will be safeguarded. ☐
6. I am happy for the information I provide to be used in academic papers and other formal research outputs. ☐
7. I am willing for my information to be audio/video recorded. ☐
8. I have been provided with a copy of the Participant Information. ☐
9. I agree to the researchers processing my personal data in accordance with the aims of the study described in the Participant Information Sheet. ☐

Print name of participant	Signature	Date
Print name of researcher	Signature	Date

This study is being conducted by Swansea University. When complete: Original copy for participant, one copy to be retained by researcher if paper copy.

Thank you for your participation in this study. Your help is very much appreciated

Appendix 2: (Participant Information Sheet)

NEOM – Lining up a new smart city

You are being invited to take part in some research. Before you decide whether or not to participate, it is important for you to understand why the research is being conducted and what it will involve. Please read the following information carefully.

What is the purpose of the research?

We are conducting research for PhD project exploring to what extent can NEOM be considered a paradigm for future sustainable smart city initiatives. The purpose of the study is to understand the motivations for building NEOM city and to discover if NEOM has unique and new dimensions of sustainable smart cities that can inspire other smart sustainable cities. Furthermore, to investigate whether NEOM learns from other smart sustainable cities around the world in trying to design itself as a paradigmatic smart city for the future.

Your participation in this study will take approximately from 30-60 minutes.

Who is carrying out the research?

The data are being collected by Abdulaziz Alqasem, Department of Geography, Science and Engineering, Swansea University.

The research has been approved by the Science and Engineering University Research Ethics Committee.

What happens if I agree to take part?

You will be asked questions about your expertise in smart cities, specifically NEOM, and your role around NEOM planning.

Additionally, we will ask for some background information including your level of education, your age and sex.

Are there any risks associated with taking part?

The research has been approved by the Science and Engineering University Research Ethics Committee. There are no significant risks associated with participation.

Data Protection and Confidentiality

Your data will be processed in accordance with the Data Protection Act 2018 and the General Data Protection Regulation (UK GDPR). All information collected about you will be kept strictly confidential. Your data will only be viewed by the researcher/research team. All electronic data will be stored on a password-protected cloud-based file. Your consent information will be kept separately from your responses to minimise risk in the event of a data breach.

Conducting research overseas

The researchers will abide by local data protection laws when collecting personal data.

What will happen to the information I provide?

An analysis of the information will form part of our report at the end of the study and may be presented to interested parties and published in scientific journals.

Is participation voluntary and what if I wish to later withdraw?

Your participation is entirely voluntary – you do not have to participate if you do not want to. If you decide to participate, but later wish to withdraw from the study, then you are free to withdraw at any time, without giving a reason and without penalty Data Protection Privacy Notice. The data controller for this project will be Swansea University. The University Data Protection Officer provides oversight of university activities involving the processing of personal data and can be contacted at the Vice Chancellors Office.

Data Protection Privacy Notice

The data controller for this project will be Swansea University. The University Data Protection Officer provides oversight of university activities involving the processing of personal data and can be contacted at the Vice Chancellors Office. Your personal data will be processed for the purposes outlined in this information sheet. Standard ethical procedures will involve you providing your consent to participate in this study by completing the consent form that has been provided to you. The legal basis that we will rely on to process your personal data will be processing is necessary for the performance of a task carried out in the public interest. This public interest justification is approved by the Faculty Research Ethics Committee, Swansea University. The legal basis that we will rely on to process special categories of data will be processing is necessary for archiving purposes in the public interest, scientific or historical research purposes or statistical purposes.

How long will your information be held?

Data will be preserved and accessible **for a minimum of 10 years after completion of the research**. Records from studies with major health, clinical, social, environmental or heritage importance, novel intervention, or studies which are on-going or controversial should be retained for at least 20 years after completion of the study. It may be appropriate to keep such study data permanently within the university, a national collection, or as required by the funder's data policy.

What are your rights?

You have a right to access your personal information, to object to the processing of your personal information, to rectify, to erase, to restrict and to port your personal information. Please visit the University Data Protection webpages for further information in relation to your rights.

Any requests or objections should be made in writing to the University Data Protection Officer:-

University Compliance Officer (FOI/DP)
Vice-Chancellor's Office
Swansea University
Singleton Park
Swansea
SA2 8PP
Email: dataprotection@swansea.ac.uk

How to make a complaint

If you are unhappy with the way in which your personal data has been processed, you may in the first instance contact the University Data Protection Officer using the contact details above.

If you remain dissatisfied, then you have the right to apply directly to the Information Commissioner for a decision. The Information Commissioner can be contacted at: -

Information Commissioner's Office,
Wycliffe House,
Water Lane,

Wilmslow,
Cheshire,
SK9 5AF
www.ico.org.uk

What if I have other questions?

If you have further questions about this study, please do not hesitate to contact us:

Abdulaziz Alqasem
Department of Geography
Science and Engineering
Swansea University
[REDACTED]

Associate Professor Richard Smith
Department of Geography
Science and Engineering
Swansea University
[REDACTED]

Appendix 3: (Research Ethics Approval).



