Article

Towards a Holistic Framework for the Olympic-Led Sustainable Urban Planning Process

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Abstract: Sport mega-events, like the Olympics, are renowned for their urban and socioeconomic impacts. Based on a literature review, this paper proposes a holistic framework for an Olympic-led sustainable planning process, encompassing five key sustainable urban principles: accessibility, integration, flexibility/adaptability, security, and sustainability compliance. The framework provides a structured approach to assess these principles at three different temporal and spatial levels: location selection, pre-event planning, and post-event planning. The proposed holistic framework is applied to the Rio 2016 Summer Olympics, revealing a significant disconnection between the initially promised sustainable development goals and practical achievements. While enhancements in accessibility were observed, the other key sustainable urban principles exhibited limited or negligible improvements. The proposed holistic framework holds the potential to foster lasting positive impacts and sustainable urban improvements in host cities, particularly in developing countries.

Keywords: holistic framework; Olympic-led sustainable urban planning; sport mega-event; sustainability; strategic plan; Rio de Janeiro

1. Introduction

Urbanization has been integral to the Olympics since its inception [1]. However, modern Olympic-led urbanization has undergone significant evolution in terms of content, scale, form, and complexity since 1896 [2]. Liao and Pitts [2] identified four distinct stages in Olympic-led urbanization: the first corresponds to the origins of Olympic urbanism (1896–1904), marked by modestly prepared, low-key events with minimal urban intervention; the second is defined by the dominance of the Olympic stadium (1908–1928); the third is marked by the rise of the Olympic Village (1932–1956); and the fourth represents the age of urban transformation (1960–2012). These stages highlight the increasing impact of the Olympics on host cities, leading to extensive urban transformation processes [3]. Indeed, they have the potential to change and develop urban structures [4] and act as powerful forces shaping cities [5]. Some scholars have stated that the Olympic Games, as exclusive sport mega-events, serve as significant catalysts for urban change [6] and may provide opportunity for the sustainable urban development of host cities [7,8]. The Olympics often contributes to urban transformation [9,10] by improving urban mobility, reorganizing the urban fabric, creating green spaces, and reshaping urban spaces. This involves the construction of event-related infrastructure and equipment, as well as new housing and retail development [11]. The unique circumstances of large-scale and rapid urban changes enable city authorities to enhance urban infrastructure [12–15] and expedite the urban planning process [16], which would otherwise take decades to materialize [17].

The Olympic Games also have the potential to influence the quality of life for local residents [18–21], even if this impact is only temporary [22]. Similarly, they are viewed as a strategy for urban regeneration designed to stimulate or justify local development, becoming a tool of urban politics [23–26]. They act as a trigger to revitalize decaying

industrial areas and redundant brownfield sites and regenerate extensive areas within the city [6,27]. For example, in Atlanta and Sydney, the Olympic sites were located in areas recognized as heavily contaminated by past industrial activities; in Barcelona, in old industrial ports and wastelands [28]; in Athens, on military bases and wastelands; and in London, in old industrial (brownfield) areas [29]. Olympic projects generally involve massive investments, complex decision making, and significant potential impacts.

Moreover, the Olympics can facilitate the generation and transfer of new knowledge from one city to another. This knowledge exchange takes place between international consultancies and local agencies, facilitated by the involvement of world-class planning consultants in event-related infrastructure plans [30,31]. Consequently, they contribute to enhancing local planning systems and creating urban planning capacity. Even unsuccessful bids for the Olympic Games can have positive impacts on urban development through urban projects and regeneration initiatives [32].

Sustainability is a primary objective of the Olympics overseen by the International Olympic Committee (IOC). Given the extensive scale and impacts of the Olympics, the IOC advocates for sustainability initiatives to enhance positive outcomes and minimize negative consequences associated with hosting such mega-events [33]. The IOC has embraced the concept that investments made by host cities in Olympic infrastructure should be regarded as integral components of a broader urban agenda. However, hosting requirements set by the IOC have become more demanding, posing significant challenges for decision makers and local planners due to the introduction of completely different development prospects and agendas [9]. Planning for sport mega-events usually creates tensions between the long-term planning goals of the host and the more short-term needs of the event [34,35]. The promises of the Olympic Games are seen as a catalyst for significant urban development, yet they have consistently fallen short of expectations [36].

In spite of the positive impacts of the Olympics on urban improvement, the displacement produced by event-related development is a significant negative aspect [15,37,38]. The Olympics' involvement in significant infrastructural development may have substantial impact on real estate values [39–42], particularly with respect to their tendency to displace, evict, and marginalize local citizens living in poorer areas [43,44]. Therefore, these events could contribute to urban gentrification, involving the replacement of lower-income urban residents with higher-income individuals [45]. As stated by Porter et al. [46], the displacement produced by event-related development is often not publicly reported, considered unimportant or unfortunate, but is deemed a necessity for urban development to successfully host events.

From a post-event usability perspective, the planning and management of the Olympic infrastructure, along with its maintenance, pose significant challenges for most host cities [47,48]. Millet [49] emphasized that there is no "after" for sport infrastructures without a well-defined and careful planning "before". It is meaningless to build new sport infrastructures without a prior plan for their future use. Rarely used sport facilities and the associated costly maintenance [31,50] are common physical challenges faced by host cities, especially in developing countries. Indeed, in the post-Games period, heavily underutilized and unwanted large-scale venues tarnish the Olympic legacy [37,51]. In some host cities, event-related infrastructures took many years to initiate reuse or were abandoned due to a lack of planning for the post-Games period [6]. Additionally, as argued by Clark and Kearns [52], the relatively well-used venues may benefit only wealthy residents and may not be economically accessible to the host community. For example, even Barcelona and Sydney, both recognized for having the most successful Olympics, struggled in the post-event period [53,54]. To avoid such problems, Doha decided to plan the recent 2022 FIFA World Cup in alignment with the four pillars of the Qatar National Vision (economic, social, environmental, and human development). The goal is to create an advanced society capable of sustaining its development and providing a high standard of living for all its people [55]. Nevertheless, the absence of comprehensive transformation processes at the master plan level, ensuring adherence to these pillars, emerged as a critical issue.

In the exploration of sustainable urban planning within Olympic-related development, it is also crucial to gain insight into the bidding process, which begins several years before the Games and is overseen by the IOC. Candidate cities submit comprehensive bid proposals detailing their vision, infrastructure plans, accommodation, transportation, security measures, environmental considerations, and legacy plans. The IOC evaluates these bids through a rigorous technical assessment, including on-site visits by the Evaluation Commission. The final decision is taken by the IOC based on factors such as infrastructure, financial capacity, experience in hosting major events, and the overall vision of the host city for the Games. However, host cities grapple with substantial challenges in the bidding process. The financial burden, including a non-refundable fee exceeding USD 100 million to the IOC, has led to the withdrawal of numerous cities from the bidding process. In recent years, Olympic bidding has undergone a significant transformation, marked by a declining interest among cities to host the Games. Between 2013 and 2018, 13 cities withdrew their bids, citing negative referenda or political pressures [16]. This trend prompted an unprecedented response from the IOC, which sought to revive interest through substantial concessions. Notably, subsidies were extended to Paris and Los Angeles, acting as incentives for hosting the 2024 and 2028 summer Games, respectively. This shift in the bidding dynamics has sparked ongoing debates, with critics often dominating discussions on whether cities should actively pursue the hosting of mega-events like the Olympics.

