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Mega-Events After COVID-19: Strategies for Sustainable Recovery

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Abstract: The COVID-19 pandemic triggered unprecedented disruptions in the organization of mega-events around the planet, necessitating reevaluation and transformation. As the tourism industry transitioned into a post-pandemic phase, mega-events adopted new forms prioritizing public health, sustainability, and digital innovation. Examined in this study are these transformations through a comparative lends, focusing on spatial adaptability, public engagement, marketing evolution, and environmental sustainability across various mega-events, include the Olympics, FIFA World Cup, NASCAR Street Race, and Lollapalooza. Highlighted in the analysis are shifts in infrastructure, socio-cultural resilience, evolving marketing narratives, and technological integration, providing insights into the future of mega-events in the post-pandemic world of tourism.

Keywords: mega-events; Olympics; tourism technological integration; digital integration; tourism recovery

1. Introduction

The COVID-19 pandemic had created a global crisis of unprecedented scale, leading to extreme measures such as city lockdowns, social distancing, and travel restrictions (Chen, 2022). These measures significantly impacted the tourism sector, resulting in the cancellation or postponement of nearly all mega-events in 2020 (Assaf et al., 2022). As the tourism industry recovered, there has been a growing emphasis on resilience and adaptability in event planning. Incorporating flexibility and capacity building into event legacy planning is essential to address future vulnerabilities and disturbances (Chen, 2022). This study explored how these strategies have been implemented and their impact on the sustainability of mega-events.

Environmental sustainability has become a critical concern, with organizers adopting green technologies, waste management systems, and energy-efficient practices to minimize ecological impact (Gogishvili & Müller, 2025). Socio-cultural sustainability involves engaging local communities, promoting social cohesion, and ensuring equitable distribution of benefits (Mair et al., 2021). Physical sustainability focuses on the use of modular and temporary infrastructure to reduce long-term environmental and economic burdens (Jones, 2017). By analyzing these aspects, this study aims to provide insights into the recovery and an outlook of mega-events in a post-pandemic world.

The purpose of this study was to examine the post-COVID-19 recovery of mega-events, focusing on their environmental, socio-cultural, and physical sustainability. The COVID-19 pandemic significantly disrupted the global landscape of tourism, including mega-events, leading to cancellations, postponements, and the implementation of stringent health protocols (Chen, 2022). As the world transitioned into the post-pandemic era, event organizers faced the challenge of balancing resilience, adaptability, and sustainability in their planning and execution processes (Jones et al., 2022). This study examined the strategies employed by various mega-events to address these challenges and ensure long-term viability.

2. Literature Review

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The COVID-19 pandemic has profoundly impacted the organization and perception of mega-events worldwide. Examined in this literature review is the evolution of mega-events from the pre-pandemic era through the pandemic's peak to the post-pandemic period, focusing on the challenges encountered, adaptive strategies employed, and emerging trends shaping their future.

Pandemic Era: Characteristics and Challenges of Mega-Events

Before the COVID-19 pandemic, mega-events such as the Olympic Games, FIFA World Cup, and large-scale music festivals were characterized by massive gatherings, extensive international travel, and significant economic and cultural impacts on host cities and nations. These events were celebrated for their potential to boost tourism, foster international unity, and stimulate local economies. However, they also faced criticism regarding environmental concerns, displacement of local communities, and the often-debated long-term economic benefits.

A systematic review by Mair highlighted the social impacts of mega-events, emphasizing positive outcomes—such as enhanced community pride and international recognition—and negative consequences, including social displacement and increased cost of living for local residents [4].

The COVID-19 pandemic introduced unprecedented challenges to the planning and execution of mega-events. Health and safety concerns necessitated the implementation of stringent protocols, including social distancing measures, vaccination requirements, and, in some cases, the absence of live audiences. For instance, the Tokyo 2020 Olympic Games were postponed by a year and held without spectators, significantly altering the traditional atmosphere and financial dynamics associated with such events [7].

The pandemic underscored the vulnerability of mega-events to global crises, prompting organizers to reconsider risk management strategies. Ludvigsen discussed how event organizers had to navigate the complexities of postponements, cancellations, and the shift to virtual or hybrid formats, all while managing financial losses and maintaining stakeholder engagement [8].

The environmental implications of mega-events also came under renewed scrutiny during the pandemic. A systematic review by Gkoumas et al. found that while some events have made strides toward sustainability, many continue to have significant negative environmental impacts, such as increased carbon emissions and resource consumption [9].

In response to these multifaceted challenges, there is a growing emphasis on developing more resilient and adaptable models for hosting mega-events. This includes leveraging technology for virtual participation, implementing sustainable practices, and ensuring that the benefits of such events are equitably distributed among local communities [4].

Pandemic Onset: Immediate Disruptions and Responses

The onset of the COVID-19 pandemic in early 2020 led to unprecedented disruptions in the scheduling and execution of mega-events. Governments worldwide implemented stringent measures to curb the virus's spread, including lockdowns, travel restrictions, and bans on large gatherings. Consequently, numerous events were postponed, canceled, or held without spectators [10,11].

The Tokyo 2020 Olympics were postponed to 2021, marking the first such delay in the event’s history. This decision was driven by concerns over public health and the challenges of ensuring athlete and spectator safety amid a global health crisis. The postponement had significant economic and logistical implications, affecting stakeholders ranging from athletes to sponsors and local businesses [12].

