

# CASE-BASED EXPLORATION OF THE NEXUS BETWEEN TRANSFORMATIVE URBAN MEGADEVELOPMENTS AND SUSTAINABILITY

**Ioannis VARDOPOULOS**

*School of Environment, Geography and Applied Economics, Harokopio University of Athens,  
17676 Kallithea, Greece  
ivardopoulos@post.com*

**Christos GEORGIU**

*School of Architecture, Land, Environmental Sciences, Neapolis University Pafos, 8042 Pafos,  
Cyprus  
c.georgiou.10@nup.ac.cy*

**Irene VOUKKALI**

*Laboratory of Chemical Engineering and Engineering Sustainability, Open University of Cyprus,  
Latsia, 2220 Nicosia, Cyprus  
irene.voukkali1@ouc.ac.cy*

**Constantinos VASSILIADES**

*School of Architecture, Land, Environmental Sciences, Neapolis University Pafos, 8042 Pafos,  
Cyprus  
c.vassiliades@nup.ac.cy*

**Luca SALVATI**

*Department of Methods and Models for Economics, Territory and Finance, Faculty of  
Economics, Sapienza University of Rome, 00161 Rome, Italy  
luca.salvati@uniroma1.it*

## **Abstract**

Focused on examining the intricate interplay between megadevelopments and sustainability, this paper analyzes four (4) international cases. The study identifies strengths, weaknesses, opportunities, and threats inherent in megadevelopments, understood as large-scale urban real estate projects with transformative effects on their surroundings, requiring comprehensive planning. Concerns about environmental impacts arise, but the research showcases notable sustainability practices, including advanced technologies and management methods dedicated to mitigating social, economic, and environmental consequences. Results highlight the importance of sustainable decision-making, governance, and policies for urban megadevelopments. The current research contributes to sustainable urban development and planning knowledge, revealing challenges and opportunities posed by megadevelopments. Further research should delve into sustainable urban transformation complexities, advancing collective understanding in this vital field.

**Keywords:** Sustainable Development, Mega-Projects, Large-scale Projects, Sustainable Construction, Sustainable infrastructure, Sustainable City Planning, Project Management, SWOT analysis

## 1. INTRODUCTION

Megadevelopments (or other synonymous –despite potential subtle divergences in their nuanced interpretations– terms such as megaprojects, megaconstructions, megainfrastructures, megabuildings, used in scholarly literature) for the context of this study, are defined as large-scale and intricate (urban) (infra-structural/ property) projects that necessitate significant investment, time, and resources (Skayannis, 2021). Beyond their distinctive scale, megadevelopments are notable for their transformative impact on urban dynamics, landscapes, and lifestyles. They encompass a wide spectrum of initiatives, ranging from the creation of entirely new districts, the revitalization of existing neighborhoods, the establishment of expansive mixed-use complexes, and the development of extensive infrastructural networks. Key part of megadevelopments is the urban planning process, which combines residential, commercial, recreational, and infrastructural components into a unified plan to create cohesive and well-functioning (urban) areas. Based on these grounds, megadevelopments –inevitably– have strong and long-term impacts on the environment, economy, and society (Mitoula & Papavasileiou, 2023). However, the sustainable development of megadevelopments is still a significant challenge for project managers, policymakers, and stakeholders. In recent years, there has been growing concern about the sustainability of megadevelopments and their potential negative impacts on the environment and society (Thounaojam & Laishram, 2022). Sustainable development, defined by the United Nations (UN) as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (Kyriakogkonas et al., 2022), is a critical concept that should be considered in the planning, development, and operation of megadevelopments (Wang et al., 2020). The United Nations's Sustainable Development Goals (SDGs) provide a framework for sustainable development, comprising 17 interrelated goals and 169 targets that address a range of social, economic, and environmental issues (Kempton et al., 2022). Megadevelopments can contribute to various SDGs, such as goals 9, 11, and 13 (Fei et al., 2021; Mylonas & Xenidis, 2018). However, achieving sustainable megadevelopments requires monitoring and measuring the performance of projects against relevant sustainability indicators (G. Wu et al., 2018). For instance, the Global Reporting Initiative (GRI) Sustainability Reporting Standards provide a set of indicators for measuring sustainability performance in various areas, such as governance, environment, social, and economic (Corazza et al., 2022). By using such indicators, the sustainability of megadevelopments can be assessed and improved (Lin et al., 2017). There are also several sustainability standards and rating systems that aim to promote sustainable development in the construction industry, such as Leadership in Energy and Environmental Design (LEED) and Building Research Establishment Environmental Assessment Method (BREEAM) (Orlov, 2017; Vardopoulos, Santamouris, et al., 2024). These systems provide a framework for assessing the sustainability performance of construction projects,

taking into account factors such as energy efficiency, water conservation, and material sourcing (Marandi Alamdari et al., 2023; Vardopoulos, Giannopoulos, et al., 2023). However, while these systems have gained widespread recognition, there is still a need to evaluate their effectiveness in promoting sustainable development in megadevelopments.

As previously discussed, despite the significant investments in megadevelopments, their sustainability has remained a major concern. Therefore, this study aims to investigate the relationship between megadevelopments and sustainability and identify the challenges and opportunities for sustainable megadevelopment development. The negative impacts of megadevelopments on the environment, economy, and society have been well documented in the literature (Thounaojam & Laishram, 2022; Vanclay, 2016; Vardopoulos, 2022). Megadevelopments often have high carbon emissions, contribute to climate change, and displace local communities. Moreover, the cost and time overruns associated with megadevelopments have often led to significant financial losses (Shaikh, 2020). In addition, the lack of stakeholder involvement and participation in megadevelopment decision-making has led to conflicts and protests, resulting in project delays and cancellations (Xue et al., 2020). Furthermore, the sustainable development of megadevelopments faces several challenges, including the lack of a comprehensive sustainability framework, the difficulty of balancing economic, environmental, and social factors, and the lack of stakeholder engagement and participation (Ezzat Othman, 2013; Thounaojam et al., 2022; Thounaojam & Laishram, 2022; Wang et al., 2020; Ward & Skayannis, 2019). In addition, the complexity and uncertainty of megadevelopments, spanning financial, regulatory, technical, and even stakeholder engagement aspects –inherent in their planning and development– pose significant challenges to project managers and decision-makers (Salet et al., 2013).