In light of the challenges outlined, this investigation aims to answer a central research question: How can the Olympic-led urban planning process be enhanced holistically to promote sustainable development in host cities? To address this question, this paper proposes a holistic framework that assesses key sustainable urban principles within the Olympic-led sustainable planning process. Focusing on the 2016 summer Olympics in Rio de Janeiro, this study explores an insufficiently examined field within current scholarly discussions, particularly concerning Olympic-led urban planning and its emphasis on sustainable impacts. Despite considerable research on mega-event planning, this specific perspective remains largely unexplored, especially in the case of legacies from mega-events in the global south [56]. This study aims to address this gap by investigating the unique challenges and opportunities presented by the integration of sustainable development principles within the context of Olympic host cities in the global south. A significant contribution of this research lies in identifying critical gaps in the current understanding of Olympic-led urban planning processes. By reviewing the existing literature, the paper aims to shed light on areas that necessitate further investigation. The novelty of this paper is highlighted by its explicit focus on creating an innovative framework that prioritizes sustainable impacts, which has been often inadequately represented in discussions on mega-event planning.

This paper is structured as follows: Following a brief background outline, the second section describes the methods employed. Section three delves into the urban planning process in Olympic-led projects' development, highlighting the requirements of sustainable urban development features in hosting such events. It also discusses the research findings from the 2016 Olympics in Rio. Finally, the Conclusion brings together the theoretical and practical implications of the research findings, introducing recommendations aimed at enhancing the sustainability of the Games.

2. Materials and Methods

This section describes the methodological approach taken in this study to carefully examine the sustainable urban planning process driven by hosting the Olympics, spanning from the bidding phase to the post-Games period.

2.1. Systematic Literature Review on Olympic-Led Urbanization

The first step of this work involved an examination of the relevant literature, focusing on qualitative aspects. The literature review served a dual purpose. Firstly, it aimed to examine the current state of knowledge related to Olympic-led urbanization and elucidate

how host cities can leverage the advantages of the Olympics for urban development. The second goal was to support event-related sustainable urban planning and contribute to the ongoing discussion about the proposed framework, providing insights into its relevance and applicability.

The literature review was conducted in accordance with the PRISMA (Preferred Reporting Items for Systematic Review and Meta-Analysis) guidelines. As illustrated in Figure 1, the literature review comprises four essential stages: (i) identification of applicable articles; (ii) screening based on established criteria; (iii) extraction of insights from selected articles; and (iv) classification according to topics and their respective analytical methods.
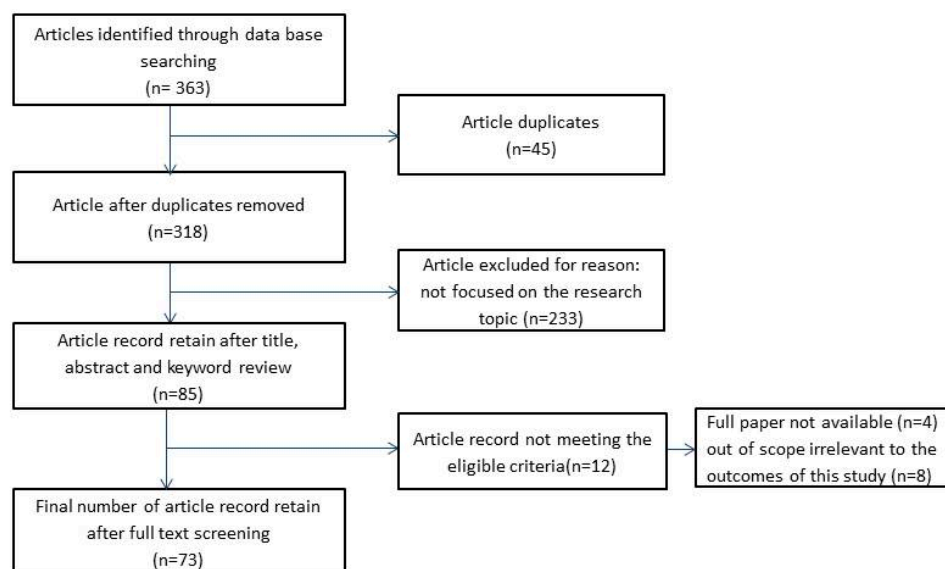
Figure 1. Flow diagram of literature review.

To identify applicable articles, a literature search was conducted using the Google Scholar and ScienceDirect databases. These databases are among the most recognized for conducting reviews and are regarded as reliable repositories for scientific publications [57]. The search employed the following terms in the full papers: (Olympic-related urban planning; sport mega-event sustainable urban planning; Olympic Game management; Olympic-related urban regeneration; urban intervention and sport mega-event; Rio de Janeiro 2016 Olympics; urban transformation and Olympics; hosting sustainable Olympics). The search was limited to peer-reviewed documents written in English and published as journal articles, book chapters, books, and theses from the inception of the electronic bibliographic databases to 31 October 2023.

Following the identification of relevant documents, the reference lists of these articles were reviewed to ensure the inclusion of any potentially overlooked studies. The screening process involved assessing the eligibility of the retrieved articles. Titles, abstracts, keywords, and, when necessary, full texts were examined to identify publications that primarily addressed the targeted topic. Duplicate publications found in both databases and documents lacking full texts were excluded.

After selecting the articles, the relevant data were extracted. This encompassed details such as publication title, article title, keywords, year of publication, authors, and full texts. Finally, the extracted documents were organized according to the principles of urban development planning, closely linked with event-related planning for hosting the Olympics.

Following the outlined steps, a total of 363 references published between 1994 and 2023 were initially identified. After removing 45 duplicates, 318 records underwent screening based on title, abstract, and keywords. Among these, 233 records were excluded as they did not align with the research topic. Consequently, 85 records underwent eligibility assessment

through full-text screening. From these, 4 records were excluded due to unavailability of full texts, and 8 records were deemed out of scope or irrelevant for the goals of this review. This included instances where the searched terms in the title, abstract, or keywords were not thoroughly explored in the papers. As a result, 73 records were deemed eligible for review.

2.2. Olympic-Related Sustainable Urban Planning Principles

Based on the conducted literature review, this subsection delves into the urban planning principles essential for enhancing the sustainability of sport mega-events, including the Olympic Games, from the bidding phase to the post-Games period. These principles serve as the groundwork for proposing a comprehensive sustainable urban framework for hosting the Games. The holistic framework is developed through an analysis of the impacts of the Games on host cities, with a specific emphasis on developing countries.