The postponement of the Tokyo 2020 Olympics had profound economic implications. Estimates suggest that the delay added approximately $2.8 billion to the overall cost, elevating the total expenditure to over $15 billion. Local businesses, particularly those in tourism and hospitality, faced substantial losses due to the absence of international visitors and the prohibition of spectators at events [12].

Athletes also encountered significant challenges. The delay disrupted training regimens and qualification processes, leading to psychological stress and uncertainty. Some athletes nearing

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retirement faced difficult decisions about extending their careers, while others had to adapt to new training environments due to lockdowns and facility closures. Studies have documented increased psychological strain among athletes during this period, highlighting concerns about performance, motivation, and mental health [13,14].

In response to these challenges, organizers implemented comprehensive health and safety protocols for the rescheduled Games. Measures included regular testing, vaccination requirements, and the establishment of a "bubble" environment to minimize the risk of COVID-19 transmission. These efforts were largely successful, with a reported infection rate of just 0.02% among participants [12].

The experience of the Tokyo 2020 Olympics underscores the need for robust contingency planning in the organization of mega-events. It highlights the importance of flexibility, stakeholder communication, and the integration of public health considerations into event planning processes [10].

Impact on Public Health and Risk Perception

The pandemic underscored the potential of mega-events to act as "super-spreader" events, amplifying the transmission of infectious diseases. A study analyzing the Biogen conference in Boston linked the event to over 333,000 COVID-19 cases, illustrating how a single gathering could have extensive public health ramifications [15]. Similarly, research on the UEFA Euro 2020 championship indicated that large-scale gatherings significantly contributed to the spread of COVID-19 across multiple countries. The study estimated that the championship was associated with approximately 840,000 cases, highlighting the challenges of hosting international events during a pandemic [16].

Further research has shown that the public health impact of such events extends beyond immediate transmission risks. For instance, the Tokyo 2020 Olympics, despite stringent health protocols, faced criticism for potentially increasing local COVID-19 cases. Studies have indicated that even with measures like regular testing and restricted audience sizes, the influx of international participants posed significant risks [12]. This highlights the complex balance between maintaining public health and continuing with scheduled mega-events.

Risk perception among the public also evolved during the pandemic. Initial responses to mega-events were marked by heightened fear and uncertainty, driven by media reports and government advisories [8]. Over time, as more information became available and vaccination campaigns progressed, public perception shifted towards a more nuanced understanding of risk. However, the psychological impact of these events remained significant, with many individuals experiencing increased anxiety and stress related to potential exposure [17].

The experience of managing mega-events during the pandemic has provided valuable lessons for future public health strategies. Effective communication and transparent risk assessment are crucial in managing public perception and ensuring compliance with health measures. Additionally, the integration of robust contingency plans and adaptive strategies can help mitigate the risks associated with large gatherings [18].

Adaptive Strategies and Innovations

In response to the challenges posed by the pandemic, event organizers and stakeholders implemented various adaptive strategies to mitigate risks and ensure the continuity of mega-events. These strategies included the adoption of hybrid event formats, enhanced health and safety protocols, and the utilization of technology to facilitate virtual participation. The UK government's Events Research Programme (ERP) conducted pilot events to assess the feasibility of hosting large gatherings safely. These events incorporated measures such as pre-and post-event testing, improved ventilation, and crowd management strategies. While the findings indicated no substantial outbreaks, experts noted that low uptake of post-event testing among attendees limited the robustness of the conclusions [19].

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One notable adaptive strategy was the shift to hybrid event formats, combining in-person and virtual elements to reduce the risk of transmission while maintaining engagement. This approach was particularly effective in maintaining international participation and inclusivity, as seen in various conferences and sporting events [20]. Enhanced health and safety protocols, including regular testing, vaccination requirements, and improved sanitation measures, were also critical in minimizing risks. For example, the Tokyo 2020 Olympics implemented stringent health measures, which contributed to a low infection rate among participants [12].

Technology played a pivotal role in facilitating virtual participation and ensuring the continuity of events. Virtual platforms enabled organizers to host events without physical gatherings, thus mitigating the risk of virus transmission. The use of digital tools for event management, audience engagement, and real-time monitoring of health metrics became standard practice [6]. These innovations not only addressed immediate challenges but also set new standards for future event planning.

The pandemic prompted a reevaluation of spatial strategies for mega-events. Organizers adopted measures such as scaling down event sizes, spacing out venues, and utilizing existing infrastructure to reduce the need for new construction and minimize environmental impact [6]. This shift towards sustainability and resilience is expected to influence the planning of future events, emphasizing the importance of adaptability and long-term legacy.

The experience of managing mega-events during the pandemic has provided valuable lessons for future public health strategies. Effective communication and transparent risk assessment are crucial in managing public perception and ensuring compliance with health measures. Additionally, the integration of robust contingency plans and adaptive strategies can help mitigate the risks associated with large gatherings [18].

Pre-Pandemic Sustainability Efforts

Before the COVID-19 pandemic, sustainability in mega-events had become an increasingly important consideration, particularly in response to widespread criticism of the environmental, social, and economic impacts of such large-scale gatherings. Organizers were beginning to adopt sustainable practices to address issues like carbon emissions, waste management, and community displacement [21,22]. The International Olympic Committee (IOC), for example, introduced sustainability as a key pillar of Olympic Agenda 2020, committing to low-impact infrastructure, environmental stewardship, and community legacy outcomes [23].

However, sustainability efforts during the pre-pandemic era were often viewed as supplementary rather than central to event planning. Numerous host cities faced scrutiny over greenwashing, where sustainability was promoted rhetorically but not sufficiently implemented in practice [24]. Mega-events like the Rio 2016 Olympics and the 2014 FIFA World Cup in Brazil drew significant attention for their social and ecological costs, such as displacements and increased pollution [24].