The main objective of this study is to analyze the extent to which megadevelopments can be developed in a sustainable manner. Specifically, this research aims to:

1. Identify the key sustainability challenges facing megadevelopments across different sectors, contexts, and stages of the project lifecycle, using a set of case studies drawn from the literature.
2. Conduct a comprehensive SWOT analysis of megadevelopments, in order to assess the strengths, weaknesses, opportunities, and threats associated with these projects, with the sustainable development goals serving as a contextual backdrop guiding the exploration of sustainability.
3. Discuss the implications of the findings for future research and practice, by providing insights into the factors that can enhance or hinder the sustainability of megadevelopments, and by

highlighting the need for a more integrated and holistic approach to project planning, management, and evaluation.

These objectives are intended to guide the research process and provide a clear framework for the analysis and discussion of the findings.

This study focuses on examining the challenges and opportunities for sustainable in megadevelopments. It analyzes four (4) diverse case studies to identify the strengths, weaknesses, opportunities, and threats of sustainable megadevelopment development. Additionally, a SWOT analysis is conducted to identify the internal and external factors that influence the sustainability in megadevelopments.

## 2. METHODOLOGY

This study employs a qualitative research approach to explore megadevelopments and sustainability. The research design involves a descriptive analysis of four (4) case studies, followed by a SWOT analysis.

The descriptive analysis of each case study provides an in-depth understanding of the sustainability features and challenges of each megadevelopment. The four (4) case studies selected for this study are the Queen Elizabeth Olympic Park in London, UK, the Apple Park in California, US, the Quzhou Sports Campus in China, and the National Library of Greece and the Greek National Opera premises, composing the Stavros Niarchos Foundation Cultural Center in Greece. The chosen case studies appear to be solid choices from a scientific perspective. They are diverse in terms of their sector and geographic scope, and are all relevant to the research questions and objectives set for the scope of the current study, as they have been built with sustainability as a key objective. This allows for a comprehensive analysis of different approaches to sustainability in megadevelopments, and the potential to draw insights and recommendations for future megadevelopments. By selecting case studies that are representative, relevant, and diverse, the study is better positioned to produce meaningful and valuable insights for the field of megadevelopments and sustainability.

The SWOT analysis was selected for this study; mostly due to its benefits and suitability (Pavlidis et al., 2023; Vardopoulos, Papoui-Evangelou, et al., 2023). The SWOT analysis is a widely used and straightforward tool that can provide a comprehensive framework for analyzing the internal and external factors that can impact the success of a megadevelopment (Vardopoulos et al., 2021; Vershitsky et al., 2021). It enables the identification of strengths, weaknesses, opportunities, and threats, and is easily understood by a wide range of stakeholders (Loizia et al., 2021; Stylianou et al., 2023). Moreover, the SWOT analysis is a standardized tool that facilitates the comparison, thereby allowing the identification of patterns and trends (Vardopoulos & Theodoropoulou, 2020; Voukkali & Zorpas, 2022). While other

options, such as Porter's Five Forces analysis, or PEST analysis, or SOAR (Vardopoulos, Giannopoulos, et al., 2023), may have been considered, but not chosen as they do not provide the same level of comprehensiveness –at least for this particular study. Overall, the SWOT analysis is a valuable tool for identifying key factors that impact the success of megadevelopments and informing recommendations for future projects.

The findings of this study contribute to the existing knowledge on megadevelopments and sustainability, highlighting best practices and areas for improvement in future megadevelopments.

### 3. RESULTS

#### 3.1. *Queen Elizabeth Olympic Park: Carbon neutrality through innovative design*

The Queen Elizabeth Olympic Park in London, UK, is a megadevelopment that has transformed an area of East London into an innovative development with a focus on sustainability (Azzali, 2017). The park was built on the vision of creating a thriving new district in London based on three key themes: People, Places, and Performance (Hopkins & Neal, 2013). People are encouraged to live sustainable lives with low carbon footprints, resource efficiency, and healthy lifestyles, while Places consist of sustainable parklands, waterways, and walkable neighborhoods prepared for the impacts of climate change (Gold & Gold, 2013). Performance is based on sustainable procurements and long-term environmental management and proactive strategies.

The park's sustainability work focuses on four main themes: Smart Park, Future Living, Neighborhoods, and the Garden District. These themes aim to utilize data and innovative technologies to enhance the park, test and demonstrate innovative approaches to living near the park and in its communities, design and develop the park's communities to enable sustainable lifestyles, and create a biodiverse and sustainable district of London (Daothong & Stubbs, 2014).

The park's sustainability efforts are evident in the land reclamation and repurposing of facilities, reduction of carbon emissions in all of its operations, and favorable impacts and services provided to the community (Stevenson, 2016). Specifically, the park's commitment to sustainability is evidenced by its use of renewable energy sources, such as biomass and solar power, which have resulted in a 50% reduction in carbon emissions compared to traditional energy sources (Kirk, 2015). The park has also reduced waste generation by implementing a zero-waste policy and promoting recycling, composting, and reuse (Parkes et al., 2015). In addition, the park promotes sustainable transportation options by providing bike rental facilities, shuttle buses, and access to public transit. The economic and social benefits of the project are

also evident, with the park creating over 40,000 jobs and providing improved public health outcomes through increased access to green space and active transportation options (Dawson, 2017).