2.2.1. Sustainable Development Planning Principles for Mega Sport Events

Mega sport events, such as the Olympics, are inherently unsustainable [55]. These events necessitate extensive constructions and result in a substantial environmental footprint. Urban interventions related to the Olympics involve two distinct planning phases: (i) preparing and transforming urban spaces for hosting the Games, and (ii) adapting the event-related spaces for long-term use [58].

Recognizing the significance of sustainable urban planning, it becomes imperative for any host city to embrace more conscientious planning. According to the literature, the essential principles of urban planning for hosting the Olympics include accessibility, integration, urban safety and security, flexibility and adaptability, and sustainability compliance [54].

- Accessibility is crucial for the success of the Olympic Games and for leaving a positive and lasting legacy in the host city [59], but the Olympics are viewed by many experts as posing the greatest transport challenges that host cities ever experience [60]. The IOC places considerable emphasis on accessibility as a key criterion for evaluating Olympic cities and their hosting capabilities [61]. Accessibility refers to the ease of reaching Olympic venues, services, activities, or specific destinations through the transport system. This entails the development of transport infrastructure to facilitate the seamless movement of athletes, officials, spectators, and others during the Games. It also involves ensuring good accessibility between sports venues, accommodation areas, and transport hubs such as airports. Urban accessibility is a critical factor, emphasizing multimodality and creating favorable conditions for sustainable mobility, specifically promoting the use of public transport and active modes and ensuring accessibility for people with disabilities [60–63].
- Integration involves the seamless inclusion of Olympic-related activities, infrastructure, and events into the existing urban environment, as well as the long-term legacy of Olympic-related infrastructure by identifying future uses for venues that align with the needs of the local community [64]. It also means enhancing connectivity, especially through sustainable modes of transport, linking residential areas, sport venues, and surrounding areas, to facilitate the daily mobility of residents [65]. Additionally, it encompasses the seamless integration of new projects into the urban fabric, which is challenging due to a certain type of "grandiose" design that complicates their integration into the existing urban context [59]. Moreover, integration aims to enhance social inclusivity and equality within the host city by addressing urban and social challenges, such as gentrification, poverty, inequality, and access to education [59,61].
- Security: Following the Munich massacre in 1972 at the Olympic Village, security has been consistently prioritized in the planning and execution of these mass public events, ensuring the safety of athletes, officials, spectators, and the general public while preventing threats and risks such as terrorism, criminal activity, and public disorder [61,66]. Security planning for large-scale public events must be an integral part of

a comprehensive event planning approach that involves collaboration between event planners and security stakeholders [67]. Integrating sports facilities into diverse urban functions and transport networks is essential to ensure their appropriate use in the post-event phase, preventing issues related to peripheral location and underutilization. This not only prevents problems such as the physical deterioration of facilities but also contributes to enhancing public security. Evidence from the literature suggests that the spatial arrangement of facilities in urban areas can either facilitate or impede criminal activities [68].

- Adaptability and flexibility are crucial elements in the planning and execution of the Olympics. Adaptability and flexibility involve designing venues and structures with the capacity to serve different functions beyond the event [59,61]. This approach helps create facilities and infrastructure that can be repurposed or adapted for various uses after the Games, aligning with the long-term needs and priorities of the host city. This prevents such facilities from becoming obsolete or underutilized after the Games, contributing to a more sustainable and resilient urban legacy. A challenge often arises due to the potential mismatch between the requirements set by this mega sport event and the future daily needs of the host city. To achieve this goal, it is crucial to avoid ad hoc approaches in the planning of Olympic-related projects [38,58], ensuring the alignment of projects with both the immediate requirements of the mega-event and the lasting needs of the host city post-Olympics. By incorporating adaptability and flexibility into the planning process, cities can leverage their investments for ongoing benefits, contributing to the long-term success and positive impact of the Games on the host community.

- Sustainability compliance: Ensuring sustainability is a crucial aspect of mega-events [69] and a specific goal outlined in the Olympic Agenda 2020 managed by the IOC, aimed at enhancing the sustainability of the Games [33,61]. Sustainable practices involve integrating environmentally friendly and socially responsible measures into various aspects of hosting the Olympics, such as ethical behavior, accountability, transparency, community and local stakeholder engagement, and inclusivity. The goal is to minimize negative environmental and socioeconomic impacts and maximize positive outcomes [69]. In recent years, efforts have been made to organize the Olympics with a commitment to sustainable development principles, involving careful planning in the construction and management of Olympic venues. These principles encompass critical issues like climate change, waste management, biodiversity protection, energy efficiency, provision of green spaces, legacy planning, and promoting healthy living, among others [70]. Despite the IOC's emphasis on environmental sustainability for more than two decades, the Olympics have faced repeated criticism for not effectively addressing the negative environmental impact of these events [31,33,70].

2.2.2. Framework for Olympic-Led Sustainable Urban Planning

The sustainability of Olympic-related urban planning extends from the bidding phase through the post-Games period. This study proposes a holistic urban framework for hosting a sustainable sport mega-event within the context of urban strategic planning. Strategic planning plays an essential role in realizing the goals of sustainable urban development through the hosting of mega-events, providing a comprehensive overview of the community's current status and future prospects. In developing countries, there is often a high level of involvement from the national government and a centralized system in managing sport mega-events [71]. Urban planning driven by these events becomes inherently political. City officials, including politicians and local authorities, often associate investments made for the Games with broader city development. However, there is a concern that organizations involved in strategic planning may be influenced by political interest groups, private developers, and real estate pressures. From this perspective, it is crucial to determine whether the strategic plan has been developed through a formal planning and decision-making process or through political means. The integration of

Olympic projects into a city's long-term urban development strategic plan not only minimizes or prevents the imbalanced distribution of event-related infrastructure in urban areas but also promotes sustainability and harmonious development between different areas. Furthermore, it addresses the challenge of sports infrastructure and venues being abandoned in the post-event period. There is a correlation between the politics involved in staging mega-events and long-term urban development strategy.

Figure 2 illustrates the strategic planning process for events as a deliberate and dynamic procedure involving explicit analysis and decision making [72]. The figure outlines the steps for conducting event-related strategic planning, emphasizing the need for adopting a creative and dynamic approach. These steps encompass determining strategic goals, specifying strategies to achieve these goals, identifying specific strategic objectives, and developing action plans that involve event management, organization, scheduling urban planning activities, and event preparation. The process advances with plan implementation, with a crucial step being the monitoring and evaluation of the plan's implementation status. Implementation and monitoring are integral components of the process, reflecting the action-oriented and results-focused nature of strategic planning. A monitoring and control mechanism serves to keep the project aligned with its objectives. This approach is a significant management tool in the sustainable practice of event-related urban planning.


Figure 2. Key element in strategic planning for a host city.