Swansea University
Prifysgol Abertawe

Approval Date: 25/07/2023

Research Ethics Approval Number: 1 2023 7226 5995

Thank you for completing a research ethics application for ethical approval and submitting the required documentation via the online platform.

Project Title NEOM – Lining up a new smart city
Applicant name MR Abdulaziz ALQASEM
Submitted by MR Abdulaziz ALQASEM /
Full application form link <https://swansea.forms.ethicalreviewmanager.com/Project/Index/9007>

The Science and Engineering ethics committee has approved the ethics application, subject to the conditions outlined below:

Approval conditions

1. The approval is based on the information given within the application and the work will be conducted in line with this. It is the responsibility of the applicant to ensure all relevant external and internal regulations, policies and legislations are met.
2. This project may be subject to periodic review by the committee. The approval may be suspended or revoked at any time if there has been a breach of conditions.
3. Any substantial amendments to the approved proposal will be submitted to the ethics committee prior to implementing any such changes.

Specific conditions in respect of this application:

The application has been classified as Low risk to the University.

No additional conditions.

Statement of compliance

The Committee is constituted in accordance with the Governance Arrangements for Research Ethics Committees. It complies with [the guidelines of UKRI](#) and the concordat to support [Research Integrity](#).

Science and Engineering Research and Ethics Chair

Swansea University.

If you have any query regarding this notification, then please contact your research ethics administrator for the faculty.

- For Science and Engineering contact FSE-Ethics@swansea.ac.uk
- For Medicine, Health and Life Science contact FMHLS-Ethics@swansea.ac.uk
- For Humanities and Social Sciences contact FHSS-Ethics@swansea.ac.uk

Appendix 4: (Interview Invitation Email).

Dear [Sample Name],

My name is ABDULAZIZ ALQASEM. I am a PhD student at Swansea University in the UK. My research is funded by The Kingdom of Saudi Arabia (Ministry of Education). I am writing to request a brief interview with you – approximately 30 to 60 minutes in length – because of your role and expertise in the NEOM project.

I am conducting interviews for a PhD project exploring to what extent NEOM can be considered a paradigm for future sustainable smart city initiatives. The purpose of the study is to understand the motivations for building NEOM city and to discover if NEOM has unique and new dimensions of sustainable smart cities that can inspire other smart sustainable cities. Furthermore, my research investigates whether NEOM learns lessons from other smart sustainable cities around the world in designing itself as a ‘model’ smart city for subsequent sustainable smart city initiatives.

The interview will be about NEOM in general and explore themes such as those listed below:

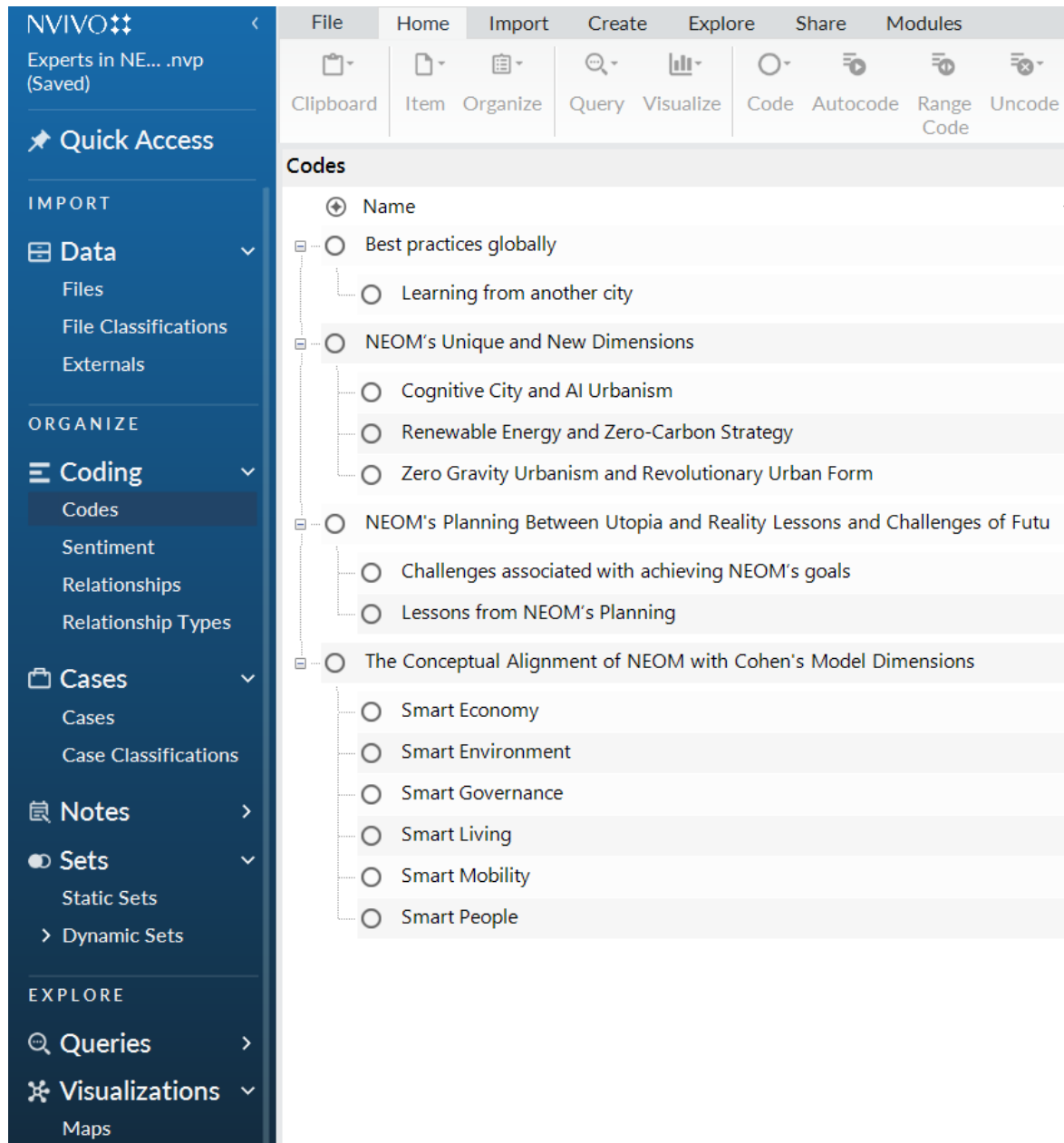
- The motivations for building NEOM smart city.
- How the planning of NEOM has incorporated lessons learned from other smart cities.
- NEOM’s social, economic, and environmental dimensions.
- Best practices and strategies for the successful implementation of smart city initiatives in general.
- What is new about NEOM; how NEOM may be seen as a ‘model’ for future Sustainable Smart City developments.