FIGURE 1 - AERIAL VIEW OF QUEEN ELIZABETH OLYMPIC PARK (2022). SOURCE: ARNE MÜSELER / WWW.ARNE-MUESELER.COM, CC BY-SA 3.0 DE, VIA WIKIMEDIA COMMONS

This megadevelopment is congruent with various SDGs, actively contributing to sustainable urban development, climate change mitigation, responsible consumption and production, enhanced health and well-being, community engagement, and biodiversity conservation, making it an exemplary case study for understanding the sustainability of megadevelopments. More specifically, the project contributes to SDG 11 by transforming a historic community into a sustainable hub for living, working, studying, and visiting (McCullough et al., 2021). Furthermore, its emphasis on sustainable parklands, waterways, and walkable neighborhoods prepares it for climate change impacts, thereby supporting addressing SDG 13. Additionally, the project's commitment to sustainable procurement and long-term environmental management mirrors SDG 12. The project's sustainable living initiatives also contributed to SDG 3, by promoting healthy lifestyles with low carbon footprints and resource efficiency. Moreover, the project's focus on neighborhood development and community involvement reflects its contribution to SDG 16. Lastly, the project's dedication to creating a biodiverse and sustainable urban district in London directly contributes to SDG 15.

### 3.2. *Apple Park: Corporate sustainability through closed-loop systems*

The Apple Park mega-project, is a prime example of how a sustainable approach can be taken in the construction of a megadevelopment (Yun et al., 2018). The campus is built with a focus on sustainability and ecological responsibility (Apanaviciene et al., 2020). It features a vast green space, powered by renewable energy, which includes a low-carbon emission on-site power plant. The campus's architecture incorporates solar power for electricity, natural ventilation, and 4,300 hollow concrete slabs that help the building stay cool. These sustainable measures have enabled the campus to reduce its carbon footprint significantly. The Apple Park has reduced its water usage by 60% compared to typical office buildings, and its solar panels generate 17 MW of energy, which is sufficient to power 75% of the campus during peak daytime.



FIGURE 2 - AERIAL VIEW OF APPLE CAMPUS (2018). SOURCE: DANIEL L. LU, CC BY-SA 4.0, VIA WIKIMEDIA COMMONS

The campus's circular design represents security, protection, and autonomy, aligning with Apple's values on technology and environment (Cooke, 2020). The building's construction materials are locally sourced, and the campus's architecture includes natural light to reduce energy consumption (Malфона, 2018). The campus's landscaping was achieved by restoring indigenous plant life and recycling water systems, with 7,000 trees and plants planted around the campus, which promotes employee health by offering a 100,000-square-foot fitness center, healthy food options, and outdoor activities.

The campus's sustainable practices are significant in their impact on the environment and the community. By promoting sustainable transportation, ride-sharing is encouraged, and 1,000 bikes are available for staff to use. The campus's sustainable practices have enabled it to become relevant to all SDGs, including goals 7, 9, 11, and 13.

The Apple Park has achieved a balance between the physical and virtual, and the local and global spaces in such a massive development, making it a sustainable megadevelopment. By integrating sustainable design and promoting sustainable practices, the campus has become a significant contributor to the community's social, environmental, economic, and human factors. The Apple Park is a valuable case study for understanding the sustainability of megadevelopments, demonstrating how sustainable practices can be integrated into the design and operation of a large-scale development.

### **3.3. Quzhou Sports Campus: Integrating sports and ecology into sustainable urban design**

The Quzhou Sports Campus in China is a massive development that aims to create a connection between the historic city and the natural landscape while providing a tranquil environment for visitors to enjoy. The project reflects several SDGs, including goals 1, 3, 5, 9, 10, and 11. The development has significant social and environmental impacts on the sustainable expansion of cities, creating a new period of harmony between humans and the environment.



FIGURE 3 - AERIAL ILLUSTRATION OF QUZHOU SPORTS CAMPUS. SOURCE: WWW.I-MAD.COM



One of the significant sustainable strategies employed in this project is the use of earth covering for the main facilities, providing good thermal mass and stabilizing the temperature. Additionally, studies on sunlight and wind were conducted to integrate natural ventilation systems that are responsive to wind conditions. These sustainable strategies create an environmentally friendly space that reduces the campus's carbon footprint and enhances the natural environment, directly contributing to goals 7, 12, 13, and 15.

The Quzhou Sports Campus exemplifies the "Sponge City" concept, which was introduced in China in 2014 as an urban water management initiative, addressing goals 6 and 14. This approach involves covering land or buildings with a layer of soil that can absorb and retain water during periods of rainfall, thus mitigating the risks of flooding and water scarcity during dry spells. The project also utilizes an artificial lake as a cooling and heating system, contributing to a lower carbon footprint.

The campus comprises a 30,000-person-capacity stadium, a 10,000-person-capacity gymnasium, a natatorium, outdoor training grounds, a service and experience center, and a children's area. Communal areas such as a science and technology museum, hotel accommodations, youth center, and retail premises are also developed. The structures are integrated into the terrain and the facades blend into the earth, surrounded by verdant vegetation, transforming the campus into the landscape itself.

Moreover, the development of this project has created new opportunities for accommodation and employment for local communities, supporting goal 8. The project also promotes gender equality and inclusivity, contributing to SDG 5. Additionally, the campus's sustainable practices have enabled it to become relevant to all SDGs, including goals 9, and 11.

In conclusion, the Quzhou Sports Campus is an excellent example of how sustainable development can contribute to multiple SDGs, creating a positive impact on both the environment and society. The project's sustainable practices, such as the use of natural ventilation systems and the "Sponge City" concept, contribute to a lower carbon footprint and enhance the natural environment. The development of the project has also created new opportunities for accommodation and employment for local communities, promoting decent work and economic growth.