Considering the principles and key elements of the strategic planning process in Olympic-led urban development planning, the main requirements are outlined in Figure 3. This figure illustrates that event-related planning occurs at three distinct spatial levels: location selection, pre-event planning, and post-event planning.

First phase: This involves decision making for selecting the site of sport infrastructure, marking a crucial step in preparing for an event planning cycle. The Olympics play a unique role in contributing to the spatial expansion of a host city, serving as instruments for integrating isolated or marginal sites in urban peripheries and revitalizing targeted urban areas. The site selection process engages various national organizations and public sectors, including urban planners, exploring diverse scenarios for Olympic-related infrastructure development. Choosing the best potential location for sport facilities and related structures is vital, often involving the repurposing of deteriorating industrial zones and redundant brownfield sites, thereby revitalizing them into integrated urban areas [27]. While the location of sport facilities can catalyze urban development, an improperly chosen location can hinder future development. Poorly located facilities may remain underutilized in the

post-event period, generating negative impacts on surrounding areas and neighborhoods. Location, especially when placed in areas with more critical and strategic long-term usage, needs careful consideration, as it can undermine the overall urban scale. The chosen location should be assessed in alignment with the city's long-term plans. Similarly, the selection of a site for the Olympic Park should account for the protection of the local ecosystem and access to the existing public transport network [73].
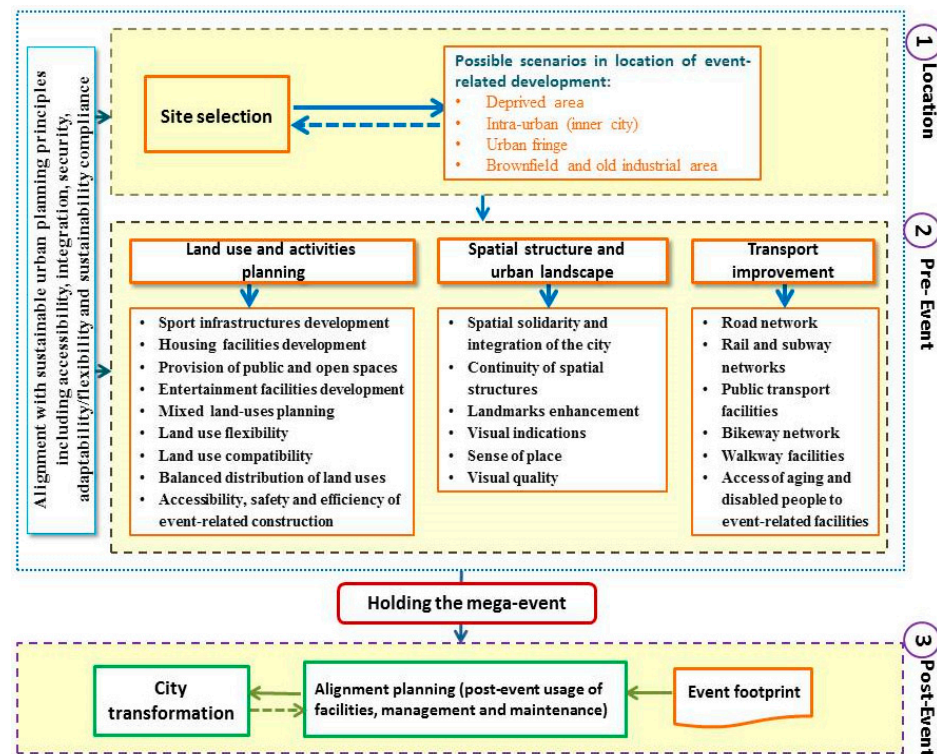
Figure 3. Sustainable urban planning requirements for hosting a sport mega-event.

Second phase: After selecting the location, pre-event planning continues with division into three substeps: land use planning and activities, spatial structure and urban landscape, and transportation planning. These main activities are meticulously broken down into several subactivities to ensure a comprehensive approach. In land use planning and activities, a detailed examination explores how the designated areas will be utilized during and after the event. This includes allocating spaces for various Olympic infrastructures and considering potential post-event uses, with a focus on optimizing the urban environment for both short-term and long-term needs. The substep of spatial planning and urban landscape examines the integration of Olympic facilities into the existing urban landscape. This considers the impact on the city's overall structure, aesthetics, green spaces, and the urban envelope. Transportation planning, as an integral aspect of event planning, addresses the complex task of organizing transportation infrastructure to accommodate the influx of visitors during the Olympics. It explores strategies for efficient traffic flow, public transportation enhancements, and the creation of temporary or permanent transport hubs. These planning activities, breaking down the main tasks into several subactivities, are conducted with strict compliance to the urban planning principles previously mentioned, emphasizing the importance of carrying out these planning activities in accordance with the established principles.

Third phase: Another important issue in planning to host an Olympics is the usability of constructed infrastructures in the post-event period. Experiences have shown that many host cities were faced with post-usage sport infrastructure problems, and it seems like these were mostly due to a waste of resources [74]. It is important to plan for the post-Olympic landscape in order to ensure the long-term success of the sport mega-event and the proper

utilization of the facilities that were built. Planning for an Olympics does not end with the completion of an event but is considered a continuous process that begins from the bidding and extends after the Games to attain sustainable outcomes. Therefore, the usability of event facilities should be evaluated and integrated into the fabric of urban life and the needs of the local community [75]. In the third phase, designated as post-event, event footprint assessment and the development of a management system to reuse the event-related facilities and to take care of their maintenance are highlighted. Likewise, planning for alignment starts immediately for post-event adaptation to ensure the sustainable usage of sports facilities after the event.

