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Saudi Arabia's NEOM Project as a Testing Ground for Economically Feasible Planned Cities: Case Study

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Abstract: The objective of this case study was to examine how the planned city of NEOM in Saudi Arabia can contribute to the country's economy and sustainability goals. The case study was intended to assess the challenges of planned city projects through the lens of the potential benefits to the host country's economy. Using data from the project's official website and relevant publications, it became possible to assess the risk management in urban megaprojects and to explore the issue of sustainable urbanization in the context of NEOM. In order to analyze the data, content analysis and thematic analysis techniques were used which allowed for the identification of patterns and trends in the data and to draw conclusions about the potential contributions of NEOM to Saudi Arabia's economy and sustainability goals. The findings suggest that NEOM, which aims to be a net-zero carbon city, has attracted significant partners and investors interested in testing renewable energy technologies and infrastructure. The viability of NEOM as a testing ground for sustainable planned cities and their impact on the host country will depend on the ability to effectively balance the potential economic benefits with the risks and costs associated with the project. This study's results indicate that NEOM represents an opportunity for Saudi Arabia to rebrand its image and participate in the creation of a green future, but its success will depend on fulfilling the investment requirements and managing the project-related challenges.

Keywords: NEOM; renewable energy; Saudi Arabia; sustainability; sustainable planned cities; urban megaprojects



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1. Introduction

Saudi Arabia has a rich cultural heritage and has recently begun a journey toward sustainable economic development facilitated by social transformations. The unique conditions of this journey are precipitated by the meteoric rise of the conservative state throughout the second half of the twentieth century. Although almost 85% of the 34 million population currently lives in urban areas, the situation was strikingly different in the 1970s when nearly 54% of 5.8 million Saudis were rural residents [1]. Taking into consideration the predominantly desert landscapes of Saudi Arabia and suboptimal urban planning, high urban growth rates put a strain on the local economy, logistics, and infrastructure. Coupled with the preference for private vehicles as the primary mode of transportation, the increasing reliance on oil products creates a bottleneck for policymakers and engineers seeking to implement sustainable solutions to the problem [2]. Without socio-economic mechanisms to ensure the country's resiliency in the face of diminishing natural resources, unregulated expansion of existing population centers will exacerbate the vicious cycle of fossil fuel dependence. The circumstances are further complicated by the lack of arable land on the Arabian Peninsula as well as limited reserves of readily accessible freshwater [3]. In this context, there is a need for technology-driven sustainable solutions that would remain economically feasible from the long-term perspective.

One such solution is the NEOM project, an integral component of Saudi Vision 2030 which is expected to diversify Saudi Arabia's economy by helping to attain social, economic, and environmental sustainability. The NEOM project is being promoted as a sustainable city of the future and aims to incorporate a range of innovative technologies, including green hydrogen plants, solar-powered desalination plants, and urban air mobility systems [4]. The project has attracted significant partners and investors interested in testing and implementing renewable energy technologies, and it is being developed as a test case for sustainable and economically feasible planned cities [2]. The NEOM project represents an opportunity for Saudi Arabia to rebrand its image and participate in the creation of a green future, but its success will depend on its ability to overcome economic challenges and secure additional investment.

Consequently, the ambitious goals of the Saudi government, as articulated by Prince Mohammad bin Salman, can only be achieved by breaking from a decades-long dependence on fossil fuel reserves [5]. To this end, the government has pledged \$500 billion to the NEOM project in an attempt to establish a testing ground for sustainable planned cities [6]. Initially announced in 2017 in collaboration with foreign investors, the project has grown to encompass multiple sub-components, such as The Line, The Oxagon, and others. The unprecedented scale of proposed planned cities ensures that Saudi Arabia will become the first country to implement and test fully sustainable technologies that align with Sustainable Development Goal 11 (SDG 11) as defined by the United Nations [7]. Consequently, the entire concept or its components could be employed to resolve similar issues faced by other countries across the globe.

The planned city of NEOM in Saudi Arabia represents a significant opportunity for the country to promote sustainable urbanization and diversify its economy. Specifically, the project can facilitate both social and technological transformations in Saudi Arabia [8]. Aspiring to distance itself from the image of a fossil fuel-dependent country, the Kingdom is in a position to spearhead the ongoing struggle against climate change. Nevertheless, international observers express considerable skepticism due to the ambitious nature of NEOM and the failure of other sustainable planned city projects [9]. The implementation of NEOM, a net-zero carbon city, is not without challenges. There are a number of economic and risk management issues that must be considered in order to ensure the success of the project and its potential contribution to the country's economy and sustainability goals [4]. The scientific objective of this case study is to examine the potential contribution of NEOM to the economy and sustainability goals of Saudi Arabia. In this context, the research provides an opportunity to evaluate the challenges and risks associated with planned city projects through the lens of the potential benefits to the host country's economy. Through a review of data from the project's official website and relevant publications, it is expected to facilitate the assessment of risk management in urban megaprojects and exploration of the issue of sustainable urbanization in the context of NEOM. The objective is to evaluate the potential challenges and opportunities associated with NEOM and provide insights into the potential economic impacts of the project on Saudi Arabia.