My preference is to conduct an interview with you in person in Saudi Arabia. Hopefully we can arrange a mutually convenient date for me to visit you. However, if that is not possible, then an interview on Zoom or Teams would also be very helpful because your views and opinions are essential for the evidence base of my PhD study. I do hope you can help me with my University study.

I very much look forward to hearing from you.

Sincerely,
ABDULAZIZ ALQASEM

Appendix 5: (Thematic Coding Framework for Analysing by NVivo).



Appendix 6: (Sample One – Expert Interview Transcript).

Speaker 1(The researcher)

This is a brief overview of my study and the purpose of the research, which explores to what extent NEOM can be regarded as a model for future smart city initiatives. I have several aims here, including discovering whether NEOM possesses unique and novel dimensions as a smart, sustainable city that could inspire other smart cities, as well as investigating whether NEOM learns lessons from other smart cities around the world in designing itself as a paradigm for future smart cities. May I now proceed with the first question, please?

Speaker 2(Mansoor Hanif)

Yeah.

Speaker 1

Mr. Mansour, what common best Practises have you observed in smart sustainable city initiatives globally?

Speaker 2

Well, I think that in terms of best practice, it's more lessons learned that we've seen because I don't think we can consider the smart cities area as a big success at the moment. There have been a lot of attempts, but it has not been as successful as people imagined ten years ago. So, one of the really key things there are two or three things which we think are key to making a smart city into a cognitive city, which is what we're aiming for, which is the next level. First of all, you need to have 100% ultra-reliable connectivity everywhere. And this has been a big issue for smart cities around the world because not many cities have that level of connectivity.

So if you want to go to really make it homogeneous across the whole of the city infrastructure, you need to be sure that the connectivity is ultra-reliable. Now, that's very difficult in most cities where you've got legacy infrastructure and you've got a lot of different landlords and different types of assets, and that makes it very difficult. So we had a good look at that to see how ambitious we could be based on the fact that we are a clean slate and starting from scratch and building the infrastructure as we go. The second area we looked at was data sharing and data privacy. And we've looked at a lot of benchmarks across the world. I think the main ones are in Asia.

There's a lot of interesting work on data in China, in Singapore, in Korea, in Tokyo, but also in Europe, in Copenhagen, for example, and in London in the way they've tried to publish data. So I think in terms of best Practise, one is, number one, we want to publish as much open data as possible in the public interest, and that's to make sure there's easy access to third parties and entrepreneurs and businesses. And if there's no reason not to publish, then we should make sure they have access to that free of charge and they can build cognitive applications on top of that. That's the first thing. So there is also then a class of data which we're looking at the business model for data which is more commercially minded and it's not open data.

And there will be a category of that , for instance, we're looking at the Copenhagen model for that to see how that works. The open data publishing model, I think the best we've seen is in London with the Greater London Authority, and the more commercial minded one, I think is Copenhagen. And then the big issue that we see, I mean, of course in China they've got a very different data regulation strategy and so they're more advanced in certain areas that are more difficult. In Europe, they can go a lot further in terms of automation in many cases because they're using data, because they have different regulations there. But we see that current regulatory frameworks such as GDPR are simply not adapted to maximising smart city capabilities and becoming cognitive simple restrictions, like the fact that you cannot reuse data without asking for consent.

Again, you need to kind of specify all of the use cases up front. So that's quite difficult to optimise smart city services because what you want is to have no silos and be able to capture data and then reuse it as much as possible in the public's interest. To provide the smart services, however, we need to also maintain privacy. So one of the things were very careful of looking at is how we get the balance between data privacy and data sharing, but we go beyond the current blockers so that we can maximise the use of data. And that's how sometimes we say we'd like to use 95% of the data, but still making sure that privacy is maintained. And the third area I would say is on the open architecture and open systems.