#### **3.4. *The Stavros Niarchos Foundation Cultural Center: Green Oasis of Sustainable Innovation***

The National Library of Greece and the Greek National Opera premises, compose the Stavros Niarchos Foundation Cultural Center, often simply referred to as the 'Cultural Center', stands as a beacon of sustainable innovation amidst the urban landscape of Athens. This megadevelopment seamlessly integrates architectural excellence with environmental consciousness, creating a harmonious nexus of culture, nature, and sustainable practices (Karachalis & Sarantakou, 2023).

At the heart of the Cultural Center lies a huge urban park, a meticulously designed green haven covering 85% of the site. Conceived by landscape architects Deborah Nevins & Associates, the park is a testament to the region's botanical heritage. The park's composition is inspired by Italian, French, and English landscape styles, providing not just aesthetic beauty but also functionality. Amidst panoramic views of the city, visitors are enveloped in a world that fosters a connection with nature while addressing climatic extremes. Nevins' choice of drought-resistant plants and innovative water management techniques, including desalinated seawater, ensures the park's sustainability amidst Athens' challenging climate.

The Cultural Center's commitment to ecological preservation is evident through the selection of indigenous endangered species, promoting biodiversity and restoring the region's ecological balance. A "Sponge City" concept is embodied in the park, using a layer of soil to absorb and retain rainwater, mitigating floods and water scarcity. This approach supports SDGs, and in particular goals 6, and 15, showcasing a paradigm shift towards ecologically conscious urban planning.

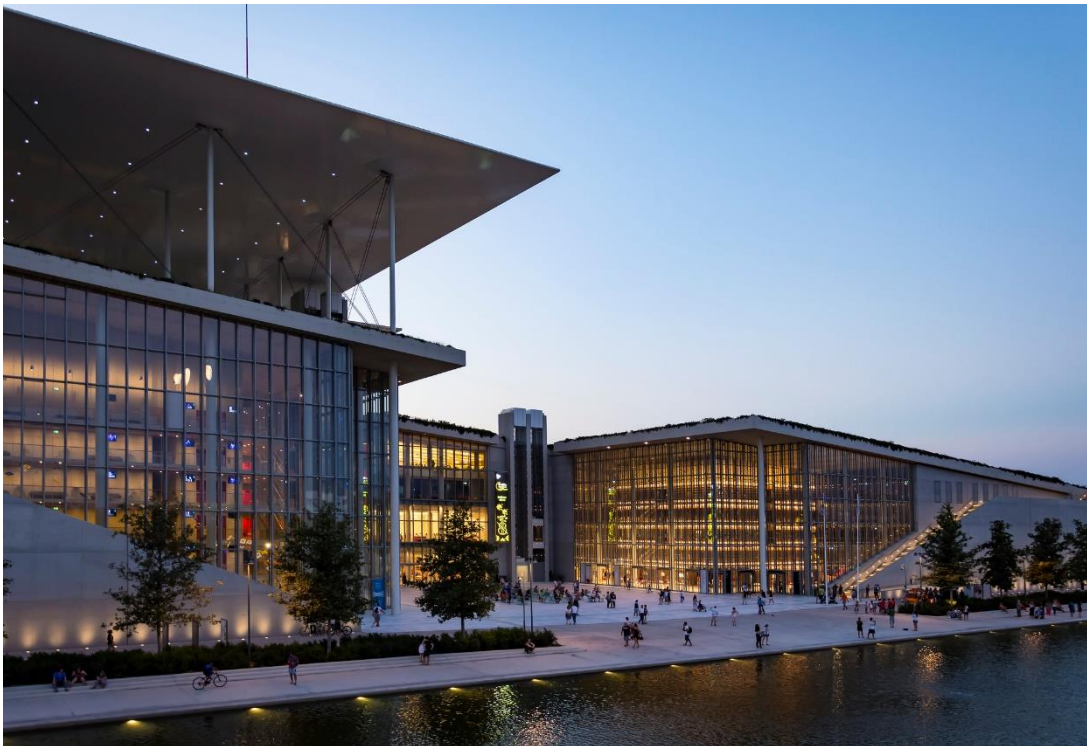


FIGURE 4 - VIEW OF THE NATIONAL LIBRARY OF GREECE AND THE GREEK NATIONAL OPERA PREMISES IN KALLITHEA (2017). SOURCE: AVA BABILI, ATTRIBUTION-NONCOMMERCIAL-NO DERIVS VIA FLICKR

The architectural brilliance of the Cultural Center extends to its structures, incorporating innovative technology like the ferro-cement canopy panels that integrate solar panels (Makowska, 2021). This canopy generates energy through solar power, providing a portion of the facility's electricity demand while reducing its carbon footprint. By optimizing critical systems, reducing natural gas consumption, and

streamlining irrigation practices, the Cultural Center has achieved remarkable energy efficiency, leading to annual energy savings and significant reductions in CO2 emissions (Kalfa & Kalogirou, 2017).

Situated in the densely populated district of Kallithea, the Cultural Center serves as an urban oasis amidst limited green spaces in Athens metropolitan area. As a key recreational and cultural hub, it offers respite to the community and visitors alike, revitalizing a district with historical significance. The park itself addresses the urgent need for greenery, exemplified by the prevailing low green space ratios in the city. Its multifaceted benefits extend beyond cultural enrichment, encompassing physical health, environmental conservation, and social well-being.

The Cultural Center's innovative blend of sustainable design, indigenous flora preservation, energy efficiency, and community engagement sets a remarkable precedent for megadevelopments globally. As an emblem of sustainable urban transformation, the Cultural Center mirrors numerous SDGs, including – among others– goals 7, 11, and 13. Its harmonious integration of architecture, nature, and sustainability underscores the transformative power of conscious design on the trajectory of urban development.