There are several reasons why this research is important and justified. First, NEOM represents a major investment by the government of Saudi Arabia, with the potential to significantly impact the country's economy and sustainability goals. Understanding the potential economic impacts of NEOM and the risk management challenges it faces is essential for policymakers and stakeholders who are responsible for making decisions about the project. Second, the issue of sustainable urbanization is a global challenge, and the success or failure of NEOM could have implications for other countries and cities that are considering similar projects. By evaluating the potential economic impacts and risk management challenges of NEOM, it is possible to contribute to a better understanding of the potential benefits and risks of sustainable urbanization more broadly. In other words, this paper seeks to approach Saudi Arabia's NEOM as a testing ground for sustainable planned cities of the future through the lens of sustainable urbanization and its economic

outcomes. By adequately managing risks, the Kingdom can succeed in attracting sufficient foreign direct investments to ensure its long-term economic feasibility.

Seeking to assess and analyze the NEOM project and its potential outcomes in Saudi Arabia, the current study was subdivided into sections highlighting major aspects of the studied subject. The first section pertains to establishing a theoretical foundation precipitating the need for sustainable urban projects in the twenty-first century. After explaining the economic and social challenges caused by Saudi Arabia's dependence on fossil fuels, this study proceeds with framing sustainable urbanization as a step toward new opportunities. Furthermore, scholarly approaches toward risk management in planned city projects are presented to provide the context for the consequent section centering around sustainable planned city projects that had been proposed or were launched in the MENA region. The overview of regional precedents is critical for identifying the problems and opportunities that NEOM is likely to face. Risk management in planned city projects was used as a theoretical foundation for exploring the challenges and risks associated with NEOM. By examining Saudi Arabia's policies, plans, and previous attempts at sustainable urbanization, the country's level of preparedness for implementing radically novel solutions is assessed. Drawing from the theoretical background laid down in the preceding section, this study continues with a detailed analysis of the NEOM project and its subcomponents, such as The Line, The Oxagon, and others. The final section is reserved for discussing the NEOM megacity and its economic and social outcomes for Saudi Arabia. Specifically, the analysis focuses on the project's propensity to achieve the Kingdom's goal of promoting inward foreign direct investments (FDI) while also attracting expatriate professionals and researchers. The project's impacts are further analyzed from the perspective of risk management to determine NEOM's long-term feasibility as a sustainable city.

2. Research Methodology

This study identified sustainable urbanization as a key concept that requires further research to fully understand its practical implications in real-world scenarios. In the context of risk management in planned city projects, this study was guided by the following research question: 'How can planned cities such as NEOM contribute to Saudi Arabia's economy and sustainability goals?' In order to answer this research question, this study relied on a case study research design to thoroughly examine the NEOM project and its potential contributions to Saudi Arabia's economy and sustainability goals. Case study research is a flexible and holistic approach that allows researchers to explore a specific case in depth and to consider the complex relationships between various factors [10]. It is particularly useful for studying real-world phenomena in their natural settings, such as planned city projects such as NEOM.

To gather data for this case study, two types of sources were used. The first type of data sources included the official website of NEOM, press releases, and other publicly available information about the project. These sources provided firsthand accounts of the project and its development, starting with its first announcement in 2017. The second type of data sources included scholarly articles on the topic of sustainable urbanization and planned city projects that focus on Saudi Arabia as well as other countries. These sources provided a broader context for this study and helped to understand the larger issues and trends related to sustainable urbanization and planned city projects using a combination of secondary qualitative data. Taken from publicly available sources such as the OECD reports, the FDI inflow dynamics and other financial cues offer an additional layer of evidence to address the research objective cohesively.

This study focused on the feasibility and potential risks of the NEOM project, with the ultimate objective of assessing the viability of NEOM as a testing ground for sustainable planned cities and their impact on the host country. In other words, this study ascertained the existing and potential challenges of planned city megaprojects through the lens of their expected benefits to the host country's economy. In order to analyze the data, a variety of qualitative methods were applied, including content analysis and thematic analysis [11].

Content analysis is a systematic method for analyzing written or spoken communication, and it allows researchers to identify patterns and trends in the data. Thematic analysis is a method for identifying and organizing the themes that emerge from the data, and it helps researchers to understand the underlying meaning and significance of the data. These techniques allow for the identification of patterns and trends in the data and to draw conclusions about the potential contributions of NEOM to Saudi Arabia's economy and sustainability goals [11]. They also provided a solid foundation for the findings and recommendations of this study.

Although information about previously planned city projects in Saudi Arabia and surrounding countries is readily available, the novelty of NEOM precipitates the scarcity of data on the topic. Nevertheless, a comprehensive literature review and case study analysis enabled the subsequent research process and allowed for providing a plausible answer to the research question.

3. Background and Literature Analysis

3.1. *Planned Cities as a Tool for Sustainable Urbanization*

Sustainable urbanization is a key concept that has gained increasing attention in recent years due to the growing recognition of the environmental, economic, and social challenges facing cities around the world. Sustainable urbanization refers to the development of cities in a way that is environmentally, economically, and socially sustainable while also reducing the reliance on fossil fuels and other non-renewable resources [12]. Planned city projects, which are large-scale urban developments designed to address specific urban challenges, have the potential to contribute to sustainable urbanization by providing opportunities for the implementation of sustainable technologies and practices.

Previous authors have shown that planned city projects can offer a range of benefits for sustainable urbanization, including the development of efficient and sustainable transportation systems, the integration of renewable energy technologies, and the promotion of low-carbon development [13,14]. However, these projects also present a number of challenges, including the need for effective risk management to ensure that they are financially, environmentally, and socially sustainable. Studies have identified a range of risks associated with planned city projects, including economic, social, and environmental risks, and have suggested a variety of approaches for addressing these risks, including the use of risk assessment tools, the engagement of stakeholders, and the development of contingency plans [12,13].