I think in the legacy world, when some smart cities started off about ten years ago, they were very much vendor led operating systems and they were closed. At the time, there wasn't so much information about open architecture and open source and open systems. Open source, I know, even like when my days in BT, six, seven years ago, the BT management would laugh at anything open source and say, it's like a virus, it's never going to work and all that. Now open source is adopted by some of the biggest corporations as actually being more secure and more open and more robust. So that's been a big change. So we're dipping into those changes to actually be much more ambitious and go for the full cognitive city.

And I think the other thing about smart cities is that I come from the networks world and I built networks all over the world. And once you have a standard, you need to adapt the way you design a network to the country because you'll have different type of population mix, you might have different type of usages. Some people use more iPhones, some people use more data laptops. So you would obviously do specific engineering, but it's quite easy to get scale across on a global

case and then you have a big ecosystem and you can really scale up the solutions and make them everywhere. In cities, the smart cities are usually linked to the city mayor, the city municipality services, the public services, and the scope of what they need to do is not standardised.

So even in every city in the UK, they don't have the same list of services they do between Birmingham, between London, between Bristol and Cardiff. So that means that the vendors and the ecosystem, the supply chain, they can't really scale up because the market is fragmented, really. And so what we're trying to do here in Neom is use the scale of the line that we're building, making sure it's open architecture, open standards, and that we push and we impose that upfront as we build so that we can actually impose a much better interconnectivity and open architecture to interconnect everything and go full speed on the automation across everything.

Speaker 1

Great. Thank you for answering. Actually, you answered the second question as well, which is, have these best practices influenced the planning of Neom? And you answered already, so great. Thank you, Mr Mansour. So the third question right now, what unique dimensions could you identify in NEOM that could potentially set new standards or become future best practices in smart cities?

Speaker 2

Yeah, I mean, obviously my current role is now on the line. I'm leading the technology for the line. So the line in itself is a total revolution in the way we live and based around vertical living, vertical mobility, sustainability, livability. And I think the reality of the situation of the world today is that we realise that there's a lot of wastage in the way we currently have cities. We spend too much time in traffic jams, we waste a lot of time repeating bureaucratic tasks. And actually, if you look at Dubai, for example, even as Dubai is considered to be quite a developed city, you have this very long road, Sheikh Zayed Road, and then you've got all of these skyscrapers all along it that have been developed over the last 2030 years. But if you want to go from one to the other, you have to go all the way down, go all the way around and then go back up again.

And that's bad enough for transport, but think about synergies across. So sustainability is really about making the best use of resources. And that's heating, that's cooling, it's water provisioning, it's data provisioning, all of that uses up energy and carbon. So all of those are discrete buildings that cannot pool or share. They can never be connected together either, because they're different landlords. So the development model we have here is all about the sustainability and effectively having a single building, city building has a huge impact on your overall carbon footprint. And because effectively, you can balance up the requirements between different assets with these consent of the community to optimise the heating the power, the data by shifting things around through the building. So there's a huge amount of benefits in terms of efficiency and sustainability and livability and the fact that we have no cars as well, making everything easy to reach.

Speaker 1

Awesome. Mr Mansour, so the question number four now, could you explain how the linear urban form is anticipated to enable sustainable and smartness development in the line?

Speaker 2

Yeah, so I've mentioned this already in the past. Well, first of all, it's a linear, but it's a modular linear purpose. So effectively, it's a modular approach that we do by phase and we build out by phase in a consistent way. And then secondly, the underlying connectivity and transport and utility layers are going below and are supported below. So effectively, it's the optimal model for footprint and for sustainability if you have the possibility to build the infrastructure underneath that doesn't get blocked by your development. Because I think cities usually start initially, they started very often, from my perspective, either as squares or as lines. Squares are the old Greek and Roman model with the concrete.

And so that's a defensive it's a defensive outpost where you got the square walls and you got the forum in the middle and that's the model of a lot of cities. Then you've got the straight line approaches for kind of basically the transport links that then grew up to be trading posts along the line and along a road. So those were lines, but because the traffic would get congested because you're going through the city, then they grew out in different ways. But today, if they had the opportunity to have the traffic going below, it would have been much more feasible to have the linear city.

So the shape of the city, the line, has been really optimised to make the use of those capabilities and to reduce the footprint and make sure that we keep 95% of neo free and also to allow for equity of views and visibility by making it more vertical. Because everybody wanted to see the sea, right? But then everybody wants to have a chance to see the mountain as well. We have such a varied landscape that's where the line kind of you could choose where to have your priority area. Is it the line, is it the desert, is it the coast? But then you can easily move from one to the other as well. And with a 500 metre height, you have got lots of opportunity to share the views, make it equitable.

Speaker 1

Yeah. So, Mr Mansour, according to the academic literature, there is the Boyd Cohen model. If you allow me to share my screen, please. Just a minute. Thank you. Yeah. Mr Mansoura, as you have seen here, this is Boyd Cohen model. Based

on your understanding of this model, I was kind of wondering if there I mean, here the left dimension, six dimensions, if there any of these dimensions, is not being done in the Neom planning or you do all of them right now.