### 3.5. SWOT Analysis

The SWOT analysis was conducted to assess the environmental and sustainability performance of four (4) megadevelopment case studies: the Queen Elizabeth Olympic Park in London, UK, the Apple Park in California, USA, the Quzhou Sports Campus in China, and the Cultural Center in Athens metropolitan area (Kallithea), Greece. The analysis was carried out based on extensive research, including a review of available literature, reports, and documents related to each project's environmental and sustainability initiatives. The strengths, weaknesses, opportunities, and threats were identified, and the results were used to evaluate each project's overall environmental and sustainability performance.

Across all four (4) case studies, notable strengths were identified, demonstrating a commitment to innovation and sustainable practices. These projects prioritize environmental responsiveness, resource efficiency, and community and cultural sensitivity, actively supporting the SDGs. They serve as pragmatic and methodological examples of sustainable planning and environmental sensitivity, offering valuable insights into urban development. These projects not only create tourist clusters and new community services but also establish sustainable communities by incorporating unique cultural values that prioritize the human factor in all development operations.

On the flip side, the analysis revealed weaknesses common to similar megadevelopments. Challenges include cost overruns and benefits shortfalls. Some projects, like the Apple Park, faced criticism for their environmental impact and non-renewable resource use during construction. Reliance on government

policies and funding for sustainability initiatives poses sustainability risks, potentially affecting long-term sustainability.

These transformative urban megadevelopments offer opportunities to advocate for sustainable development in large-scale projects, inspiring global adoption of environmentally responsible practices. Their potential to drive economic growth through tourism, serve as models for sustainable building, showcase sustainability on an international stage, promote cultural and environmental exchange, and enhance community resilience during crises amplifies their positive impact and influence on the future of urban development.

Potential conflicts between economic development and sustainable practices were identified as threats. In some cases, megadevelopments may prioritize economic development over sustainability, resulting in environmental degradation and adverse social impacts. Additionally, political instability and changes in government policies can disrupt sustainability initiatives, as exemplified in the Queen Elizabeth Olympic Park, where shifts in policy led to changes in sustainability priorities.

Overall, the SWOT analysis provides insight into the environmental and sustainability performance of these four (4) megadevelopments and highlights areas for improvement in sustainable planning and development.

TABLE 1 - ASSESSING MEGADEVELOPMENT SUSTAINABILITY: A SWOT ANALYSIS

**Strengths**

- **Strong Commitment to Sustainability:** All four (4) megadevelopments share a common strength in their unwavering commitment to sustainability. They have embraced innovative design and sustainable practices to reduce their environmental impact while achieving their respective project goals.  
*Cf. (Orueta & Fainstein, 2008) for additional context.*
- **Third-Party Certifications:** The collective achievement of third-party certifications, including LEED and BREEAM, demonstrates a shared dedication to meeting and surpassing rigorous sustainability standards, setting a high standard for transformative urban development projects globally.  
*Cf. (Cole & Jose Valdebenito, 2013) for additional context.*
- **Innovative Building Design:** The incorporation of innovative building designs, such as the world's largest naturally ventilated building and the use of ferro-cement canopy panels with integrated solar panels, reflects a collective strength in utilizing cutting-edge technology to enhance energy efficiency and reduce carbon footprints.  
*Cf. (Brooks & Rich, 2016) for additional context.*

**Weaknesses**

- **Scale and Complexity Challenges:** The sheer scale and complexity inherent in transformative urban megadevelopments pose challenges to implementation and management. This common theme can lead to cost overruns and schedule delays, impacting the efficiency of project delivery.  
*Cf. (C. Wu et al., 2018) for additional context.*
- **Environmental Impact and Sustainability Trade-offs:** Despite their sustainability efforts, all four (4) megadevelopments still have significant environmental impacts. These include land use and carbon emissions associated with construction, transportation, and energy consumption. Balancing sustainability with development needs remains a shared challenge.  
*Cf. (del Cerro Santamaría, 2021) for additional context.*
- **Social and Community Displacement:** Both the Queen Elizabeth Olympic Park and the Cultural Center faced criticism for their roles in displacing local residents and businesses during redevelopment. Addressing the social consequences of megadevelopment, such as community displacement, remains a challenge shared by these projects.