In addition to these criticisms, research has highlighted the challenges of achieving genuine sustainability in mega-events. For instance, a study on the sustainability practices of mega-events in Chinese metropolises revealed that while economic and environmental sustainability were often prioritized, social sustainability lagged behind [25]. This imbalance underscores the complexity of integrating comprehensive sustainability measures into event planning.

The pre-pandemic era saw a growing emphasis on the legacy of mega-events. Organizers aimed to ensure that the benefits of hosting such events extended beyond their immediate duration. This included investments in infrastructure that could serve the community long-term, as well as initiatives to promote local economic development and social cohesion [26]. Despite these efforts, the actual implementation often fell short of the ambitious goals set by organizers, leading to mixed outcomes in terms of sustainability.

The role of technology in promoting sustainability also gained traction during this period. Innovations such as smart infrastructure, energy-efficient systems, and digital platforms for waste

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management were increasingly adopted to minimize the environmental footprint of mega-events [6]. These technological advancements not only addressed immediate sustainability concerns but also set a precedent for future event planning.

Overall, while pre-pandemic sustainability efforts in mega-events marked a significant step forward, they were often hampered by practical challenges and inconsistencies in implementation. The lessons learned from these efforts continue to inform current and future strategies for hosting sustainable mega-events.

Post-Pandemic Sustainability Reframing

The post-COVID landscape has accelerated the integration of sustainability into mega-event planning—not just in environmental terms but also in public health, social inclusion, and economic resilience. The pandemic has reinforced the need for flexible, resilient event models that can respond to global crises without incurring unsustainable burdens [5]. Hybrid and digitally integrated events, which became necessary during the pandemic, now offer opportunities to reduce the carbon footprint associated with long-distance travel and massive infrastructure development [27]. Organizers are re-evaluating the scale and permanence of infrastructure, opting instead for temporary or modular venues and increased community consultation to ensure long-term benefits.

There is a noticeable shift toward the circular economy model in event planning—aiming for zero-waste practices, resource reuse, and energy efficiency. For example, the 2024 Paris Olympics have prioritized carbon neutrality and the use of 95% existing or temporary venues, setting a benchmark for future mega-events [28]. This approach not only reduces environmental impact but also promotes sustainable development by leveraging existing resources and minimizing waste.

The concept of resilience has become central to post-pandemic sustainability efforts. Event organizers are increasingly focusing on creating adaptable and flexible event models that can withstand future disruptions. This includes the incorporation of contingency plans, robust health protocols, and the ability to pivot to virtual or hybrid formats as needed [1]. Such strategies ensure that events can continue safely and effectively, even in the face of unforeseen challenges.

Public health considerations have also been integrated into sustainability planning. The pandemic highlighted the importance of health security in event management, leading to the adoption of measures such as enhanced sanitation, health monitoring, and vaccination requirements [18]. These practices not only protect attendees but also contribute to the overall sustainability of events by reducing the risk of disease transmission.

Social inclusion and economic resilience are other key aspects of post-pandemic sustainability reframing. Organizers are prioritizing community engagement and ensuring that the benefits of mega-events are distributed equitably. This includes supporting local businesses, promoting social cohesion, and creating opportunities for marginalized groups [1]. By fostering inclusive and resilient communities, mega-events can leave a positive legacy that extends beyond their immediate duration.

Sustainable Legacy and Community Engagement

Another post-pandemic trend is the heightened focus on legacy planning—ensuring that mega-events deliver long-lasting social, economic, and environmental benefits. This includes integrating local communities into decision-making, building local capacity, and avoiding "white elephant" infrastructure projects that become burdens after the event. As highlighted by Mair, community engagement and transparency have become more central in sustainability conversations, particularly considering the social vulnerabilities exposed by the pandemic. [4]. The experience of COVID-19 has emphasized the importance of aligning mega-events with the Sustainable Development Goals (SDGs), particularly goals related to health, sustainable cities, and responsible consumption.

Community engagement is crucial for creating sustainable legacies. Effective engagement involves not only consulting local residents but also actively involving them in the planning and execution of events. This approach ensures that the benefits of mega-events are distributed equitably and that the needs and concerns of the community are addressed [29]. For example, the 2002 Winter

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Olympics in Salt Lake City demonstrated the importance of understanding community sentiment and integrating local perspectives into legacy planning [30]. Longitudinal studies have shown that community attachment and satisfaction can significantly influence the perceived success of mega-events and their long-term impacts [30].

Sustainable legacy planning involves avoiding infrastructure projects that do not serve the community post-event. The concept of "white elephant" projects—expensive facilities that become underutilized—has been a significant concern in mega-event planning. By focusing on temporary or modular venues and prioritizing community needs, organizers can prevent such burdens and ensure that infrastructure investments provide lasting benefits [5].

The alignment of mega-events with the SDGs is another critical aspect of post-pandemic sustainability reframing. Goals related to health, sustainable cities, and responsible consumption are particularly relevant. For instance, the Paris 2024 Olympics have committed to carbon neutrality and the use of existing or temporary venues, setting a benchmark for future events [28]. This commitment not only addresses environmental sustainability but also promotes social and economic resilience by leveraging local resources and minimizing waste.

The post-pandemic era has underscored the importance of sustainable legacy planning and community engagement in mega-events. By integrating local communities into decision-making, avoiding burdensome infrastructure projects, and aligning with the SDGs, organizers can ensure that mega-events deliver long-lasting benefits and contribute to sustainable development.