Speaker 2

Yeah. So I had a quick look at this when you sent it through and I couldn't see anything we're not doing. So it's very much the only thing is we go beyond smart. We talk about cognitive. And what that means is that it's not just about being reactive, it's about being predictive and making sure that the city uses the indicators to predict your needs rather than just to cater for them in a reactive way. So, yes, we're doing all of these, but we're doing them in a way that's really based on technology and AI so that we can use these KPIs and indicators to change the algorithms and change the city. And the city can learn and adapt to our needs.

Speaker 1

Nice. Could you please order them from the importance for Neom's planning?

Speaker 2

Six there.

Speaker 1

Yeah.

Speaker 2

So we talk more about cognitive elements. But I think, first of all, it's human centric is key. So we do everything about the people. So everything that we develop is putting the human being at the centre and then working around it rather than the other way around. That's why we have no cars, for example, and our technology is there to enhance, but it's invisible. Then I would say smart living. So livability is absolutely critical for us. And as I mentioned, the shape and size of the line is part of that. And we're defining everything we do about being smart, being, let's say, a new standard for livability. Of course, environment sustainability is key to neom. We're working on 100% renewable energy so that I would put that on next.

Smart economy, obviously, it actually follows on from everything else because today's economy is not something that's separate to sustainability and livability and human centric, it's actually spurred by those things. And you can see that the biggest sectors of society globally are those which are linked to increasing sustainability and livability. So a few years ago when we started, people thought you have to make a compromise between being economically viable and environmentally sustainable and technologically advanced. But actually, no. Today all of the investments are going in that direction. So it's actually a magnet for a smart digital economy to be focusing on these factors. So it was very prescient of our chairman, HRH to think in that way. Then, of course, governance, we talk about an invisible government or invisible authority, digital authority, which is all automated.

So in terms of headcount, compared to any other authority city authority in the world, we are like multiple factors below because we are digitising everything and automating everything. And the mobility, of course, is again, a key factor where the principal factor is no cars on the line, so no roads. But we do have a very developed transport network plan which is automated.

Speaker 1

Yeah. So would you like to add new dimensions in this model? I mean, in neom's planning?

Speaker 2

So the dimension, I would say, is going from each of these, going from smart to going to cognitive. Yeah, we do that by moving from being, as I said, reactive to being predictive, maximising the reuse of data in the public interest while safeguarding privacy and making sure that the technology is serving people's real needs. And we see kind of the city as a concierge city, the city itself as a concierge that looks after your needs, that understands you. So rather than a smart city which understands one way data from IoT devices, and then makes a decision based on that, and it understands software, and then if you want to change that algorithm, you have to upgrade. So it's not real time. Everything we want to do is real time.

So the cognitive will it will be two way communication between the sensors and the city and the sensors back to you to double cheque. So the city will say, by the way, we know that Aziz, we know that at 05:00 every day, you normally take this train, but we rerouted you in a different path because there's a delay. But we want to cheque in with you before we do that. Is that okay with you? Is that your plan today?

Speaker 1

Yeah.

Speaker 2

So the systems don't do that today. They like to check it. And I've often found my luggage rerouted when actually I was still able to make my plane, which is very annoying. So it's a big difference. When the city is two-way communication, it's

checking in with you. It wants to understand you as a human rather than the software that is currently described by smart cities.

Speaker 1

Great. So could you please discuss any particular smart solution? Smart infrastructure for living and mobility and environment, what is the future of Neom?

Speaker 2

I mean, I could spend hours on this, but I mean, if you look at the AI, for example. So what we'd like to do is we'd like to move away from so first of all, I think, as I said, the smart cities today are fragmented. What we'd like to do is first build the baseline of the line as taking the smart capabilities of today and putting them everywhere by effectively getting that 100% reliable connectivity, no data silos, maximising data sharing with protection and trust and also getting an open architecture so that all our assets are interconnected through APIs and can be automated. So based on that, you maximise the smart utilities of today. The way I look at it is legacy city utilities where water, energy, waste removal, things like that.

Smart utilities that are only partially available today are Fibre 5G WiFi data to a certain extent, and some software, but they're in silos. But to get to cognitive, we'd like to have this whole generation of new utilities for cities, where the future of cities will be built upon these, and they'll build upon the smart utilities to provide these cognitive capabilities. And those are AI as a service, robotics as a service. Mixed reality as a service, compute as a service, and curated data as a service, quantum protection as a service for security securing data. So these are the way we see things that effectively, we can pipe these are kind of utilities that we pipe through the city and provide all our stakeholders so they can build the future of the cognitive solution. So it's a totally different way of designing and implementing a city.

The other thing that's really exciting is we're building the city as a mixed reality so we can move in and out of immersive worlds and interconnect them. And especially with our spatial anchor system across the city, we can position content, digital content, in the real world in a way that nobody has ever done before. So those are the most exciting things, from my perspective.

Speaker 1

Yeah. The last questions, Mr. Mansour, what key lessons could the future smart city development learn from NEOM's planning?