Overall, the literature suggests that planned city projects have the potential to contribute to sustainable urbanization but that their success will depend on the effective management of risks and the integration of sustainable technologies and practices [15,16]. Further research is needed to better understand the specific challenges and opportunities of sustainable urbanization in planned city projects such as NEOM, and to identify best practices for ensuring their long-term sustainability.

3.2. *Sustainability in Saudi Arabia*

For the past five decades, Saudi Arabia has experienced consistent demographic, social, and economic growth, which has translated into the country's rapid urbanization. Compared to the 1970s, the number of citizens living in urban areas has risen from 46% to nearly 85% by the 2020s [1,17]. Further driven by the entrance of foreign businesses as well as the influx of expatriate workers, urbanization processes resulted in the growth of cities to the point where they face modern urban challenges. Consequently, Saudi Arabia's largest population centers struggle with the following issues: pollution, water scarcity, traffic congestion, overcrowding, unemployment, and others [18]. Being one of the twenty countries with the most significant total emissions of greenhouse gasses, the Kingdom is characterized by an underdeveloped public transport system and high consumption of fossil fuel products [19]. Both cultural and economic factors contribute to the high amount of CO₂ emissions as citizens and businesses are increasingly reliant on conventional motor

vehicles as the main mode of transportation. Since most population centers are connected only by roads, and there is limited infrastructure for trains or electric vehicles, pollution and traffic congestion remain critical urbanization challenges. Another major concern pertains to the scarcity of freshwater reserves, with nearly half of drinking water originating from energy-demanding desalination plants [3]. Ever-diminishing freshwater reserves are a confounding factor that urges local authorities to explore new solutions, such as sustainable desalination facilities. Furthermore, the over-reliance on non-renewable energy sources is especially evident in Saudi Arabia, as the country remains one of the largest producers and exporters of petroleum products [18]. Considering that the Middle Eastern state is exceptionally reliant on fossil fuels, the government appreciates the urgency of adopting sustainable alternatives, including solar power and wind power.

As transformational processes undergoing in the second half of the twentieth century in Saudi Arabia were largely unexpected and slightly chaotic, neither policymakers nor city planners prioritized sustainability. However, the ever-increasing threat of climate change and the economic unsustainability of the current economic model precipitated the shift toward approaches that account for all of the above-mentioned concerns. To achieve the global sustainability goals delineated by the UN, the Saudi government had to design a plan that would account for local climate conditions, geography, and culture. Among the major threats to sustainable urbanization efforts in the region are the desert climate, inadequate pedestrian infrastructure, and the lack of public awareness regarding preserving natural resources [20]. In this framework, the Ministry of Municipal and Rural Affairs is responsible for ensuring that all 285 currently existing Saudi cities are up to the task of sustainable urbanization, which has the following purpose according to SDG 11: ‘Make cities and human settlements inclusive, safe, resilient, and sustainable.’ [7]. In the scope of Saudi Vision 2030, the above-mentioned objectives should be achieved by developing modern transportation systems such as the MEDSTAR in Riyadh, water preservation projects in Wadi Hanifa, and NEOM [1,19]. Overall, the NEOM project is specifically tailored to address all of the challenges mentioned in the current section. Regardless of its ultimate outcome, the futuristic megaproject will provide invaluable lessons concerning practical solutions to problems surrounding transportation, sustainable energy, and water scarcity.

3.3. Sustainability Efforts: Saudi Vision 2030 and Economic Diversification

Emerging as a response to the country’s dependence on the petroleum industry, Saudi Vision 2030 is a long-term plan to diversify Saudi Arabia’s economy and address concerns about urbanization and climate change. The authorities proposed a complex of solutions aimed at reducing energy consumption per capita while strongly prioritizing the exploitation of renewable energy sources [1,5]. Moreover, the government invested in improvements to the transportation system and the development of tourism, entertainment, and other promising industries. For example, the recent retraction of the three-decade-long ban on cinema signals the intent to embrace global values [21]. The scarcity of freshwater resources is another problem that remains at the forefront of the national agenda. With sustainability at the core of the Kingdom’s strategic framework for the upcoming decade, NEOM is expected to become the pinnacle of Saudi Vision 2030.

Taking into account the ambitious goals set by Saudi Vision 2030, the government chose to gradually implement changes that would encourage the participation of Saudi citizens. Starting with the establishment of King Abdullah University (KAUST) in 2009, transformations encompassed nearly all industries and sectors in Saudi Arabia. In this context, research-oriented megaprojects are intended to provide a robust technological base for local and foreign scientists while offering Saudi students opportunities for scientific pursuits. The Kingdom’s ‘soft power’ approach facilitates sustainable changes as experts and businesses worldwide are invited to become a part of NEOM, KAUST, and other megaprojects [20]. The advent of expatriates is closely tied to the need to attract foreign direct investments for further distancing the country’s economy from fossil fuels. In this context, the ambitious development plan involves transformational changes across Saudi

Arabia's industries and sectors. In combination with incentives offered to entrepreneurs and scholars, the government developed a set of policies intended to promote the economic, environmental, and social objectives of Saudi Vision 2030 [22]. The attainment of sustainable principles cannot be achieved without a legal framework for preserving natural resources, reducing pollution, and raising public awareness.