- **Renewable Energy Integration:** All four (4) megadevelopments have prioritized the integration of renewable energy sources like solar and wind power into their designs, highlighting a shared strength in harnessing clean energy and promoting sustainability.  
*Cf. (Sliz-Szkliniarz, 2013) for additional context.*
  - **Resource-Efficient Systems:** The implementation of resource-efficient systems and technologies, such as water-efficient fixtures, rainwater harvesting, and the "Sponge City" concept, collectively demonstrates strength in reducing resource consumption and addressing environmental challenges like water scarcity and flooding.  
*Cf. (Barykin et al., 2022) for additional context.*
  - **Community and Well-Being:** Each of these megadevelopments contributes positively to the communities they serve, offering green spaces, cultural enrichment, physical well-being, and employment opportunities, thus strengthening the social fabric and overall quality of life in their respective regions.  
*Cf. (Chaberek-Karwacka & Ziółkowska, 2017) for additional context.*
  - **Revitalization and Heritage Preservation:** By repurposing underutilized land, promoting biodiversity, and revitalizing historical districts, these megadevelopments collectively demonstrate a strength in preserving local heritage and promoting sustainable urban transformation.  
*Cf. (Said, 2018) for additional context.*
  - **Holistic Approach to Sustainability:** Together, these megadevelopments exemplify a holistic approach to sustainability, integrating architectural excellence, environmental consciousness, and community engagement to create harmonious, sustainable urban environments.  
*Cf. (Mylonas & Xenidis, 2018) for additional context.*
- Opportunities**
- **Sustainable Development Advocacy:** These megadevelopments demonstrate the potential for sustainable development of large-scale infrastructure projects, which can inspire other developers and cities globally to prioritize sustainability in their future projects, leading to broader adoption of environmentally responsible practices in urban development.  
*Cf. (del Cerro Santamaria, 2021; Kennedy, 2015) for additional context.*
  - **Economic Growth Through Tourism:** The Queen Elizabeth Olympic Park and Quzhou Sports Campus have shown the capacity to attract tourists, driving economic development in their respective regions. This sets the stage for similar cultural and recreational facilities to stimulate local
- Threats**
- **Economic Uncertainty:** Uncertain global economic conditions, such as economic recessions or financial crises, can impact the financial stability of these megadevelopments. Economic downturns may lead to reduced funding availability, affecting the progress and completion of projects.  
*Cf. (Agaurov & Zykova, 2023) for additional context.*
  - **Resource Availability:** The availability of essential resources, including construction materials, water, and energy, can be vulnerable to supply chain disruptions, resource scarcity, or price fluctuations. These factors can increase project costs and impact timelines.  
*Cf. (Shenoy & Mahanty, 2021) for additional context.*
  - **Regulatory and Permitting Challenges:** Evolving or stringent regulations permit delays, or changes in
- Cf. (Dziomba & Matuschewski, 2007) for additional context.*
- **Transportation and Accessibility Concerns:** Apple Park's reliance on single occupancy vehicles for transportation and the remote location of the Quzhou Sports Campus are examples of transportation-related challenges. Ensuring accessibility and sustainable transportation solutions are important common weaknesses.  
*Cf. (Priemus, 2010) for additional context.*
  - **Public Infrastructure Strain:** The extensive scale of these transformative urban megadevelopments can strain public infrastructure, such as transportation networks, utilities, and public services. This strain can lead to congestion, increased demand for resources, and potential challenges in accommodating the needs of both new and existing residents.  
*Cf. (Altshuler & Luderoff, 2004) for additional context.*
  - **Financial Viability and Funding:** Securing and managing funding for such large-scale projects can be a recurring challenge. Financial sustainability is a common concern, as these developments often require substantial investment for construction, maintenance, and ongoing operation. Ensuring long-term financial viability and stability is critical.  
*Cf. (Thounaojam & Laishram, 2022) for additional context.*

economies, create jobs, and enhance the quality of life for residents.

*Cf. (Abbas et al., 2024; Karachalis & Sarantakou, 2023) for additional context.*

- **Sustainable Building Models:** Apple Park's innovative design and sustainability features can serve as a model for other corporate campuses and office buildings worldwide. This presents an opportunity for businesses to adopt greener building practices, improving indoor air quality, and prioritizing employee well-being while also reducing their environmental impact.

*Cf. (Abu Aisheh, 2021; Caprotti, 2017) for additional context.*

- **Global Sustainability Showcase:** The Quzhou Sports Campus, with its sustainable initiatives, offers a unique opportunity to showcase the benefits of sustainable development to the global community (e.g. while hosting sports events). This international stage can highlight the positive environmental and social impacts of sustainable megadevelopments, influencing other sports event host cities/ developments and promoting responsible urban development practices.

*Cf. (Brooks & Rich, 2016) for additional context.*

- **Cultural and Environmental Exchange:** The Cultural Center can play a pivotal role as a hub for cultural and environmental exchange. By hosting international events, exhibitions, and performances that promote cultural understanding and sustainability, it can foster global collaboration and awareness while enhancing its role as a catalyst for positive change.

*Cf. (Li et al., 2019) for additional context.*

- **Community Resilience and Crisis Response:** Transformative urban megadevelopments, with their extensive infrastructure and facilities, can play a pivotal role in enhancing community resilience during crises. They have the potential to adapt and serve as crisis response centers, including the transformation into field hospitals during pandemics or providing shelter and essential resources in the aftermath of natural disasters. This multi-purpose functionality enhances their value to the community and reinforces their positive impact beyond their primary objectives.

*Cf. (Abbas et al., 2024; Vardopoulos & Tsilika, 2020) for additional context.*

government policies can pose significant threats. Compliance with new or changing environmental and zoning regulations may require costly modifications or project delays.

*Cf. (Plotch, 2015) for additional context.*

- **Community Resistance and Protests:** Community opposition or protests related to issues like environmental concerns, land use, or displacement of local residents can pose challenges to megadevelopments establishment. Public resistance can lead to legal battles, delays, and reputational damage.

*Cf. (Jordhus-Lier, 2015) for additional context.*

- **Technological Advancements:** Rapid technological advancements may render certain aspects of a megadevelopment obsolete or outdated. For instance, advancements in transportation or construction technology could impact the viability of existing transportation or infrastructure systems.

*Cf. (Priemus & van Wee, 2013) for additional context.*

- **Geopolitical Instability:** Geopolitical tensions, conflicts, or changes in international relations can have indirect consequences on megadevelopment projects, affecting investment, trade, and political support.

*Cf. (Jia et al., 2011; Vickerman, 2008) for additional context.*

- **Environmental Vulnerability:** Climate change and the increasing frequency of extreme weather events can pose significant threats, especially to megadevelopments located in areas prone to sea-level rise, hurricanes, or wildfires. These events can damage infrastructure, disrupt operations, and incur substantial recovery costs.

*Cf. (Annema & Priemus, 2013; Söderlund et al., 2017) for additional context.*

- **Resilience to Shocks and Crises:** Megadevelopments should be prepared for unexpected shocks and crises, such as pandemics, or natural disasters. These events can disrupt normal operations, reduce tourism, and affect the economic performance of these projects. The lessons learned from handling events like the COVID-19 pandemic should inform strategies for building resilience and adapting to unforeseen challenges.