Drawing from event-related planning processes and urban planning requirements, a sustainable conceptual scheme is developed within the framework of urban strategic planning (Figure 4). This scheme illustrates an ideal process for hosting a mega-event, integrating urban planning and management with the event-organizing process. Objectives are derived from strategic planning before the bidding process, aligning with the city's development needs. Early-stage planning involves engaging all relevant stakeholders, especially community representatives, ensuring transparency and accountability in the urban planning process. Stakeholder engagement enhances overall accountability and transparency, fostering public trust in government and acting as a safeguard against the influence of powerful economic groups. Effective governance is crucial for driving sustainable development during sport mega-events. The conceptual scheme demonstrates that carefully designing event outcomes and implementing strategic plans should commence alongside event preparation. Simultaneously, a monitoring and control system oversees planning and implementation, evaluating alignment with host city development plans. The monitoring process continues until the completion of implementation. Planning for the post-event period begins concurrently, with an immediate focus on post-event utilization management. This event planning process aims to reduce the impact on affected communities and mitigate negative consequences.
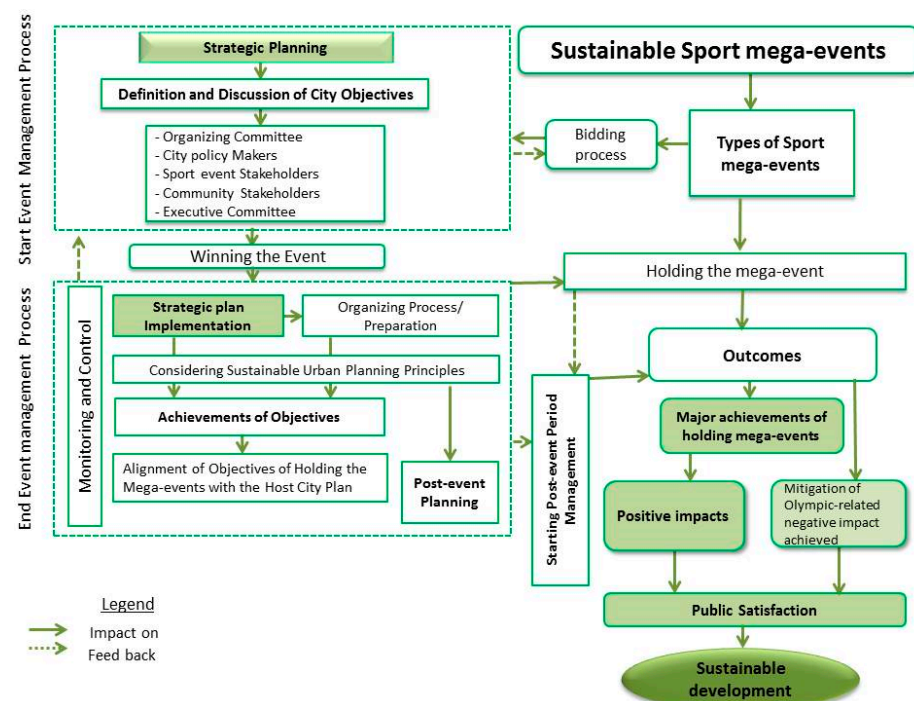

Figure 4. Sustainable conceptual scheme for a sport mega-event.

3. Results and Discussion

This section describes and discusses the application of the methodological framework outlined above to the Rio 2016 Olympic Games. More specifically, it analyzes the develop-

ment of the holistic framework for hosting the Rio Games and provides empirical evidence on how strategic planning processes and sustainable principles materialized during the location, pre-event, and post-event phases. This research extends beyond theoretical considerations to examine the practical implications that hosting such an event had on the sustainable urban development of Rio.

3.1. The Rio 2016 Olympic Games

The Olympic Games in Rio were part of Brazil's strategy for hosting large-scale events [59]. Since the late 1990s, Rio de Janeiro's development plans have been adapted to accommodate mega-event bids, holding significant potential for the transformation of urban space and the entire city. The first Strategic Plan of the City of Rio de Janeiro was presented in 1995 with the title "Rio always Rio". This plan aimed to start a new era of sport mega-events, leveraging the natural and human resources of the city. The candidacy to host the 2004 Summer Olympics was within this overarching strategy [76]. Although Rio de Janeiro's bid to host the 2004 Olympics failed, the city successfully hosted the Pan American Games in 2007, and Brazil hosted the Football World Cup in 2014, indicating the success of the city's strategy to attract major sporting events [76]. On October 2nd, 2009, Rio was confirmed as the host for the 2016 Summer Olympic Games. Through these mega sport events, especially the Olympics, the city attracted significant public investments in a relatively short time to execute projects with the potential for profound urban and social impacts. These include: (i) a revolution of the city's transportation system through the construction of Bus Rapid Transit (BRT) and the extension of metro lines to facilitate mobility between the Olympic venues and within the city during the event [56]; (ii) significant urban changes, including the construction of various structures directly related to the Games, such as the Olympic Park; and (iii) a unique opportunity to tackle some of Brazil's priorities, including poverty, corruption, security, and education [77].

The Olympic Games were staged in four areas spread throughout the city: Barra da Tijuca, Copacabana, Deodoro, and Maracanã (Figure 5).
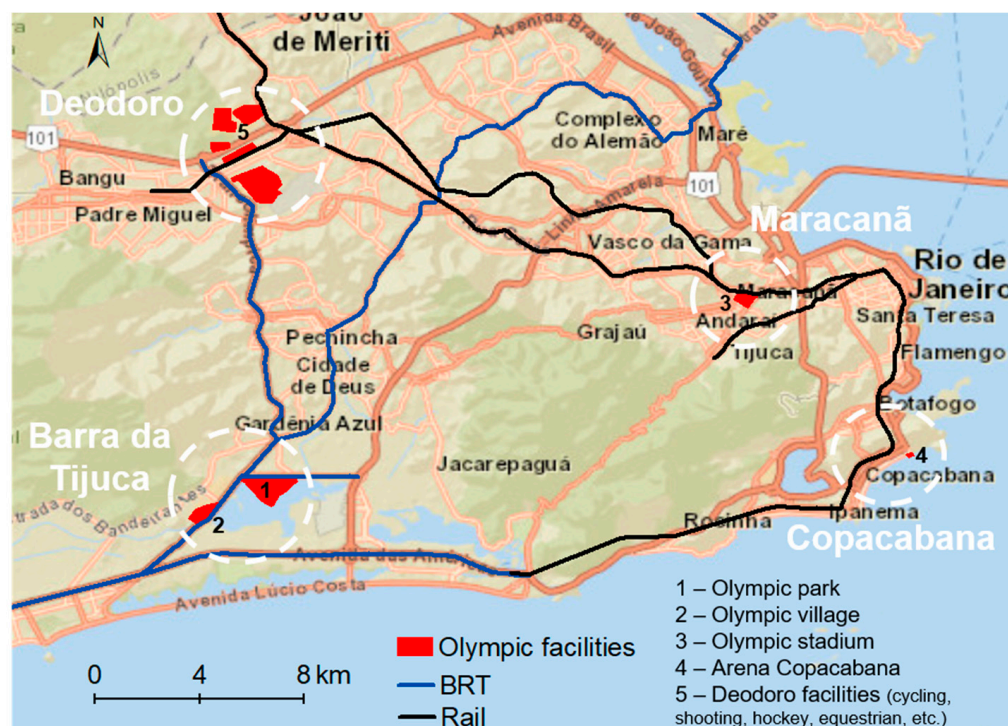

Figure 5. Main stages of the Rio 2016 Olympics.

The most significant urban interventions took place in Barra da Tijuca and Maracanã. Barra da Tijuca hosted the majority of the Games' venues, including the Olympic Park—a

large sports complex on the waterfront of the Jacarepagua Lagoon—and the Olympic Village. The Maracanã zone includes the historic Maracanã Stadium, renovated to host the final match of the 2014 FIFA World Cup and the opening of the 2016 Olympics. A large-scale regeneration took place in the port area at Maracanã, now known as "Porto Maravilha", covering around 5 million square meters, primarily comprising public land. Deodoro was chosen because it already had sports facilities and a high percentage of young population [77] and it is near a military area. Finally, Copacabana is a consolidated urban space, primarily known as a tourist area.