3.4. Sustainable Planned City Projects

While the scope of NEOM indeed distinguishes it from other similar projects, the concept of sustainable planned cities is not new, as evident from several historical and more recent examples. An important distinction should be made between conventional planned cities, such as Brasilia, developed by Oscar Niemeyer, and their modern equivalents relying primarily on green technologies [23]. Namely, planned urban development projects are well-attested in historical records from the period of the Roman Empire to the contemporary time, with the following prominent examples: Kangbashi District in Ordos, China (dubbed by the press as 'Ghost City'); Arcosanti Project in Arizona, US; Islamabad, Pakistan; and others [19,24]. Apart from NEOM and its constituent components, the list of projects that place sustainability and livability at the center is significantly shorter [25]. The closest example that might have served as an inspiration for NEOM is Masdar City in the UAE. The following distinctive features could be observed in the initial plans of Masdar City: environment preservation; water and energy preservation; incorporation of modern technologies; and culturally appropriate architectural solutions [26]. Inaugurated in February 2008, Masdar City was envisioned as a response to the urbanization challenges outlined in the previous section. Unfortunately, the ambitious plans for achieving net-zero carbon levels and implementing a carless transport system were ultimately discarded in favor of less radical alternatives [19]. The sustainable project in the UAE remains uninhabited as the construction deadline was recently pushed back to 2030.

Incorporating many of the ideas proposed in Masdar City's original design, NEOM can further benefit from the lessons presented by its Emirati competitor. On the other hand, KAUST can be considered a direct predecessor of the NEOM project that successfully addressed many of the sustainable challenges [18,27]. Although considerably smaller than The Line or The Oxagon, the KAUST campus features compelling design features such as solar panels, wind towers, and passively cooled spaces. The newly constructed campus is dissimilar from NEOM in many ways. Still, the former helped to test solutions that would eventually be proposed for implementation as a part of the latter. Practical applications of AI-driven technologies and smart solutions are sporadic across the world. Still, an evidence-based analysis of previous trials and successes serves as a basis for the expectations of NEOM's planners. A separate note can be added regarding The Line, which draws from century-old research on linear city concepts that started with Arturo Soria y Mata's Ciudad Lineal in Spain [28]. However, there are no notable precedents for octagonal city designs such as the one recently announced by Prince Mohammed bin Salman.

3.5. Risk Management in Planned City Projects

The study of risks associated with urbanization has been an interdisciplinary effort that expands beyond the scope of a single urban project or city. Apart from the foreseeable and planned objectives that architects and planners initially cover, large-scale endeavors encompass numerous disciplines and spheres. For example, any urban project on a meaningful scale would have to be assessed regarding its capacity to meet the needs of residents and visitors safely and reasonably. Although urbanization risks tied to conventional processes are well-researched, scholars are yet to create a cohesive theoretical foundation for risk management in planned city projects. Nevertheless, the existing city management and urbanization research can be partially applied to NEOM and similar planned cities by accounting for their unique conditions and characteristics [8]. To ensure that The Line sub-project satisfies all the requirements for becoming a sufficiently adjusted environment for new residents, planners are expected to account for pollution risks, technological risks,

environmental risks, economic risks, and others [29]. The list is not exhaustive because urbanization is a process associated with largely unpredictable challenges that are yet to be explored on the scale of Saudi Arabia's NEOM.

In contrast to already established cities, The Line would need to be planned in accordance with predictions and expectations regarding communication, healthcare, transportation, education, and other basic needs. The Saudi government's effort to drive investment and immigration cannot be accomplished without the adequate identification of the risks leading to the development of appropriate mitigation plans [30]. However, such strategies can only be formulated in response to the socio-cultural, economic, and operational concerns of all the involved stakeholders. Given that Saudi Arabia attracts sufficient investments to launch and start populating NEOM, the megaproject would have to function as a self-sufficient urban unit [20]. In this context, risk management efforts should also account for ethical considerations connected to the pervasive deployment of so-called smart technologies that can threaten the privacy and security of residents [31]. Finally, previous studies outlined sustainability and environmental risks as a rising point of concern in regard to urban megaprojects [8]. Based on the analysis of the risk management literature, the following section presents a systematic classification of risks in planned city projects.

- Construction risks. One of the most consequential factors, construction risks, involves all problems tied to a project's planning, coordination, and quality. Apart from affecting completion timeframes, this category can have tangible effects on the resulting costs [32].
- Contract-related risks. The involvement of numerous stakeholders in megaprojects necessitates careful consideration of contractual risks to avoid potential delays, renegotiations, and conflicts [32].
- Design risks. Particularly important during the planning stages, design risks can compromise the future sustainability and self-sufficiency of large-scale urban projects as they involve transportation, healthcare, and infrastructure [33].
- Operational risks. Concerned with the operational and maintenance stages, these risks are likely to have considerable economic impacts due to external factors, inadequate quality, or the lack of economic viability [33].
- Economic risks. This category includes short-term and long-term risks associated with internal and external factors, such as investments, financial planning, profitability, debt, and others [32].
- Technology-related risks. Adopting complex technological solutions that involve tracking and managing personal data is an integral component of future smart cities that leads to various security and privacy considerations [31].
- Environmental and sustainability risks. Due to their scale, megaprojects have the capacity to irreversibly change flora and fauna in a given ecosystem by negatively impacting the environment via pollution, displacement, emissions, and others [30].

Although the lack of literature on risk management in planned city projects creates certain constraints for research inquiries, the available data for urban risk management can be partially extrapolated to NEOM and other planned megaprojects [8]. Moreover, the rising interest in this under-explored topic will likely result in further in-depth research of specific risk factors associated with NEOM and The Line.