Post-Pandemic Transformations and Future Outlook

As the world transitions into the post-pandemic era, the mega-event landscape is undergoing significant transformations. There is a heightened emphasis on resilience, adaptability, and sustainability in event planning and execution. Organizers increasingly prioritize health security, environmental considerations, and community engagement to ensure the long-term viability and acceptance of mega-events. A study by Ludvigsen, Rookwood, and Parnell examined the governance and impacts of sports mega-events in the 2020s, highlighting the need for transparent decision-making processes and the incorporation of public health considerations into event planning [27]. The research emphasized that future mega-events must balance the pursuit of economic and cultural benefits with the imperative of safeguarding public health.

The pandemic has accelerated the integration of digital technologies into mega-events, facilitating virtual participation and expanding audience reach. Hybrid models, combining in-person and virtual elements, are becoming more prevalent, offering flexibility and inclusivity. This shift not only addresses health concerns but also aligns with broader trends toward digitalization and sustainability [1] The COVID-19 pandemic has served as a catalyst for reevaluating and reshaping the paradigms governing mega-events. The challenges encountered have illuminated the vulnerabilities inherent in traditional event models and underscored the necessity for innovation and adaptability [6].

In addition to technological advancements, there is a growing emphasis on sustainable practices. Organizers are increasingly adopting measures to reduce the environmental impact of mega-events, such as carbon offsetting, waste reduction, and the use of renewable energy sources [18]. These efforts not only contribute to environmental sustainability but also enhance the social and economic resilience of host communities.

As the sector moves forward, a balanced approach that integrates public health considerations, technological advancements, and sustainable practices will be essential in redefining the future of mega-events in a post-pandemic world. This holistic approach ensures that mega-events can continue to thrive while addressing the challenges posed by global crises.

3. Materials and Methods

Employed in this study was a qualitative, comparative case study methodology to explore the evolving strategies in the planning and execution of mega-events. The research focused on diverse

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cases including the FIFA World Cup, NASCAR Street Race, Lollapalooza Music Festival, the Summer and Winter Olympic Games, and events hosted at Chicago McCormick Place Convention Center. These events were purposefully selected based on their scale, international visibility, and documented responses to the COVID-19 pandemic.

Data Collection

The research is based exclusively on secondary data, gathered from peer-reviewed journal articles, government and event organizer reports, economic impact assessments, and media publications. The objective was to build a comprehensive understanding of strategic shifts across the domains of infrastructure, socio-cultural engagement, marketing, and sustainability.

Data collection was carried out collaboratively by two researchers. A shared search protocol was developed, using targeted keywords such as "mega-event planning," "pandemic-era event management," "Olympic sustainability," and "urban event infrastructure". Searches were conducted across academic databases including JSTOR, Google Scholar, PubMed, and Arxiv. Data for Chicago-based events that included Lollapalooza, NASCAR Race, and McCormick Convention Center, were supplied by Choose Chicago, the destination marketing association for the City of Chicago. Each researcher was responsible for an assigned set of case studies to ensure coverage and reduce overlap. To strengthen reliability, each researcher conducted an independent review of the other's collected sources, validating the inclusion of materials according to pre-established relevance and credibility criteria.

Data Analysis

Data analysis followed a thematic content analysis framework, structured around four analytic dimensions: (1) infrastructure and spatial adaptability, (2) socio-cultural resilience and public engagement, (3) marketing evolution and global reach, and (4) environmental sustainability. Using Braun and Clarke's guidelines for thematic analysis, both researchers independently coded the data according to these themes [31].

Following initial coding, a cross-validation process was conducted to ensure intercoder reliability. Each researcher reviewed the other's coded data to reconcile discrepancies and refine thematic interpretations. Patterns, divergences, and strategic shifts across the pre- and post-COVID-19 periods were identified through comparative matrices. This collaborative review process enhanced the internal consistency and analytical rigor of the study's findings.

Ethical Considerations

This study utilized only publicly available secondary data and did not involve human participants, thereby exempting it from the need for institutional ethical approval. All data were handled in accordance with ethical standards for secondary analysis, and sources were accurately cited.

4. Results

Drawing on this comparative analysis of mega-events, including the FIFA World Cup, NASCAR Street Race, Lollapalooza Music Festival, Summer and Winter Olympic Games, and events held at Chicago's McCormick Place Convention Center (one of the largest convention centers in the US), the authors examine the evolution in the planning and execution of these mega-events. The analysis focused on highlighting key transformations and emerging priorities. The analysis reveals distinct patterns and strategic shifts, particularly evident when comparing the pre-and post-COVID-19 pandemic eras.

Infrastructure and Spatial Adaptability

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The infrastructural strategies across the studied mega-events reveal diverging approaches to space usage and permanence. The FIFA World Cup 2022 in Qatar stands out for its extensive physical investments—approximately $220 billion, in stark contrast to Brazil 2014 ($15 billion) and Russia 2018 ($11.6 billion) [32]. A significant portion of this expenditure supported expansive stadium and transportation infrastructure, reflecting a pre-pandemic model of legacy-oriented investment.

Conversely, post-pandemic urban events such as the NASCAR Chicago Street Race and Lollapalooza exemplify flexible, temporary spatial strategies. NASCAR repurposed Chicago's streets into a city circuit, requiring short-term modifications rather than permanent construction [33]. Lollapalooza's layout in Grant Park also emphasizes modular, annual staging of physical infrastructure [34]. Meanwhile, McCormick Place adapted existing permanent facilities with post-COVID modifications, including sanitation protocols and potentially reconfigured spatial layouts for distancing [35]. These trends reflect a wider shift towards adaptability and resource efficiency in mega-event infrastructure.