3.2. Sustainability of the Olympics in Rio

Understanding the factors that are essential to successfully host a sport mega-event can help committees to accurately evaluate the advantages and disadvantages of events and to adopt methods that can reduce costs and enhance the sustainability of the events. This subsection analyzes the sustainability of the Rio 2016 Olympics concerning the urban planning phases outlined in Figure 3 and the findings in the literature. These phases address event-related planning at three spatial levels, including location selection, pre-event planning, and post-event planning.

3.2.1. Site Selection of the Hosting Stages

As mentioned in Section 3.1, the Olympic Games were staged in four areas spread throughout the city. It is now evident that the selected sites resulted in an unbalanced distribution of event-related urban infrastructure, with the main benefits accruing to Barra da Tijuca, where the main Olympic Park was located [41,76]. To clear the site, an informal settlement was demolished, displacing over 4000 residents [59]. This decision was criticized by scholars such as Vannuchi and Criekingen [78] for favoring elite residents and landowners in an affluent area, with little connection to the city center. Importantly, the master plan for this site lacked provision for affordable housing, indicating a preference for middle-class urbanization and neglecting critical city needs. Significant attention and investments were also directed to the old port area (Maracanã stage), specifically for the "Porto Maravilha" project, which aimed at the renovation and restructuring of this area to disseminate a new urban image in the future [76]. Deodoro is an area situated peripherally with several adjacent slum neighborhoods, showing a disconnection between the isolated, low-income neighborhood and the specific sports facilities constructed for the Games [79]. Finally, and in addition to some interventions in sport and transport infrastructure, the plan did not include significant urban interventions in Copacabana [80].

3.2.2. Pre-Event Activities and Their Impacts

Large Brazilian urban projects, particularly mega-events, are known for their severe urban and socioeconomic impacts, including land valorization, prioritization of public spending in the wealthiest areas, and violence associated with the removal and displacement of people from low-income areas [76]. In the case of Rio 2016, the main urban interventions in Barra da Tijuca and Maracanã, related to new sport facilities and transport infrastructure, resulted in the expropriation and displacement of around 65,000 people, with no measures taken to address the eviction of low-income residents removed from these areas [76]. The transformation of Barra da Tijuca into the Olympic Village resulted in the creation of the so-called "islands of regeneration" or "bubbles" [81], with a focus limited to event venues and precincts, indicating a failure to achieve proper integration with the rest of the city. Moreover, this approach led to the displacement and gentrification of the Vila Autódromo community, reflecting a neglect of existing spatial and social structures. The negative impacts, such as community displacement and a lack of social inclusion, highlight potential shortcomings in effectively incorporating spatial and social considerations into the implementation of Rio's Olympic urban planning. Partly due to this main reason, both the site selection and demolitions were criticized for the lack of public participation and transparency in the process, conducted under an aggressive urban

planning framework [31,59,78]. Some interventions in impoverished urban areas, like "favelas" (designation given to informal and often poor and densely populated urban settlements) in Maracanã, as well as in abandoned buildings, were primarily cosmetic and artistic, aimed at decorating facades [82]. Some authors argued that these interventions were carried out to hide and beautify poverty in the vicinity of the Olympic stages, rather than to genuinely improve these areas and their communities [31].

However, some positive impacts should also be highlighted. The improvement in transportation—specifically, better public transport accessibility—stands out as a significant positive impact [73,83,84]. Due to a lack of adequate existing public transportation infrastructure, the city had to make substantial investments in new transportation projects to serve the Olympic facilities. One of the most notable initiatives involved interconnecting the four main Olympic zones through the implementation of 125 km of new Bus Rapid Transit (BRT), extending metro lines—particularly the line between Copacabana and Barra da Tijuca—and establishing a 28 km light rail line to connect the port area (Maracanã) with the center. The implementation of certain Olympic projects in the Deodoro area also resulted in positive tangible improvements, including the creation of green spaces, a radical park, and enhanced access to public transport facilities [85]. These positive impacts on the neighborhood, which had previously suffered from a lack of urban infrastructure, underscore some of the beneficial outcomes of the Games.

3.2.3. Post-Event Activities and Their Impacts

Legacy has become a watchword in hosting mega-events, often used to justify massive spending and significant urban transformations. However, in developing countries like Brazil, the impacts of large-scale infrastructural enhancements have frequently been linked to a range of negative consequences resulting from these mega-events [78]. In the case of the Rio 2016 Olympics, some authors argued that there was not a legacy from the Games but rather an inventory of facilities, with uncertain future use and needs, highlighting poor adaptability and flexibility [86].

According to the municipal plans, the legacy of the Olympics was divided into three main sectors: transport infrastructure, urban renewal, and urban environment [87]. Despite improvements in transport infrastructure through the creation of BRT and the extension of metro lines, the positive impacts on urban mobility decreased after the event. The new infrastructure was primary designed to connect the main sports stages rather than to serve the needs of the overall urban population. The travel needs of residents differ from those of Olympic guests. Therefore, some BRT lines, such as Transolímpica, have approximately half of the initially estimated demand (70 thousand passenger/day) [80]. The creation of the new transport options (BRT, light rail, and extended metro lines) led to the extinction or alteration of more than 70 bus lines, impacting the daily travel habits of thousands of residents [78]. Residents' perceptions indicate a worsening of urban mobility after the Olympics [88]. Despite improvements in the accessibility and connectivity from the south to the north parts of Rio, transportation enhancements in other parts of the city have been neglected. In fact, infrastructure projects primarily favored the middle- and upper-class areas of Barra da Tijuca and Copacabana, which already had reasonable connections with other parts of the city. The Games had a limited positive impact on the accessibility of poorer peripheral urban neighborhoods [63] and, therefore, the accessibility gap between high-income and low-income areas, rooted in historical spatial segregation, persists in the city. Rio also had insufficient access via public transport and walking to most Olympic sports facilities, excluding those in close proximity to the city center, and the Games did not contribute to promoting soft mobility along the shoreline [59,63]. On the contrary, BRT had adverse effects on active mobility due to reduced sidewalk width, the construction of physical barriers, and the elimination of crossings. These alterations resulted in accidents and injuries for pedestrians and cyclists, making it more challenging for people to walk and cycle in the areas crossed by BRT lines. Moreover, authors like Oliveira et al. [76] argued that transportation investments were not directed toward connecting the city center

with the neighboring municipalities of the metropolitan region, home to around 12 million residents. Therefore, despite the improvements in connecting the four areas, it is evident that the envisioned "Transport Revolution" in the city is far from its initial goals.

Urban renewal policies included the transformation of areas of the city around the Olympic venues, the renovation of the old port, and the integration of "favelas" across the city. The prioritization of specific zones over others led to a skewed distribution of resources, further exacerbating the existing social–spatial segregation and gentrification in the post-Olympics period [87]. Additionally, some BRT lines were dissociated from high-density mixed-use zoning, resulting in less impact in promoting compact and sustainable occupation of space. For instance, it is now recognized that some BRT lines, such as Transolímpica, have inadvertently reinforced urban sprawl along their courses [56].