4. Case Study: The NEOM Project

4.1. Overview of the NEOM Project

Formed via combining Greek and Arabic words, the name 'NEOM' is intended to represent a 'new future' for people across the globe [17]. First announced in late 2017 as a sustainable project on an unprecedented scale, NEOM remained in an apparent state of dormancy for more than three years as stakeholders pushed through the initial planning stage [1]. Although the COVID-19 pandemic shifted global attention away from ambitious megaprojects, the interest in NEOM was invigorated with the announcement of The Line and The Oxagon in 2021. Since information about the planned cities is scarce,

the official website of NEOM and press releases provide a fruitful ground for guesswork and speculation. Nevertheless, Prince Mohammed bin Salman confirmed that 26,500 sq. km. of the northwestern Tabuk Province would be reserved for NEOM and its constituent planned cities [34]. Situated in a topographically diverse region along the Red Sea shoreline, NEOM will be able to benefit from renewable resources while preserving access to the lucrative trade route passing through the Suez Canal. The central location along global transportation and trade routes presents an opportunity for developing tourism, commerce, and technology [6] (Figure 1). Currently headed by Nadhmi Al-Nasr and managed by the Public Investment Fund of Saudi Arabia, the planned urban region received support from influential business leaders such as SoftBank's Masayoshi Son and Blackstone Group's Stephen Schwartzman [20].



Figure 1. The location of NEOM and its sub-projects in relation to Saudi Arabia and surrounding countries.

As evident from press releases and promotional materials frequently appearing on the official resources, the uniqueness of the NEOM project extends well beyond its scale and futuristic design. Currently, the majority of publicly available data are centered on two planned cities branded as The Line and The Oxagon. The former represents a chain of urban oases connected by an ultra-high-speed transportation line that is claimed to enable 20-min travel between populated clusters [6]. With motor vehicles being banned from the city's surface layer, the services and logistics will be conducted in the two underground layers [35,36]. The city's design caters to individuals seeking living conditions that cannot be experienced elsewhere on Earth. On the other hand, The Oxagon is planned as a coastal hub for commerce and industry that would be connected to The Line and the recently constructed Neom Bay Airport [37]. The partially floating city is expected to tap into the trade passing through the Red Sea and bolster Saudi Arabia's manufacturing sectors. While nearly all parts of the larger NEOM project, except for Neom Bay Airport, are still in the initial stages, Prince Mohammed bin Salman has set 2025 as a tentative date for the completion of Phase 1.

To achieve the sustainable goals set by Saudi Vision 2030 and communicated by the Saudi government, NEOM should become a testing ground for innovative technological solutions. Namely, the plan to reach net-zero carbon levels can be accomplished by shifting to renewable energy sources, which requires the construction of offshore wind turbines and solar power plants [19,38]. Thanks to the launch of a \$186 million solar panel factory in Tabuk and favorable regional insolation rates, NEOM is expected to become independent from fossil fuel sources of energy [39]. The Green Hydrogen company responsible for the construction of a hydrogen-based ammonia plant in NEOM has announced a decision to

source energy from local contractors by investing in a battery energy storage system and energy transmission infrastructure [40]. The lack of freshwater reserves is planned to be addressed with the help of solar-powered desalination plants such as the one constructed in cooperation with Solar Water Plc [41]. While the plant is yet to be completed, the reports suggest that the solar dome plant will satisfy the region's demand for freshwater while complementing the freshwater profile of the entire country.

Additionally, NEOM developers have set 2026 as a tentative date to launch the largest electrolysis plant in the world to produce green hydrogen for local purposes and export [42]. Considering that NEOM will have no petroleum-powered vehicles, both logistics and public transportation will be accomplished via sustainable alternatives such as an urban air mobility system established in cooperation with Volocopter [43]. The pervasive implementation of artificial intelligence and robotics is another critical step toward sustainable urbanization, as robots will replace humans in labor-intensive and low-skilled jobs [17]. Finally, the connectivity between residents and systems will be ensured by the so-called 'digital air,' a free 5G Internet network enabled by satellites and high-speed fiber cables. To facilitate the interconnectivity of various systems and technologies, Neom Tech & Digital Company proposed constructing a \$500 million collocation data center encompassing three data centers powered by 36 MW of renewable energy from the surrounding plants [44].

4.2. Risk Management of the NEOM Project

Characterized by the introduction of unprecedented infrastructural solutions, the NEOM project is invariably tied with significant risks, many of which have been outlined in the corresponding section above. Moreover, only some of the ambitious goals presented by Mohammed bin Salman were previously implemented in similar urban endeavors on this scale. The following purposes precipitate the critical challenges tied to the planning and risk management of NEOM: a population of 9 million residents; a 170-km-long underground transportation system; the integration of drones and robots in urban infrastructure; the reliance on 100% renewable energy sources for the city; and others [45,46]. While some of the listed objectives have been partially implemented on a smaller scale in other places, they still need to be completed within the short timeline set for the NEOM project [20]. Additionally, the project is expected to incorporate one-of-a-kind developments that require additional research and major contributions from local and foreign investors [8]. For example, the development of AI-powered robots and smart systems for their consequent implementation within an urban megaproject is a largely untested sphere that requires further research [31]. All of the challenges mentioned above will be analyzed through the lens of urban risk management to identify pertinent problems, propose viable courses of action, and inform future research.