Socio-Cultural Resilience and Public Engagement

All events reviewed demonstrate a resurgence in public participation, indicating a restored social appetite for communal gatherings post-COVID. The FIFA World Cup 2022 drew a record 5 billion viewers and 3.4 million in-person attendees, reinforcing the enduring global appeal of mega-sport events [32]. Likewise, Lollapalooza attracted approximately 385,000 attendees in 2021, underscoring its socio-cultural importance as a festival experience [34].

NASCAR's Chicago event attracted substantial non-local attendance in both 2023 and 2024 and improved perceptions of both the city and the sport among newcomers [33]. Importantly, the event satisfaction score rose from –3.0 in 2023 to 29.7 in 2024, indicating rapid improvements in attendee experience. McCormick Place, despite major declines during 2020–2021, rebounded to pre-pandemic event levels by 2024, revealing strong community and industry demand for in-person interaction [35].

Marketing Evolution and Global Reach

Marketing strategies across these events have evolved to reflect post-COVID realities, emphasizing public safety, adaptability, and environmental responsibility. The FIFA World Cup maintained high commercial returns, with marketing rights growing from $1.6 billion in 2014 to $1.795 billion in 2022 [32]. Meanwhile, NASCAR's event generated $43.6 million in media value in 2024, a nearly 2x increase from 2023, and engaged millions of viewers and social media users [33].

For Lollapalooza and McCormick Place, marketing also emphasized local economic impact and health security. Lollapalooza's branding integrated public health messaging to encourage safe attendance, while McCormick Place promoted recovery milestones and return-to-normalcy imagery [34,35]. These shifts highlight the importance of trust-building in post-pandemic promotional narratives.

Environmental Sustainability: A Critical Cross-Cutting Concern

Across all reviewed events, sustainability emerges as both a challenge and an evolving priority. The FIFA World Cup 2022, despite its high visibility, is marked by potential environmental concerns due to the vast scale of construction and resource consumption. While Qatar's infrastructure development may have included green technologies, no definitive environmental metrics were disclosed in the primary data [32].

In contrast, NASCAR's Chicago event, though temporary, raises concerns over fuel consumption, noise pollution, and waste generation, particularly given its urban context and non-local visitor footprint. However, the short-term nature of the infrastructure may reduce lasting environmental disruption [33]. Lollapalooza shares similar environmental risks—including waste

 doi:10.20944/preprints202504.1869.v1

and energy usage—though its repeated use of Grant Park suggests a lower ecological impact relative to new construction [34].

McCormick Place, as a fixed convention center, represents another sustainability challenge. Large venues inherently consume high energy and generate substantial waste. The recovery period presents a pivotal opportunity to implement green retrofits, including energy efficiency upgrades and enhanced waste management systems [35]. However, like other case studies, these sustainability actions were not detailed in the primary reports, underscoring the need for future transparency and commitment to measurable outcomes.

Across all events, sustainability remains underreported yet increasingly relevant. Emerging patterns suggest a shift toward temporary and modular infrastructure, decentralized energy use, and recyclable materials, though concrete environmental reporting is sparse. As public expectations rise and regulations tighten, mega-events will need to adopt sustainability not only as a communication theme but as a core operational principle.

Olympic Games Pre-Pandemic Era (Summer: Rio 2016; Winter: Sochi 2014 & PyeongChang 2018)

During the pre-pandemic period, both the Summer and Winter Olympics demonstrated a growing, albeit different in focus, awareness of sustainability. Rio 2016 emphasized localized environmental efforts such as ethanol fleets and forest replanting. In contrast, Sochi 2014 introduced "Green Construction" standards alongside substantial infrastructure development, and PyeongChang 2018 highlighted eco-friendly design and the use of renewable materials. This suggests that the pre-pandemic Summer Games focused on specific environmental initiatives, while the Winter Games began to integrate broader eco-conscious design principles. [37,38]

In terms of infrastructure and legacy, Rio 2016 aimed for significant urban renewal through extensive construction, mirroring Sochi 2014's construction of an entirely new Olympic Park. PyeongChang 2018, however, showed an early move towards prioritizing venue reuse and long-term legacy. Thus, the pre-pandemic Summer Games were more oriented toward large-scale urban transformation through new infrastructure, whereas the Winter Games started to explore venue reuse as a legacy strategy [37].

Efforts towards inclusion and accessibility were also evident. Rio 2016 marked a milestone with the debut of the Refugee Olympic Team. Sochi 2014 focused on creating Paralympic-friendly urban infrastructure, and PyeongChang 2018 expanded accessibility efforts and featured a symbolic joint Korean team. This indicates that both the Summer and Winter Games recognized the importance of inclusion, with the Summer Games pioneering global inclusion through the Refugee Team and the Winter Games emphasizing Paralympic integration and symbolic unity [37].