Speaker 2

Everything, because we're doing things. So our vision, our mission is as an accelerator of human progress. So it's part of our mission to kind of attempt the impossible, be very ambitious, create this whole new way of living, but then share it with the world, make some mistakes as we go and correct them, but share and impact the whole world, not just our population. So it's very much about creating the future and attracting the best minds with that fearless mindset. And so we are building the city for hundreds of years, not for a decade. So we expect that. I think that if we do this right, and certainly taking a lot of learnings along the way, we have the template of how you would create cities for the next two or three centuries.

Speaker 2

Okay, Aziz, I'm going to have to go, I'm afraid.

Speaker 1

Yeah. Thank you. Thank you very much. And as a part of the process, I need your signature and consent form. So I would like to email you later

Sure. Thank you.

Thank you very much for your time.

Appendix 7: (Sample Two – Expert Interview Transcript).

Speaker 1 (The researcher)

What common best practices have you observed in sustainable smart city initiatives globally?

Speaker 2 (Dr Abdullah Almuraiqeb)

Globally, you mean? What lessons have been learned and deployed here at NEOM?

So NEOM, as you know, is presenting itself as a new model for urbanism and urban planning across the world. Essentially, the whole idea of NEOM, specifically for The Line, is to start from scratch, from a blank slate. I wouldn't say we're forgetting all of the learnings from the past but rather detaching from current practices in the world of urbanism, generally speaking. So the learnings aren't necessarily about looking at good or best practices and implementing them here, but about learning from the mistakes, essentially. We're looking at the current problems in our cities such as sprawl, congestion, and all the issues that come with traditional horizontal planning, and trying to find creative ways to solve those problems. Hence, the idea of The Line was born: to move vertically, to think in three-dimensional space, to rethink components of the city such as roads, transportation, and connectivity, and to see how those can be embedded within the city fabric to create spaces that are multi-use. So, essentially, when you move around in The Line, you go from private to semi-private to public spaces. And while moving, those public spaces serve different functions. You walk instead of using a car. The idea is that these spaces become lively and that the programming of the modules is continuous, with no interruptions. If you look at cities today, specifically cities like Riyadh, which is considered the model for urbanism in Saudi Arabia, you go from enclosed, inward-facing spaces and then need to take a car to move from one to another. I call it the "urban desert", a complete disconnection from people. You get into your car, you're in an individual space, and you move from A to B, sometimes even through C and D, because of how the city is designed and the ongoing work. You reach your destination, park your car, walk into a space, and then meet people again. In NEOM's models, you are continuously in contact and communication with your surroundings. The social space is continuous and closely tied to the urban space. There is no disconnection between the two.

Speaker 1

Great. Thank you. Actually, you answered the second question already, which is: in your expert opinion, how have these best practices influenced the planning and perception of NEOM? So, does that mean in NEOM's planning, you don't have a benchmark to focus on?

Speaker 2

The benchmarks are looked at in different aspects. For instance, in land management, one of the models we closely examined is Singapore. And that is because Singapore has a scarce land resource and requires land management that is efficient the reason why NEOM is looking at Singapore as an example in that aspect specifically is because NEOM has a constitutional foundation which says that 95% of NEOM is a natural reserve that is going to be preserved for nature and that is going to be completely untouched land, and therefore only 5% is going to be developed. By design, land is a scarce resource and must be allocated (A) efficiently and (B) using the best approaches and practices. Our team does not deal with the master plans, but we are responsible for regional infrastructure and both temporary and permanent land use. We allocate land outside of the master plans, either temporarily or permanently, to enable the development of those master plans. For example, we look at temporary construction sites or what we call construction villages, where we currently live and where workers reside. We aim for light-touch interventions. Construction must be easily dismantlable and should not disturb the natural habitat. There's strong coordination with the environmental and nature reserve teams to ensure the selected sites are not of high conservation value. When suitable areas are found, we implement measures to ensure not only light-touch interventions but also proper reinstatement upon project completion. For instance, Trojena has many logistical requirements, and there are villages and construction logistics scattered around the project. However, we avoid cutting mountains or moving rocks, as those are not easily reinstated. We avoid wadis because they are natural features that must be preserved. We seek plain areas and then apply layers of self-optimisation: for example, reducing the footprint of interventions. If you need a certain number of cabins, can you build vertically? Can you increase the number of stories to limit horizontal spread? These temporary camps, which may be in place for several years (say, five), also require sustainable user environments. People need not just infrastructure but also quality living conditions. So we focus on landscaping and incorporating nature into the temporary setups. The landscaping team helps us identify native

plants, so reinstatement is proactive plants are integrated during the intervention, not just afterwards. This leaves the environment in a better state than it was when we arrived. This principle, reinstating land in a better condition than before, is something NEOM's board has embedded as a guiding discipline across sectors.

Speaker 1

Great. Awesome. Thank you for answering, Dr. Abdullah. What unique dimensions could you identify in NEOM that could potentially set new standards or become future best practices in smart city development?