Both environmental impacts and sustainability risks of the NEOM project emerge as the primary area of concern because of the vast land area being reserved for construction and terraforming. Based on the available data, the ambitious plan to rely on 100% renewable energy sources is likely to be achievable with the help of current technologies and proposed investments [46]. Moreover, the installation of solar power plants and other renewable energy projects associated with this goal do not create significant sustainability risks due to the availability of suitable conditions in the surrounding desert [29]. Regional carbon neutrality is likely to become achievable with the help of wind and solar plants supplemented by large-scale battery energy storage systems that ensure optimal energy production [40]. On the other hand, the linear design of the 170-kilometer-long city creates an impenetrable barrier for local wildlife. The sunlight reflecting mirror walls of the unconventional skyscraper will only exacerbate this environmental impact. A set of additional sustainability risks pertains to an artificial moon, sand illumination systems, and cloud-seeding solutions. The long-term objectives of NEOM involve increasing Red Sea trade which emerges as another major risk to the marine flora and fauna [30].

The second area of concern relates to the economic risks of NEOM, as megaprojects are typically associated with significant funding and financial challenges. Namely, the initial

investment cost projections of \$500 billion cannot be solely covered by Saudi Arabia and other stakeholders in the relatively short timeline allocated for NEOM's completion [45]. For this reason, the need to secure foreign direct investments predicated the creation of suitable social and economic conditions. While external factors such as the COVID-19 pandemic were found to seed transformations in urban environments, it is essential to secure connections with foreign investors focusing on the long-term prospects of the project [29,47]. In other words, the Saudi government is facing a branding problem that can be addressed by responding to various concerns and risks voiced by international observers. Apart from helping to acquire FDIs, a positive brand image of the country is crucial for attracting expatriate professionals and retaining the workforce necessary to complete and maintain the project [48]. The aforementioned financial risks are also closely connected to contract-related and operational concerns that would require a comprehensive approach involving not only the project's managerial team but also leading figures in the Saudi government as well as the global community.

A fundamental breakdown of the weighted risk components for the NEOM project based on the literature review analysis can be presented as follows:

- **Construction risks:** The NEOM project involves the introduction of unprecedented infrastructural solutions and is associated with significant risks, including those related to the planning and coordination of the construction process. These risks can impact the completion timeline and the resulting costs of the project.
- **Contract-related risks:** The NEOM project involves a number of stakeholders, and careful consideration of contractual risks is necessary to avoid potential delays, renegotiations, and conflicts.
- **Design risks:** These risks are particularly important during the planning stages of the NEOM project and can impact the sustainability and self-sufficiency of the project by affecting transportation, healthcare, and infrastructure.
- **Operational risks:** These risks are related to the operational and maintenance stages of the NEOM project and can have significant economic impacts due to external factors, inadequate quality, or the lack of economic viability.
- **Economic risks:** This category includes risks related to internal and external factors such as investments, financial planning, profitability, debt, and others that can impact the short-term and long-term success of the NEOM project. The initial investment cost projections of \$500 billion for the project may not be fully covered by Saudi Arabia and other stakeholders within the timeline allocated for its completion, so it is necessary to secure foreign direct investments in order to achieve the project's goals.
- **Technology-related risks:** The adoption of complex technological solutions, such as those related to tracking and managing personal data and the integration of drones and robots in urban infrastructure, is an integral component of the NEOM project and can lead to various security and privacy considerations.
- **Environmental and sustainability risks:** Megaprojects such as NEOM have the potential to irreversibly change the flora and fauna in a given ecosystem and can negatively impact the environment through pollution, displacement, emissions, and other factors. The project's reliance on 100% renewable energy sources may be achievable with the help of current technologies and proposed investments, but the linear design of the city and the use of reflective mirror walls for skyscrapers can create barriers for local wildlife. Additionally, the long-term objectives of NEOM, including increasing the Red Sea trade, can pose risks to marine flora and fauna.

5. Sustainable Urbanization and Its Economic Outcomes in Saudi Arabia

Despite unquestionable economic benefits associated with the petroleum industry, Saudi Arabia underwent a process best described as 'oil urbanization' [20]. Characterized by rapid socio-economic transformations, population growth, and increasing dependence on fossil fuel reserves, the process is unsustainable due to the challenges outlined in the previous sections. Planned within the scope of Saudi Vision 2030, the NEOM project

presents a complex of innovative solutions that would put the Middle Eastern country on the path toward sustainable urbanization. However, the government's decision to invest a relatively risky investment of \$500 billion into the untested project has sparked both doubts and excitement among international observers [17,20]. Inherently aimed to become leverage for diversifying Saudi Arabia's economy, the NEOM megacity is a major endeavor that can streamline the growth of the renewable energy industry and associated sectors. From another perspective, the involvement of technology companies that are leaders in their respective spheres is likely to address GDP leakage by offering unprecedented investment opportunities backed by the country's Public Investment Fund [49]. Along with solid branding efforts, a set of reforms initiated by Prince Mohammed bin Salman promotes Saudi Arabia's image as a nation embarking on the path toward sustainable urbanization [50]. In this context, one of the objectives is to build strong international connections with countries that share the aspiration for a greener future.

The chart in Figure 2 outlines the dynamics of foreign direct investments per GDP in the fossil fuel-dependent economy of Saudi Arabia. The most recent report by the OECD did not reveal a significant rebound after the pandemic, but the evidence suggests an expected increase in inward FDIs in response to the announced initial public offering of NEOM [49,51,52]. Moreover, the recent launch of an inward investment agency is tied to an ambitious plan to attract \$103 billion of yearly FDIs, a figure vastly exceeding the \$1.97 billion invested in Q1 of 2022 [53]. Together with measures aimed at diversifying the country's economy and promoting trade openness, sustainable megaprojects can prove to be key determinants for attracting inward FDI in the oil-dependent kingdom [48,54]. The vast opportunities offered in NEOM for research-focused initiatives and organizations is another facet of the multi-layered strategy used by Saudi Arabia's authorities to achieve the objectives of Saudi Vision 2030.