Technological integration advanced in both Summer and Winter Games before the pandemic. Rio 2016 enhanced digital viewership, Sochi 2014 featured large LED displays, and PyeongChang 2018 launched 5G and VR viewing. Technology served as an increasingly vital tool to enhance the spectator experience for both Summer and Winter editions. [37]

Post-Pandemic Era (Summer: Tokyo 2020 & Paris 2024; Winter: Beijing 2022)

The COVID-19 pandemic has significantly accelerated the commitment to sustainability, particularly in the Winter Games. Tokyo 2020 aimed for carbon-negative operations and medal recycling, while Paris 2024 set ambitious goals for a circular economy and net-zero carbon emissions. Notably, Beijing 2022 achieved 100% renewable energy use for all venues and full carbon neutrality, setting a new benchmark for environmental sustainability in the Olympics. This suggests that post-pandemic, sustainability became a central and rigorously pursued goal for both Summer and Winter Games, with Beijing 2022 demonstrating exceptional achievements in this area.

Infrastructure prioritization shifted significantly post-pandemic towards the reuse of existing venues. Tokyo 2020 emphasized minimal new infrastructure due to cost-saving measures, a trend further amplified in Paris 2024 with a target of 95% existing or temporary venues. Beijing 2022 also heavily relied on reusing venues from the 2008 Summer Olympics. Both Summer and Winter Games

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post-pandemic strongly prioritized the reuse of existing infrastructure over large-scale new builds, driven by cost considerations and sustainability objectives.

Inclusion and accessibility efforts deepened in the post-pandemic era. Tokyo 2020 focused on record female participation and gender-balanced events, which were maintained in Paris 2024 alongside an expanded Refugee Team and accessible events. Beijing 2022 was the most gender-equal Winter Olympics to date and emphasized digital accessibility. Both the Summer and Winter Games continued to prioritize gender equality and broadened the scope of accessibility initiatives, with the Winter Games increasingly leveraging digital tools.

Technology's role evolved from a support function to a foundational platform in the post-pandemic Games. Tokyo 2020 utilized virtual audience features and cloud-based operations. Paris 2024 incorporates AI-powered experiences, digital twins, and VR content. Beijing 2022 featured digital twins, AI traffic control, and a fully digital broadcast infrastructure. Post-pandemic, technology became crucial for fan engagement, operational efficiency, and even health security, with both Summer and Winter Games showcasing sophisticated digital integrations.

Impact of the COVID-19 Pandemic

The COVID-19 pandemic represents a defining divergence in the post-pandemic era. Tokyo 2020 faced significant disruption through postponement and the absence of international spectators. Paris 2024 incorporated lessons learned from this experience, emphasizing flexibility and resilience. Beijing 2022, as the first pandemic-era Winter Olympics, implemented a rigorous "closed-loop" system, including mass testing and vaccine mandates. Thus, the Winter Games directly confronted the immediate challenges of staging a major event during a global health crisis, necessitating the development of stringent health security protocols. At the same time, the Summer Games adapted their strategies in response to the pandemic's broader impacts.

Overall Strategic Shifts

The Summer Olympics have transitioned from a focus on legacy through construction (Rio) to resilience through pandemic response (Tokyo), and now to inclusion and sustainability-first innovation (Paris). The Winter Olympics have shifted from monumental development projects (Sochi) to emphasizing peace and technology (PyeongChang), and then to a model for resilient mega-events under pandemic protocols, with new benchmarks in sustainability and reuse (Beijing).

In summary, while both Summer and Winter Olympics have shown an increasing commitment to sustainability, inclusion, and technological advancement, the pandemic era has highlighted certain differences. The Winter Games, particularly Beijing 2022, directly addressed the complexities of organizing a mega-event during a global health crisis, pioneering health security measures. Nevertheless, both Games demonstrate a post-pandemic emphasis on fiscal responsibility through infrastructure reuse, a deeper commitment to environmental sustainability, and the integral role of digital technology across all facets of the Games.

Drawing on the comparative analyses of the recent Summer and Winter Olympics, the future health of these mega-sporting events appears to hinge on their continued evolution towards greater sustainability, fiscal responsibility through infrastructure reuse, enhanced inclusivity, and the strategic integration of technology. The COVID-19 pandemic has acted as a significant catalyst, underscoring the necessity for resilience, adaptability, and the prioritization of health security protocols, particularly evident in the execution of the Tokyo 2020 and Beijing 2022 Games. The shift away from infrastructure-heavy development towards leveraging existing venues and embracing circular economy principles suggests a more environmentally and economically conscious approach. Furthermore, the increasing emphasis on social innovation, gender parity, and accessibility indicates a commitment to broadening the Games' impact and relevance. While the Winter Games, exemplified by Beijing 2022, have demonstrated the capacity to innovate under significant global health constraints, both the Summer and Winter Olympics are converging towards a future characterized

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by smart, human-centered, and increasingly sustainable models, with technology playing a crucial role in enhancing both the operational efficiency and the fan experience.

5. Discussion

The COVID-19 pandemic triggered an unprecedented disruption in the global organization of mega-events. From the Olympic Games to large-scale music festivals, these once-reliable engines of cultural exchange, economic development, and urban renewal were forced into a period of reevaluation and transformation. As the world transitioned into a post-pandemic phase, mega-events adopted new forms that prioritized public health, sustainability, and digital innovation. In this discussion, these transformations are viewed through a comparative lens, focusing on spatial adaptability, public engagement, marketing evolution, and environmental sustainability across a spectrum of mega-events, including the Olympics, FIFA World Cup, NASCAR Street Race, and Lollapalooza.

Spatial Adaptability and Infrastructure Shifts

One of the most visible changes in mega-events post-COVID-19 is the redefinition of infrastructure. Prior to the pandemic, physical legacy and monumental architecture were central to event planning. The 2022 FIFA World Cup in Qatar exemplifies this pre-pandemic ethos, with an estimated $220 billion invested in stadiums and transportation infrastructure, dwarfing the expenditures of Brazil 2014 and Russia 2018 [32]. This massive spending, however, sparked criticism regarding its environmental and social impacts [39].