*Cf. (Alaimo et al., 2022; Tsiotas et al., 2023) for additional context.*

Source: Authors' elaboration

#### 4. DISCUSSIONS

The discussion of megadevelopments and sustainability has become increasingly important as the world moves towards a more sustainable future (Wang et al., 2020). Megadevelopments can have significant impacts on the environment and communities close to where they are located (Vanclay, 2016).

Sustainability, on the other hand, refers to meeting the needs of the present without compromising the ability of future generations to meet their own needs (Vardopoulos, Escrivà Saneugenio, et al., 2024). In recent years, there has been a growing recognition of the need to integrate sustainability considerations into the planning, design, and construction of megadevelopments (Cantoni & Pagnone, 2020; del Cerro Santamaría, 2021; Vardopoulos, 2023).

The case studies of the Queen Elizabeth Olympic Park, Apple Park, Quzhou Sports Campus, and the Cultural Center provide important examples of how megadevelopments can be designed and built with sustainability considerations in mind. The Queen Elizabeth Olympic Park in London was designed with the goal of creating a sustainable legacy for the city after the 2012 Olympic Games. The park was designed with the principles of sustainability in mind, including the use of renewable energy, green spaces, and sustainable transport options. Similarly, Apple Park in California was designed to be one of the most sustainable corporate campuses in the world. The project incorporates a number of sustainability features, including a large solar array, a cooling system that uses natural ventilation, and a water recycling system. Apple Park is an excellent example of how megadevelopments can incorporate sustainable design principles to achieve significant reductions in energy use and greenhouse gas emissions.

The Quzhou Sports Campus in China is another example of a megadevelopment designed with sustainability in mind. The campus was designed to be a model for sustainable urban development, incorporating a range of sustainable features such as the use of renewable energy, green spaces, and water conservation measures. The project demonstrates the potential for sustainable megadevelopments to have significant positive impacts on the environment and surrounding communities.

The Cultural Center in Athens metropolitan area (Kallithea), Greece, represents a unique blend of cultural and environmental sustainability. With its meticulously designed green haven covering 85% of the site and innovative water management techniques, the Cultural Center showcases the preservation of botanical heritage and biodiversity while supporting sustainability goals.

Despite these positive examples, there are also significant challenges to incorporating sustainability considerations into the planning and design of megadevelopments (Souliotis et al., 2014). One of the main challenges is the sheer scale and complexity of these projects, which can make it difficult to achieve sustainability goals (Denicol et al., 2020). Additionally, there may be competing priorities such as cost, schedule, and technical considerations that can make it challenging to prioritize sustainability.

Another challenge is the lack of consensus on what constitutes sustainability in the context of megadevelopments. There are many different definitions and frameworks for sustainability, and it can be difficult to determine which approach is best suited for a particular project. Additionally, there may be

trade-offs between different sustainability goals, such as environmental sustainability versus social or economic sustainability.

Despite these challenges, there are many reasons why incorporating sustainability considerations into the planning and design of megadevelopments is important. By designing and building these projects with sustainability in mind, it is possible to minimize these negative impacts and maximize the positive benefits.

Additionally, there is a growing recognition that sustainability considerations can actually be beneficial for megadevelopments in terms of reducing costs, improving efficiency, and enhancing the reputation of the project (Metaxas et al., 2023). Sustainable design principles such as energy efficiency and water conservation can lead to significant cost savings over the lifetime of the project. Similarly, incorporating sustainable design principles into a project can enhance the project's reputation and increase its attractiveness to investors and stakeholders (Winch, 2017).

Megadevelopments have indeed the potential to have significant positive or negative impacts on the environment and surrounding communities (Shenhar & Holzmann, 2017). By incorporating sustainability considerations into the planning (Pissourios, 2013), design, and construction of these projects, it is possible to minimize negative impacts and maximize positive benefits. The case studies of the Queen Elizabeth Olympic Park, Apple Park, Quzhou Sports Campus, and the Cultural Center provide important examples of how this can be achieved. However, there are also significant challenges to incorporating sustainability.

## 5. CONCLUSIONS

In light of the current challenges and opportunities faced by the global and urban communities with respect to megadevelopments, this study questions the capacity of these developments to foster a sustainable relationship with local communities. The primary challenge identified in this study pertains to the sustainability of megadevelopments vis-a-vis eco-friendly urban development. When large-scale urban developments emerge, they also pose high risks and challenges. By strategically utilizing real estate development with sustainable action plans, future generations can be safeguarded and natural resources protected. The relationship between humans and nature involves not only ecology and sustainability but also the emotional and psychological states it engenders. The culture and philosophy that underpin the development of future cities should be environmentally conscious. It is incumbent upon real estate practitioners to convert climate and sustainability challenges into integral development strategies, guiding market decisions towards sustainable and climate-friendly outcomes throughout the business cycle, thereby generating financial and economic benefits for the real estate industry over the medium and long term.



This study examined the role of megadevelopments in promoting sustainability and analyzed four (4) case studies: the Queen Elizabeth Olympic Park in London, UK, the Apple Park in California, USA, the Quzhou Sports Campus in China, and the Cultural Center in Athens metropolitan area (Kallithea), Greece. The analysis revealed that while megadevelopments are typically viewed as harmful to the environment due to their large-scale characteristics and long timetables, they can also be developed in a sustainable manner.

The SWOT analysis highlighted the strengths, weaknesses, opportunities, and threats of sustainable megadevelopments, indicating that innovative technologies and advanced management tools can be utilized to promote sustainable practices. The analysis also showed that sustainable decision-making, governance, and policies were influenced by participants to ensure all operations were on sustainable dimensions. The Quzhou Sports Campus and Cultural Center case studies exemplify the potential for sustainability in megadevelopments by providing pragmatic and methodological examples that contribute to understanding sustainable planning and environmental sensitivity. These projects not only respect nature's fundamental values but also reduce ecosystem destruction while fostering cultural and environmental exchange.