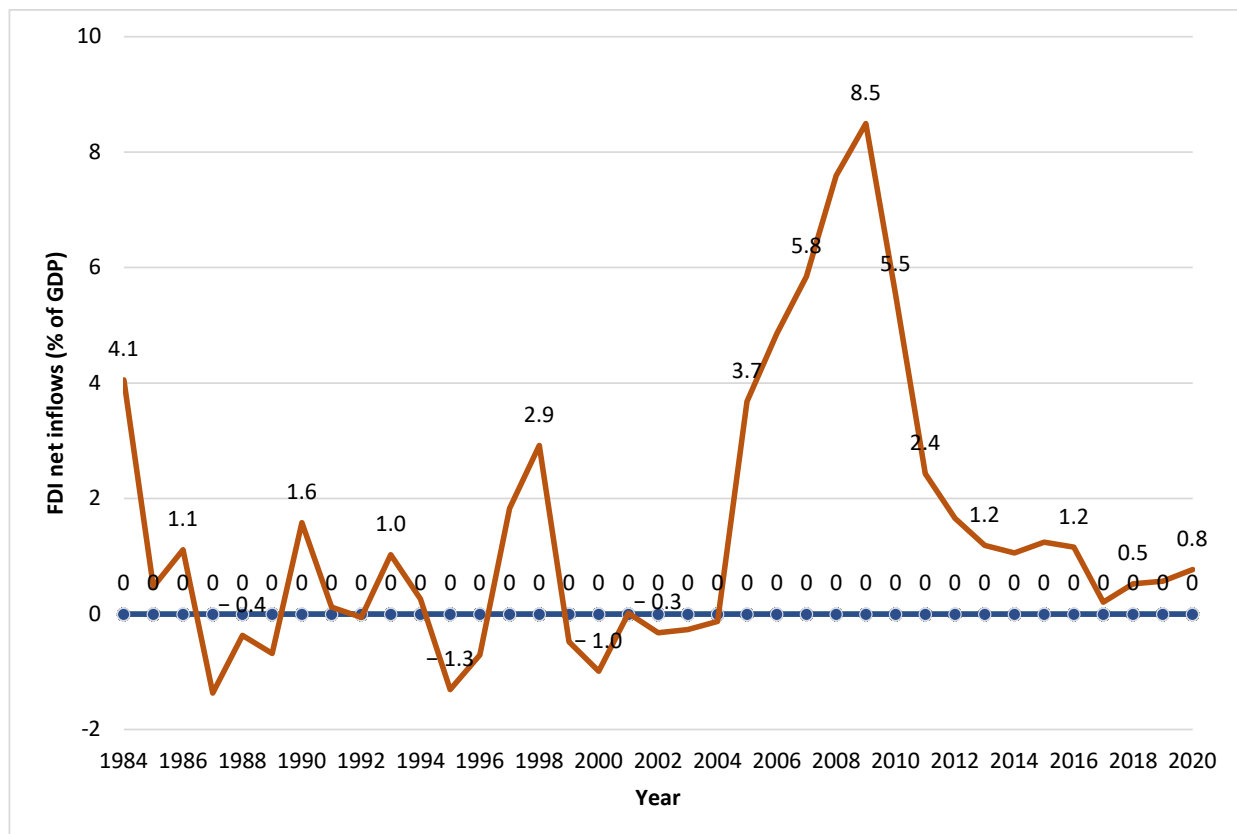


Figure 2. The dynamics of FDI net inflows as a percentage of GDP in Saudi Arabia from 1984 to 2020 [55].

Some of the specific factors that may contribute to the attractiveness of the NEOM project to potential investors include the availability of research opportunities, the potential for economic returns, and the overall stability and predictability of the investment environment.

The involvement of technology companies that are leaders in their respective fields would be a major factor that contributes to the attractiveness of the NEOM project to potential investors. These companies may be able to bring expertise and resources that could help to drive the growth of the renewable energy industry and associated sectors, which could, in turn, generate economic returns for investors. Additionally, the efforts by the government to promote Saudi Arabia as a nation embarking on the path toward sustainable urbanization and to build strong international connections with countries that share the aspiration for a greener future may also help to enhance the reputation and attractiveness of the NEOM project. Overall, it is important for policymakers and stakeholders to carefully consider the potential economic outcomes of the NEOM project, as well as the factors that may influence those outcomes. By analyzing these factors and providing evidence to support their analysis, all the involved parties can better understand the potential economic impacts of the project and make informed decisions about its implementation.

Thanks to the establishment of partnerships with organizations such as Boston Dynamics, Solar Water Plc, Volocopter, and others, NEOM emerges as a future-oriented platform for deploying and testing sustainable technologies. In turn, the country will be favorably positioned to attract foreign direct investment as well as potential partners for developing sustainable cities. To allow for the facilitation of the non-oil economic transition, the planned launch of a solar-powered desalination plant, an urban air mobility system, and a green hydrogen plant will also create vacancies for high-skilled experts [43,56]. Research opportunities offered by NEOM, branded as a research-oriented hub for ‘visionaries,’ will bolster the education sector in Saudi Arabia. Another crucial facet pertains to the socio-cultural impacts ushered in by the development of carless people-centered cities maintained by artificial intelligence and robots [17]. While NEOM seeks to introduce innovation, the project is expected to preserve and build upon Saudi cultural identity. The construction of The Line and The Oxagon has only begun, but the global community is increasingly aware of Saudi Arabia’s aspirations to embrace sustainability through social, economic, and environmental lenses [57]. Hassan and Lee concluded in their research that a critical obstacle to the comprehensive sustainable development of urban areas would be to prioritize one facet of sustainability over the myriad of other constituent components [58]. Finally, the megaproject can attract industry leaders and local and foreign tourists who will be enthusiastic about exploring and experiencing the ‘new future’ ushered in by NEOM. Considering the aforementioned discussion of NEOM’s potential outcomes, the megaproject will demonstrate whether sustainable planned cities are feasible from socio-economic and technological perspectives.