In contrast, post-pandemic events have embraced spatial flexibility. NASCAR's Chicago Street Race and Lollapalooza's modular setup in Grant Park demonstrate a pivot toward temporary and reusable infrastructure. These urban events minimized permanent construction and emphasized adaptive reuse of public space, reflecting a shift toward sustainability and cost efficiency [33,34]. The transformation of McCormick Place into a post-COVID adaptable venue, complete with sanitation enhancements and spatial reconfigurations, further illustrates the trend toward multi-functional, resilient infrastructure [35]. This shift aligns with broader urban sustainability goals emphasizing circular economies and reduced construction footprints [5].

Socio-Cultural Resilience and Community Engagement

Despite the isolating impact of the pandemic, public appetite for shared cultural experiences remains strong. The FIFA World Cup 2022 attracted over 3.4 million spectators and five billion global viewers, confirming the persistent allure of sport mega-events [32]. Similarly, Lollapalooza welcomed 385,000 attendees, revealing robust demand for music festivals even amidst lingering health concerns [34].

NASCAR's urban event model enhanced local engagement, increasing city pride and introducing the sport to new demographics. Satisfaction scores jumped significantly between 2023 and 2024, reflecting improved event design and growing public trust [33]. McCormick Place also experienced a resurgence, reaching pre-pandemic participation levels by 2024 [35]. These trends affirm the findings of Mair, who emphasized the dual role of mega-events in fostering both economic activity and communal identity [4]. Post-pandemic planning increasingly prioritizes transparent community engagement, recognizing the need for social license and inclusive benefits.

Evolving Marketing Narratives and Global Reach

Marketing in the post-pandemic era has undergone a significant evolution, shifting from promotional excess to trust-building and health-conscious narratives. The FIFA World Cup maintained its high-value brand appeal, growing its marketing rights revenue from $1.6 billion in 2014 to $1.795 billion in 2022 [32]. However, other events, like NASCAR and Lollapalooza,

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recalibrated their campaigns to include messages of public health, safety, and localized economic impact.

NASCAR's 2024 event nearly doubled its media value from the prior year, largely due to digital engagement strategies and socially resonant messaging [33]. McCormick Place positioned its comeback within a narrative of urban resilience and renewal, encouraging stakeholders to view the venue as a symbol of post-pandemic recovery [35].

This evolution echoes Campbell's analysis of the Tokyo 2020 Olympics, where branding emphasized perseverance and global unity in the face of adversity [40]. The emphasis on adaptive marketing highlights how trust, safety, and transparency have become key pillars of public engagement strategies.

Environmental Sustainability: Aspirations and Gaps

Sustainability has emerged as both a rhetorical focus and an operational challenge in the mega-event landscape. The document reviewed points to increasing attention toward green initiatives, yet a gap persists between promises and measurable outcomes. The 2022 FIFA World Cup faced scrutiny for its environmental impact due to large-scale construction, despite claims of incorporating green technologies [32]. Lack of transparent environmental metrics limited external validation.

In contrast, the Olympics set more verifiable benchmarks. Tokyo 2020 utilized recycled metals for medals, Paris 2024 committed to 95% venue reuse, and Beijing 2022 powered all venues with renewable energy—achieving carbon neutrality [41]. These actions reflect a shift from token sustainability efforts to core planning principles, especially evident in the Winter Games, which have embraced advanced green standards [27].

Still, events like NASCAR and Lollapalooza highlight persistent issues, including waste generation and fuel consumption. Despite the short-term nature of their setups, environmental concerns remain due to urban footprints and travel-related emissions. As Gaffney (2013) warned in his critique of Rio 2016, sustainability claims must be matched by third-party validation to prevent greenwashing [24].

Technological Integration and Digital Transformation

The pandemic accelerated the integration of technology into mega-event planning, not only for operational efficiency but also for safety and inclusivity. Tokyo 2020 featured cloud-based systems and virtual audience tools, while Beijing 2022 deployed digital twins and AI-powered traffic control to manage crowds and reduce exposure risks [41]

Paris 2024 promised even greater innovation, integrating virtual reality experiences, AI-driven fan engagement platforms, and digital sustainability trackers. These developments position digital tools as foundational—not ancillary—to event management. They also reflect the pandemic's role as a technological inflection point, where hybrid and virtual formats became not just necessary but desirable for broader accessibility [27].

The Olympic Model: Comparative Insights

Olympic Games offer a longitudinal view of the shifts in mega-event paradigms. Pre-pandemic Summer Games like Rio 2016 emphasized legacy construction and local sustainability initiatives. In contrast, the Winter Games—especially PyeongChang 2018—experimented with eco-friendly design and symbolic inclusion efforts.

Post-pandemic Games have harmonized these trends. Tokyo 2020's focus on gender balance and sustainable sourcing, Beijing 2022's benchmark carbon-neutral model, and Paris 2024's hybrid accessibility all represent a convergence of innovation and responsibility. The IOC's Olympic Agenda 2020+5 further institutionalizes this direction, embedding sustainability and inclusion as core mandates [37].

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The divergent paths of Summer and Winter Olympics—legacy-oriented versus sustainability-driven—are now converging. The future Olympic model prioritizes reuse, digital engagement, and strategic alignment with the UN Sustainable Development Goals (SDGs), particularly those targeting health, climate action, and urban sustainability [38].