Speaker 2

I would highlight densification and the adoption of different modes of transportation in a climate like Saudi Arabia's, which has long been considered too arid or harsh for walking or cycling. The car, with its air conditioning, has always seemed indispensable. But in our temporary village, cars are not allowed. By design, we walk to our offices, use bicycles or scooters even in traditional Saudi attire, and we're fine. This proves that, even in cities like Riyadh, if you provide shade and suitable infrastructure, people can move around without cars. There's an initial adjustment period, but people adapt. Look at Amsterdam. The Netherlands doesn't have perfect weather; winters are cold and rainy, but people still cycle. Similarly, in Saudi Arabia, despite the heat, with the right infrastructure, people will adapt. That's one key lesson we hope NEOM can demonstrate: infrastructure design can overcome climate barriers and enable more sustainable mobility.

Speaker 1

Great. So the next question is about urban form. Could you explain how the linear urban form is anticipated to enable sustainable development in The Line city?

Speaker 2

The original idea, as described by Crown Prince Mohammed bin Salman, was a circular model, like a giant enclosed slope. But that was changed to a linear model to allow for expansion on both ends. The Line crosses varied topography: the coastal area connecting to the Red Sea via a cantilever, the plains, the mountainous region, and the Red Sea. Each landscape has unique characteristics, offering diverse views and access to nature. The linear form supports broader national objectives, such as the North-South Royal Corridor, which links northern regions to Riyadh. The Line occupies a strategic position along this corridor and supports future East-West connections, as proposed by the Ministry of Transport. The circle, as a form, is finite. But a line is theoretically infinite. There's a symbolic idea that The Line continues beyond the Red Sea, beyond the horizon, both physically and conceptually. NEOM also aims to establish international links via airports, railways, and ICT infrastructure. For example, Saudi Arabia currently lacks sufficient cloud services. Due to regulatory constraints, companies like Amazon and Apple avoid Saudi. NEOM's regulatory environment aims to change that and become a hub.

Speaker 1

How will living in The Line city be? I've heard about "zero gravity urbanism" and "five-minute walks" from every point. Could you talk about that?

Speaker 2

Yes. The idea is that vertical urbanism enables us to create clusters where residents have immediate access to all basic needs, within five minutes. Seeks to minimise the city's footprint and environmental impact while maximising the efficient use of space. From any point on The Line, you'll be within walking distance of supermarkets, schools, healthcare, education, sports, parks, and more. Verticality and technology make this feasible. The Line is being developed physically and virtually, via a digital twin. This enables real-time analytics during design and operation. For example, we can simulate five-minute walks and analyse them in real time post-construction. The Line's vertical orientation will allow for multi-level transportation networks, with pedestrian walkways, autonomous vehicles, and hyperloop systems stacked on top of one another, reducing the need for sprawling road infrastructure. We, NEOM's planners envision a city where residents can access all essential amenities within a 5-minute walk, reducing reliance on private cars and enabling a pedestrian-friendly environment. Even though The Line's overall form is fixed, the interior is dynamic, constantly reassessed and readapted to meet user needs. Think of it as a superstructure with living, evolving elements.

Speaker 1

Thank you. According to academic literature, there is the Boyd Cohen model. If I may share my screen?

Speaker 2

Yes, go ahead.

Speaker 1

Thank you. Is it clear now?

Speaker 2

Yes.

Speaker 1

As you have seen, according to the academic literature, there is the Boyd Cohen model. Based on your understanding of the model, I was wondering if there are any dimensions in the model that NEOM is not currently addressing?

Speaker 2

All of those dimensions are covered. For the economy, there is an organisation within NEOM that looks at socioeconomics. There is a separate sector that focuses on mobility in all its components land, sea, and air mobility. Within each category, the focus is on the subcomponents. For land mobility, for instance, we don't just mean cars we mean all modes of land-based transportation, including rail systems and freight. The Line will include components like the Spine, which is the underground high-speed rail linking both ends of The Line. Within The Line itself, there will be different modes of transportation allowing people to move from module to module. Governance is also a major subject in NEOM. It is the reason why, given that it's being designed as its own economic zone that is governed by its own legal framework in order to create an environment that is investor friendly and opens up opportunities for the wider international communities to come and thrive in that ecosystem. NEOM has also different organisations. We have the holding company, but also subsidiaries and each is designed in order to have what call it a decision-making process that is independent of people and is also designed in order to allow for voices to be raised and heard. And also, NEOM as a company is the company that is making decisions when it comes to development. NEOM includes the holding company and various subsidiaries. Each entity is designed to ensure independent decision-making and to enable voices to be heard. While I can't go into too much detail, there are independent entities being set up to maintain checks and balances. These will hold NEOM accountable to its citizens and to the international community. As for the environment, it is perhaps the biggest subject in NEOM's development. The vast majority of land 95% is preserved for nature. There are large-scale efforts to restore natural ecosystems. For example, grazing used to be unregulated, which harmed fauna and habitats. Now that grazing is controlled, we're seeing a revival of plant and animal life.