NEOM as a Sustainable Planned City for Future Generations

The planned city of NEOM in Saudi Arabia has the potential to contribute to the country’s economy and sustainability goals through the testing and implementation of renewable energy technologies and infrastructure. As a net-zero carbon city, NEOM has attracted significant partners and investors interested in exploring sustainable urbanization practices and technologies [20,32]. However, the viability of NEOM as a testing ground for sustainable planned cities and their impact on the host country will depend on the successful fulfillment of investment requirements and the effective management of the associated risks. To fully understand the potential economic impacts of NEOM on Saudi Arabia, it will be important to consider a range of factors, including the costs of implementing sustainable technologies and practices, the potential for economic returns through the development of new industries and businesses, and the overall stability and predictability of the investment environment. It will also be important to consider the potential risks associated with the

project, such as the possibility of cost overruns or delays, and to develop strategies for managing these risks to ensure the success of the project.

Overall, the viability of NEOM as a testing ground for sustainable planned cities and their impact on the host country will depend on the ability to effectively balance the potential economic benefits with the risks and costs associated with the project. By carefully considering these factors and providing evidence to support their analysis, policymakers and stakeholders can make informed decisions about the implementation of NEOM and its potential economic impacts on Saudi Arabia. Importantly, the current case study highlighted a significant scarcity of detailed financial reports from official sources affiliated with the project. Without such data, it would be unfeasible to proceed with any economic projections or analytical analyses because pledges taken from press releases tend to shift drastically over time. The lack of financial transparency surrounding NEOM is another obstacle that can potentially be addressed by future research as additional evidence becomes available. In this context, it can be acknowledged that, although publicly available data create a fruitful ground for conjectures and wishful thinking, the actual value of NEOM as a sustainable city of the future remains to be seen.

6. Conclusions

The NEOM project, a planned city in Saudi Arabia, is a key component of the country's Vision 2030 initiative, which aims to diversify the economy and promote sustainability on social, economic, and environmental levels. This case study was conducted to assess the potential contributions of NEOM to Saudi Arabia's economy and sustainability goals. Using a combination of official project data and relevant publications, this study applied a risk management framework to NEOM as a megaproject and explored the concept of sustainable urbanization in the context of the planned city. The findings suggest that NEOM has garnered interest from a diverse array of investors and partners seeking to test and implement renewable energy technologies, such as the construction of a green hydrogen plant and a solar-powered desalination facility. The unique infrastructure and technological innovations planned for NEOM, such as urban air mobility systems, also present opportunities for the project to distinguish itself as a global leader in sustainable urban development. However, this study also identified the need for NEOM to overcome economic challenges and secure additional investment in order to fully realize its potential as a sustainable city of the future.

Overall, the NEOM project represents a significant opportunity for Saudi Arabia to reposition itself as a driving force in the global transition to renewable energy and sustainable urbanization. Although the project has faced skepticism from researchers and business leaders, it has continued to attract significant partners and investors looking for alternatives to conventional, petroleum-dependent technologies. Through careful planning and the incorporation of the lessons learned from previous sustainable projects, as well as the goals outlined in Saudi Arabia's Vision 2030, the government has set a new threshold for sustainable urbanization. The success of NEOM will depend on fulfilling the investment requirements and effectively managing the associated risks. If successful, the project has the potential to have a tangible impact on the country's economy and reputation as a leader in sustainability. Although NEOM raised considerable skepticism from researchers and business leaders, the project represents one of the most ambitious plans to create sustainable planned cities with net-zero carbon levels. Introduced and funded by the country that seeks to shift toward renewable energy sources, it continues attracting significant partners and investors looking for alternatives to conventional petroleum-dependent technologies. Nevertheless, NEOM has to overcome economic obstacles and attract additional investors to avoid the fate of Masdar City.

7. Contributions and Limitations

The extant research makes several scientific contributions to the field. First, a risk management framework was applied to evaluate the potential challenges and opportunities

associated with NEOM and other urban megaprojects. This framework can be useful for policymakers and stakeholders who are considering similar projects in other countries and cities. Second, the research provided insights into the potential economic impacts of NEOM on Saudi Arabia, including the potential for job creation and economic growth, as well as the potential costs and risks associated with the project.

There are also several limitations to the current research. First, this paper relied on data from the project's official website and other published sources, which may not provide a complete or unbiased view of NEOM. Further research using additional sources of data and analysis may be needed to fully understand the potential economic impacts and risk management challenges of NEOM. Second, this study is focused on NEOM specifically and may not be generalizable to other sustainable city projects or urbanization efforts in other countries. Finally, the research is based on the current state of the NEOM project, and the actual economic impacts and risk management challenges may differ from the resulting predictions as the project progresses.

Overall, the current scientific inquiry provides valuable insights into the potential contribution of NEOM to the economy and sustainability goals of Saudi Arabia. By evaluating the potential challenges and opportunities associated with the project, this study has contributed to a better understanding of the potential economic impacts and risk management challenges of sustainable urbanization.

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