Rio designed ambitious plans to address environmental issues through the Games. While certain projects resulted in tangible improvements, such as the creation of green spaces in Deodoro, the initial plan to plant 24 million trees by 2016 to enhance the Tijuca forest was not achieved. Additionally, the creation of the so-called Carbon Park with plants sown by the athletes essentially remained on paper. The depollution of the Barra da Tijuca and Rodrigo de Freitas (Copacabana) lagoons, set to be accomplished through the collection and treatment of 80% of all sewage by 2016, was not achieved [80], indicating a shortfall in sustainability outcomes.

Other expected positive impacts associated with the Games included improving sporting participation, stimulating tourism by enhancing Brazil's global image, and improving public facilities [80,87]. However, recent evidence suggests that the Games and some sporting facilities such as the Olympic Training Center (COT in Portuguese) do not seem to have increased sporting participation in the local population [87]. The initial goal of strengthening Rio's position as a tourism destination was clear, but there was no discernible increase in tourist numbers resulting from the Games. General crime rates persisted, and crimes related to public transportation, as indicated by Cardoso et al. [89], remained prevalent. According to Larkins [90], the urban gentrification of Rio extends to security during mega-events. Impoverished areas endure oppressive police practices, while affluent and global elites, often residing in fortified and secured spaces, enjoy a type of "hospitality security". Thus, legacy projects failed to adequately address both general crime and security concerns within the public transport system and the city, highlighting poor security.

In line with other mega sport events, Rio 2016 left a legacy of debt for the hosts costing around USD 13 billion [77], though some estimates suggest it was USD 20 billion [91], while providing no discernible benefits. In the post-event period, various financial and institutional problems emerged, including financial issues in maintaining sport facilities and their consequent deterioration, the dissolution of the entities responsible for managing various facilities in Barra and Deodoro, and the resignation of the President of the Brazilian Olympic Committee, suspected of being involved in corruption, making the legacy of the Games even more problematic.

3.2.4. Operational Insights from the Rio Games

According to the Strategic Plan of Rio, the Olympics were intended to promote sustainable development, prosperity, and social goals. These objectives included urban greening, sustainable mobility, depollution, economic and tourism activities, as well as social inclusion and a better quality of life [92]. To achieve these goals, the Plan proposed a collaboration between public and private entities around a market-oriented agenda, framing urban sustainability within strategies implementing the concept of a "company city" and projecting investments onto the idea of a "sustainable city" within international competition. In addition to the initial intentions, the urban planning interventions related to the Olympics involved modifications to existing urban regulations, treating the city as an "exceptional state" [58,93,94], prioritizing private sector interests [44], land dispossession [42], and a lack of transparency in the planning and implementation processes [59,76]. More specifically, the selection of the four main stages and the demolitions faced strong criticism for a lack of

transparency and public participation in the decision making [59,76]. The combination of public investment, urban planning, and the privatization of urban space, coupled with the execution of sports venue projects, contributed to an intensified processes of land valorization, further exacerbating the already significant gentrification [76]. The urban planning process and execution of Olympic-related preparations excluded local residents, following a top-down approach without public participation, as decisions were made by politicians, entrepreneurs, and developers who assumed they knew what was best for the city. This lack of involvement accentuated the disconnection between decision makers and the affected community [95]. A lack of alignment between event goals and city development plans, coupled with the absence of a strategic plan and effective monitoring during preparation, became evident. Furthermore, Olympic-related projects encountered challenges related to insufficient monitoring and controls, resulting in delays, incomplete projects, unfulfilled commitments, and inaccurate cost calculations [73,84]. The inadequacies in monitoring and evaluation mechanisms during the Olympic planning process hindered effective decision making and failed to identify and address potential problems [96].

The post-Games legacy aimed to promote urban sustainability, public security, and more social equality [86]. However, challenges arose as 60% of the Olympic park was allocated to closed communities, prioritizing cars over pedestrians, conflicting with the bid's vision of a dynamic, mixed-use neighborhood [97]. The design, characterized by rigid separation between residential areas and venues, contradicts the bid's anticipation of urban integration. This goal would be overly optimistic, considering that 80% of the investment was directed to Barra da Tijuca, a medium- to high-income neighborhood where only 5% of the urban population resides [80]. The social legacy of the Games is also questionable. The residents of Rio do not recognize a lasting social legacy from the Olympics and are aware that social issues in their communities worsened as a result of hosting the event [92].

As observed in previous Games (Athens 2004, Sochi 2014), the financial challenge of maintaining world-class sports facilities post-event resulted in abandonment and vandalism [74,79]. For example, in Athens 2004, the Games also involved the construction of new stadiums, various Olympic venues, and transportation infrastructure, such as a new subway and a tram line, to connect the Olympic village to other urban areas. However, there was a lack of a comprehensive strategy for the long-term use of these facilities and infrastructure [98]. This lack of post-Games planning led to many of them becoming disused and abandoned. Many of the venues built for the Games in Athens are now underutilized or abandoned and have not contributed to the development of the host city. This was also evident in Rio; for example, in 2017, the operation of the Olympic Park covered only 2% of its maintenance costs [59]. These facilities have seen limited use, primarily for sporadic sport events or other activities such as concerts. Efforts to involve private companies in maintaining these facilities face obstacles due to conflicts between the municipal government and private organizations, leaving the future of these venues uncertain.

In sum and regarding the guiding research question, it is now evident that despite initial aspirations for a more sustainable and inclusive city, the practical outcomes of hosting the Games did not adequately address the fundamental urban challenges and the needs of Rio's residents. Despite promising sustainable development, there was a significant disconnection between promises and achievements [33,93]. As emphasized by Wade [91], the Rio Games were largely marked by scandals and left the city starkly divided between rich and poor, much as it was with only a few cosmetic changes. Table 1 summarizes the compliance or non-compliance of the Rio 2016 Olympic stage areas with essential urban planning elements, during the location, pre-event, and post-event phases.

Table 1. Compliance or non-compliance of Rio Olympic-related urban development with sustainable urban planning principles *.