Species native to the region, such as gazelles, cheetahs, and dusk, are being reintroduced. They are currently protected in designated areas, but eventually, once populations stabilise, they'll be allowed to roam freely across the 95% nature zone with minimal human interference. When it comes to "people" and "living," those are central to The Line. The Line without people is just a large-scale model. The whole point is to enable human experience. The proximity to nature, mobility systems, and the different master plans like Oxagon, Trojena, and the islands are all designed with specific roles. People have to come and live in the line and the whole idea of opening up possible spiritual strive is also being done with people in mind... The idea is that you are in the line, you're in your city, but you have direct [technological] access to the 95%. So you have the possibility of very quickly connecting with nature, with the different modes of transportation and the possibility of moving around between the different master plans The islands focus on tourism. You move from urban environments to relaxing beaches. Oxagon focuses on industrial activity and innovation incubators. Each programme is designed to attract global talent, foster creativity, and offer a legal framework that supports innovation. In short, the goal is to make NEOM not only about urban form but about enabling human potential, through a smart, efficient, and liveable ecosystem. The investment funds being created are meant to identify promising startups around the globe and invite them to thrive in NEOM.

Speaker 1

Awesome. Thank you, Dr. Abdullah. As an urban planner in NEOM, would you add any dimensions to this model—anything that's not in the Cohen model but is being implemented in NEOM?

Speaker 2

I'm trying to think hard about that. I guess at this stage, though things are maturing, we're still early in the development process. One thing I would perhaps include, within the "smart people" category, is participatory interventions. At the moment, we don't yet have the population to engage in participatory governance or decision-making. But once the master plans are activated and people begin to join NEOM, participatory governance is something being seriously discussed. This is something that's often lacking in urban planning in Saudi Arabia, and it's something we aim to change in NEOM.

Speaker 1

Yes. Could you rank the dimensions from the Cohen model in terms of importance for NEOM's planning—say, from one to six?

Speaker 2

It's a tie, I would say, between environment and people; those are the starting points. Then it trickles down to the economy and governance. If not a tie, they're very close. Then comes mobility and living. We are working on sectoral innovation hubs across NEOM, and each economic cluster will be vertically integrated, supported by advanced logistics, data infrastructure, and governance autonomy. It's a new economic geography, really. That said, these dimensions are all very important. There are nuances, but generally, they're all critical and interdependent.

Speaker 1

This model is typically used to evaluate smart or smart sustainable cities globally. Each dimension includes working areas and 46 specific indicators. That guided me to ask a question about NEOM's contents: could you discuss any particular strategy metrics that have been applied in NEOM?

Speaker 2

In our line of work, it's quite specific. As I mentioned, we're not involved in master plan development, we're focused on infrastructure. We follow mandates and directions from the Chief Planning Officer and, ultimately, from the Board of Directors. We have governance models and a decision-making framework we must adhere to. So, to be honest, in our land-focused work, we haven't applied any specific model directly. However, based on experience here at NEOM, I can confidently say that all the dimensions of the Cohen Smart City Wheel are being addressed, some in more depth than others, due to the project's early stages. But by the end state, all of them will be 100% addressed.

Speaker 1

How do you think NEOM merges technological aspects with social, environmental, and economic priorities? For instance, what smart solutions are being considered for renewable energy or waste management?

Speaker 2

This has many dimensions. Take, for example, NEOM's energy grid, which will be based on smart renewables, primarily wind and solar. A major challenge is how to store that energy efficiently. Energy is generated during the day, but demand often peaks at night. Using large batteries isn't always economically or environmentally sustainable. One of the more viable solutions we've implemented is pumped hydro storage. Essentially, near a mountain, you build two reservoirs one at a higher elevation. During the day, when you have excess energy, you pump water from the lower to the upper reservoir using that surplus energy. At night, gravity brings the water back down, powering turbines that generate electricity. AI will enable us to balance energy loads more efficiently than ever before. To do this efficiently, you need smart systems to monitor consumption, track excess energy, and predict needs. You also monitor different master plans and cities within NEOM, each will have its own energy profile. As the population and cities grow, the data will help us anticipate demand, optimise energy production, and make decisions like relocating wind turbines or expanding photovoltaic areas. All of this is enabled by IoT and smart systems.

When NEOM talks about merging technology with smart living, it includes energy grids, land management, and transportation all managed with digital foresight. Right now, we're strategically planning what datasets to collect and how to use them. Over time, we'll refine our approach, fill any gaps, and adapt accordingly. NEOM begins with sustainability as a foundational pillar, which sets it apart from many other cities that are retrofitting sustainable solutions

Speaker 1

Yes. The last question, Dr. Abdullah: what key lessons could future smart city developments learn from NEOM's planning and design to enhance sustainability and urban environments?

Speaker 2

The key lesson, and I think this is already widely understood, is to rethink transportation. Move away from car dependency. This isn't just relevant to Saudi Arabia but globally. Again, I'll reference the Netherlands. It's a strong case study that shows how car-light urban environments improve quality of life. Densification and limiting horizontal sprawl are critical. We're already seeing here that when you impose restrictions on sprawl, people begin thinking creatively about solutions that reduce footprints and encourage densification.

Speaker 1

Thank you. Thank you very much, Dr. Abdullah. It was an amazing interview. I appreciate your insights. Finally, is there anything you think I should have asked you before we conclude?

Speaker 2

Nothing comes to mind, but we will keep in touch.

Speaker 1

Yes, great. If there are any non-confidential reports or documents that I can access for research purposes, that would be greatly appreciated. Also, there is a consent form that requires your signature—I'll email it to you later. Thank you very much again. I truly appreciate your time.