The findings of this study are consistent with earlier research that emphasizes the importance of incorporating sustainability principles into megadevelopments. Previous studies have shown that sustainability-oriented megadevelopments can create value for communities and generate positive economic, social, and environmental impacts. However, megadevelopments face several challenges, including stakeholder conflicts, financing issues, and lack of institutional support. Therefore, successful sustainable megadevelopments require multi-stakeholder collaboration, adequate funding, and strong leadership.

In general, this study underscores the potential of megadevelopments in promoting sustainable urban development, provided that they are developed using a sustainability-oriented approach. The findings of this study have several practical implications for policymakers, project managers, and urban planners who are involved in megadevelopment development. First, it highlights the importance of incorporating sustainability principles into project design, planning, and implementation. Second, it underscores the need for effective governance and stakeholder engagement to ensure sustainable outcomes. Third, it emphasizes the need for innovative financing mechanisms to support sustainable megadevelopments. Finally, it highlights the importance of monitoring and evaluating the performance of megadevelopments to ensure that they are achieving their sustainability objectives.

Overall, this study contributes to the literature on sustainable megadevelopments by providing empirical evidence of the potential of such projects to promote sustainable urban development. The findings of this

study have several theoretical and practical implications that can inform future research and practice in this area. The theoretical implications suggest that megadevelopments can be designed and implemented in a sustainable manner. Case studies and SWOT analysis demonstrate that sustainable development is not only achievable but also beneficial for megadevelopments. By incorporating sustainable practices, such as innovative technologies, efficient resource management, and community engagement, megadevelopments can contribute to sustainable urban development. This study also has practical implications for stakeholders involved in megadevelopments, including project managers, policymakers, investors, and the public. Findings suggest that sustainable practices can be integrated into megadevelopments without sacrificing their goals or benefits. Instead, sustainability can enhance the long-term viability and value of megadevelopments by reducing environmental impacts, enhancing community benefits, and increasing economic returns. Furthermore, the current study contributes to the wider literature on sustainable megadevelopments. The case studies and SWOT analysis support previous research on sustainable urban development and provide empirical evidence of its feasibility in the context of megadevelopments. Findings also highlight the importance of stakeholder participation and collaboration, which have been identified as key factors in promoting sustainability in megadevelopments. Over all, this study demonstrates that sustainable development is feasible and beneficial for megadevelopments. It provides empirical evidence and practical recommendations for incorporating sustainable practices into megadevelopments, contributing to the wider literature on sustainable urban development. These findings have important implications for stakeholders involved in megadevelopments and inform future research and practice in this area.

Nevertheless, several delimitations should be noted regarding the scope and limitations of this study. Firstly, the study is limited to four (4) case studies. While these case studies were carefully selected to provide a diverse representation of megadevelopments in different sectors and geographies, they may not necessarily represent all types of megadevelopments, and there may be other relevant case studies that were not included in this study. Secondly, the study focuses on the sustainability of the selected case studies during their construction and initial operation phases, with limited analysis of long-term sustainability and the potential impacts of changes in the external environment on the sustainability of these megadevelopments. Thirdly, the study relies on publicly available information sources, which may be limited in scope or biased, potentially affecting the accuracy and reliability of the findings. Lastly, while the study aims to draw insights and recommendations for future megadevelopments based on the analysis of the selected case studies, the findings may not be generalizable to all megadevelopments, as each megadevelopment is unique in terms of its context, objectives, and stakeholders. These delimitations should be taken into consideration when interpreting the findings and drawing conclusions from this study.

To overcome the delimitations of this study and to further explore the sustainability of megadevelopments, future research could focus on several areas. Firstly, expanding the scope of case studies to include a wider variety of megadevelopments in different sectors and geographic locations would provide a more comprehensive understanding of the sustainability challenges and opportunities of megadevelopments. This could be achieved by selecting case studies that represent a range of industries, scales, and contexts, as well as incorporating primary data collection methods such as interviews, surveys, and site visits. Secondly, examining the long-term sustainability of megadevelopments and the potential impacts of changes in the external environment would provide insights into the key factors that affect the sustainability of megadevelopments over time. This could be achieved by conducting follow-up studies that examine the sustainability of the case studies after their initial construction and operation phases. Thirdly, to improve the generalizability of the findings, future research could use a larger sample size and employ statistical methods to analyze the data collected from multiple case studies. Lastly, future research could explore other topics related to megadevelopments and sustainability, such as stakeholder engagement, the impacts of technology and innovation, and the integration of sustainability principles into the design and planning of megadevelopments. By addressing these areas, future research could further advance our understanding of the sustainability of megadevelopments and provide insights that can inform the design and planning of future megadevelopments.

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Appendix 1

Table 2 - Final list of Sustainable Development Goals

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- 1 End poverty in all its forms everywhere
  - 2 End hunger, achieve food security and improved nutrition and promote sustainable agriculture
  - 3 Ensure healthy lives and promote well-being for all at all ages
  - 4 Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all
  - 5 Achieve gender equality and empower all women and girls
  - 6 Ensure availability and sustainable management of water and sanitation for all
  - 7 Ensure access to affordable, reliable, sustainable and modern energy for all
  - 8 Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all
  - 9 Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation
  - 10 Reduce inequality within and among countries
  - 11 Make cities and human settlements inclusive, safe, resilient and sustainable
  - 12 Ensure sustainable consumption and production patterns
  - 13 Take urgent action to combat climate change and its impacts[b]
  - 14 Conserve and sustainably use the oceans, seas and marine resources for sustainable development
  - 15 Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss
  - 16 Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels
  - 17 Strengthen the means of implementation and revitalize the Global Partnership for Sustainable Development
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