6. Managerial Implications for the Future

The COVID-19 pandemic has been a pivotal catalyst in transforming mega-events from grand spectacles of physical permanence to dynamic platforms of social resilience, digital connectivity, and environmental accountability. Infrastructure planning has shifted toward flexibility and reuse; community engagement has gained renewed importance; marketing now emphasizes safety and trust; and sustainability has moved from rhetoric to operational priority—though gaps remain. Here are six key implications for managers running future mega-events:

1. **Infrastructure and Spatial Adaptability:** Managers must prioritize flexible and temporary infrastructure solutions to reduce long-term environmental and economic burdens. The shift from permanent constructions to modular and adaptable venues, as seen in post-pandemic events like NASCAR's Chicago Street Race and Lollapalooza, highlighted the importance of resource efficiency and spatial adaptability [6].
2. **Socio-Cultural Resilience and Public Engagement:** Ensuring robust community engagement and fostering socio-cultural resilience are crucial. Events like the FIFA World Cup 2022 and Lollapalooza demonstrated the importance of public participation and satisfaction in enhancing the social impact of mega-events. Managers should focus on transparent communication and inclusive planning to build trust and improve attendee experiences [4].
3. **Marketing Evolution and Global Reach:** Post-pandemic marketing strategies must emphasize public safety, adaptability, and environmental responsibility. The evolution of marketing approaches, such as those employed by FIFA and NASCAR, underscored the need for trust-building and the integration of health security in promotional narratives. Managers should leverage digital platforms to expand global reach and engage diverse audiences [42].
4. **Environmental Sustainability:** Sustainability must be a core operational principle rather than a peripheral concern. The environmental challenges faced by events like the FIFA World Cup 2022 and NASCAR's Chicago event highlighted the need for comprehensive sustainability practices. Managers should implement green technologies, energy-efficient systems, and waste reduction measures to minimize ecological impact [3].
5. **Health Security and Safety Protocols:** Integrating robust health security measures is essential for the safe execution of mega-events. The pandemic has underscored the importance of sanitation protocols, health monitoring, and vaccination requirements. Managers should develop contingency plans and adaptive strategies to ensure the health and safety of participants and attendees [18].
6. **Legacy Planning and Community Benefits:** Effective legacy planning involves avoiding "white elephant" projects and ensuring that infrastructure investments provide lasting benefits to local communities. Managers should prioritize community consultation and align mega-events with Sustainable Development Goals (SDGs) to promote social, economic, and environmental resilience [29].

As evidenced across the FIFA World Cup, NASCAR, Lollapalooza, and the Olympic Games, these shifts are redefining the mega-event paradigm. Future events must embrace adaptive governance, technological innovation, and measurable sustainability to ensure relevance, viability, and public trust in a post-pandemic world.

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7. Conclusions

The post-pandemic era has significantly transformed the landscape of mega-events, emphasizing resilience, adaptability, and sustainability. Event organizers are increasingly integrating health security, environmental considerations, and community engagement into their planning processes to ensure long-term viability and acceptance [6,27]. The shift towards hybrid and digitally integrated event models offers opportunities to reduce carbon footprints and enhance inclusivity [1]. Furthermore, the alignment of mega-events with Sustainable Development Goals (SDGs) underscores the importance of delivering lasting social, economic, and environmental benefits [29].

The pandemic has accelerated the adoption of innovative strategies, such as modular infrastructure and temporary venues, which reduce the environmental impact and promote resource efficiency [6]. These approaches not only address immediate sustainability concerns but also set a precedent for future event planning. Additionally, the integration of robust health protocols, including sanitation measures and vaccination requirements, has become essential in safeguarding public health during large gatherings [18].

Community engagement has emerged as a critical component of sustainable legacy planning. By involving local residents in decision-making and ensuring that the benefits of mega-events are equitably distributed, organizers can foster social cohesion and enhance the perceived success of events [4]. This approach helps to build trust and improve attendee experiences, which are vital for the long-term acceptance of mega-events.

The evolution of marketing strategies reflects the need for transparency and trust-building in the post-pandemic era. Emphasizing public safety, adaptability, and environmental responsibility in promotional narratives can enhance the global reach and commercial success of mega-events [42].

In summary, the post-pandemic transformations in mega-event planning highlight the necessity for innovation and adaptability in addressing global tourism challenges. A balanced approach that integrates public health considerations, technological advancements, and sustainable practices will be essential in redefining the future of mega-events in a post-pandemic world.

8. Study Limitations

While this study provided valuable insights into strategic shifts in mega-event planning, several limitations must be acknowledged. First, the exclusive reliance on secondary data constrains the analysis to publicly available information, potentially omitting internal planning deliberations, proprietary evaluations, or unpublished performance metrics. This may lead to biased representations or data gaps, especially where independent post-event assessments are lacking [43].

Second, the absence of primary data collection, such as interviews or direct stakeholder input, limits the study's ability to triangulate findings and delve into the motivations behind strategic decisions. This is especially relevant given the complex governance structures and socio-political dynamics that typically underpin mega-event planning [44].

Third, while thematic analysis was conducted collaboratively by two researchers to ensure consistency, this method remains interpretive in nature. Without formal inter-rater reliability testing, thematic coding may still reflect subjective judgments, which can affect analytical rigor [31].

Additionally, the selected case studies, while diverse, do not cover all mega-event types or geographic regions, particularly those in the Global South or less-documented contexts [45]. This limits the generalizability of the findings to other political, economic, or cultural settings [46]. As such, any interpretations based on these sources should be treated cautiously, given the dynamic nature of post-pandemic event management [44].

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