Main Urban Planning Phases	Subthemes Related with Hosting the Games	Compliance across the Four Olympic Stages in Rio			
		BT	D	C	M
Location	Easiness of urban and social integration	+	−	+	−
	Potential urban and social integration	⊙	+	⊙	+
	Potential revitalizing impact	⊙	+	⊙	+
	Environmental disturbance	+	+	⊙	⊙
	Welcome from their local communities	⊙	−	⊙	−
	Facilities located in affluent and military areas	−	−	⊙	⊙
	Changes to urban planning regulations	−	−	⊙	−
	Potential future use of sport facilities	+	+	⊙	⊙
Pre-event	Improvement of poor neighborhoods	−	−	⊙	−
	Distribution of Olympic-related facilities	+	−	⊙	+
	Open and green spaces' improvement	+	+	⊙	⊙
	Adaptable land use for the Olympic facilities	−	−	⊙	−
	Land use compatibility	+	−	⊙	⊙
	Balanced distribution of land use development	−	−	⊙	⊙
	Evictions and displacements of poor communities	−	+	⊙	+
	Urban integration of the Olympic Park and Village	−	−	⊙	−
	Continuity of spatial structure	−	−	⊙	⊙
	Urban transportation improvement	+	+	+	+
	Improvement of walking and cycling conditions	−	−	⊙	−
	Improvement of public security	+	+	+	+
	Public participation in the planning process	−	−	−	−
Post-event	High maintenance costs of sport facilities and management problems	−	−	⊙	−
	Better urban and social equality and integration	−	−	⊙	−
	Better public security: less criminality and violence	⊙	−	⊙	−
	Better sustainable mobility, less traffic congestion and volume	⊙	−	⊙	−
	Improvement of the urban environmental quality	⊙	⊙	⊙	⊙

Legend: + positive; − negative; ⊙ neutral; Barra da Tijuca (BT); Deodoro (D); Copacabana (C); Maracana (M).
* Planning principles: accessibility, integration, security, adaptability/flexibility, and sustainability.

4. Conclusions

By examining the Olympic-led urban planning process implemented in Rio 2016 within a holistic framework based in key sustainable principles, this paper demonstrates that the initially ambitious goals and the legacy of the Games fall short of the desired outcomes. The described framework facilitated the identification of various issues and a lack of strategic planning for sites' selection, as well as in the pre-event and post-event phases. The selection of sites near affluent areas led to the displacement of a significant number of residents. Meanwhile, improvements in public transportation and urban operations prioritized middle and upper-middle areas, contributing to the valorization of land and accentuating issues like urban gentrification and social exclusion. Public security took on a dual nature, adopting a militarized form in the low-income areas while maintaining a lighter presence in Olympic facilities. The sustainable goals were also far from those

desired in terms of air and water pollution reduction, the protection and expansion of green spaces, and the promotion of active modes of transport. One of the most crucial lessons from Rio's experience is the adoption of a few transparent and undemocratic planning and decision-making processes. The planning procedures underwent special decision processes that were neither subordinated to ordinary institutional and democratic processes nor subject to citizens' participation and control [76]. The absence of planning transparency, coupled with an aggressive urban planning practice, resulted in prioritizing private sector interests over public interest [80,86]. In the post-event phase, sports facilities have either been underutilized or abandoned, incurring an unsustainable economic maintenance cost and leading to the dissolution and bankruptcy of the management entities.

These problems and negative impacts are, unfortunately, not exclusive to Rio. In general, sports mega-events have often been organized by undemocratic organizations characterized by anarchic decision making and a lack of transparency. These conditions frequently favor the interests of global flows rather than those of local communities [99]. In this context, this paper highlights the importance for policy and decision makers overseeing substantial investments in Olympic-related projects to prioritize the needs of the local community and ensure post-event utilization without incurring additional costs and negative impacts. Similarly, host cities can adopt an equitable development strategy for urban planning, ensuring that all residents have an equal opportunity not only to benefit from Olympic-led development but also to align with the city's future sustainable development. This is even more critical in the case of developing countries, which often face challenges in providing universal access to quality education, healthcare and sanitation, social welfare, and infrastructure development, among other essential services.

As demonstrated in this paper, planning sport mega-events in developing countries requires careful consideration of various key sustainable urban planning requirements not only to promote their capabilities, but also to ensure both successful implementation and positive long-term impacts. Drawing lessons from Rio, making the Olympics more sustainable in developing countries involves addressing various aspects related to location, pre-event planning, and post-event usage. This may include:

- Prioritizing locations with established infrastructure to minimize the need for extensive development, to reduce environmental and socioeconomic impacts (costs, displacement of people), and with various land uses to enhance their future use. Adopt crime prevention through environmental design (CPTED) principles to enhance public security.
- Selecting locations with good accessibility and promote the use of existing public transportation systems to minimize the need for additional infrastructure. Encourage sustainable modes of transportation for spectators and participants, such as cycling and walking. This can help residents transition to more sustainable transport behaviors in the future.
- Developing a clear legacy plan during the pre-event phase, focusing on long-term benefits for the host community. Consider utilizing temporary and modular structures that can be repurposed or dismantled after the Games. Identify future uses for venues that align with local needs, such as sports facilities, community centers, or affordable housing to promote adaptability and flexibility in both facilities and infrastructure, as well as urban integration.
- Promoting active engagement of local communities in the decision-making process from the early planning stages. This involves implementing initiatives that directly address community needs, such as infrastructure improvements, educational programs, and job creation.
- Utilizing the event as an opportunity to address urban and social challenges, including issues such as gentrification, poverty, inequality, and access to education—with the aim of enhancing inclusivity, equality, and social integration, common problems in developing countries

- Adopting sustainable practices encompassing energy efficiency, waste and water management, and biodiversity protection. This includes implementing renewable and energy-efficient technologies in venues, establishing comprehensive waste reduction and recycling programs, employing water-efficient and conservation technologies, and incorporating green spaces into venue designs to make the Games more sustainable.
- Improving transparency and accountability in decision making to increase public trust and confidence. This involves facilitating informed public participation and minimizing the risk of corruption and mismanagement throughout the process.

Ensuring that these urban recommendations are practically enforced and adopted by future host cities is challenging. One potential solution is to establish or mandate dedicated external entities to oversee and ensure the implementation of urban sustainability standards. Another alternative is to include provisions in contracts to define contractual obligations for the various parties involved, ensuring the attainment of urban sustainable goals in the post-bid phases and preventing deviations from the initial plan and opportunistic behaviors. However, it should be noted that these measures require a change in how the Olympics have been organized and may face resistance among Olympic stakeholders due to their practical implications, mainly in developing countries (less revenues and political control, open governance, etc.).

Finally, the framework has some positive aspects and limitations that should be highlighted. Among its strengths, the framework holds the potential for replication in other urban contexts, providing support for organizing mega-events like the Olympics. It provides a comprehensive foundation for integrating urban planning principles, with a focus on local community engagement, stakeholder collaboration, political commitment, sustainable development, and long-term legacy benefits. When applying this framework to other urban contexts, careful adaptation is crucial, involving (i) strengthening sustainability advocates, (ii) developing location-specific guidelines, and (iii) establishing a local monitoring system. These steps are essential to enhance the practicality of the framework. The adoption of the described framework with refined recommendations in the organization of mega-events, particularly in developing countries, can contribute to making these events more sustainable and leave a positive, lasting legacy for the city and its inhabitants. However, the framework has certain limitations. These include potential constraints arising from the reliance on the case study, limiting its generalizability. Additionally, the complexity of the framework might pose challenges in its implementation, requiring considerable expertise, resources, and institutional changes.

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