Australasian Transport Research Forum 2024 Proceedings
27-29 November, Melbourne, Australia
Publication website: https://australasiantransportresearchforum.org.au/

Cycling legacy from major events: Conceptualising and planning cycling impacts of Brisbane 2032

Niloofar Dehghani Samani[1], Matthew I Burke[1] Kelly Bertolaccini[1], Elaine Yang[2]

[1] Cities Research Institute/School of Engineering and Built Environment, Griffith University

[2] Griffith Institute for Tourism, Griffith Business School, Griffith University

Email for correspondence (presenting author): niloofar.dehghanisamani@griffithuni.edu.au

Abstract

Mega-events such as the Olympic and Paralympic Games are pitched as beneficial to host cities due to their legacy impacts. A key part of this is transport and sporting legacies. This paper aims to conceptualize and explore what cycling legacy means for such events and the real-world outcomes of past mega-events. This is important to assist the state and local government bodies that are planning for the Brisbane 2032 Games and to ensure that the host cities (Brisbane, the Gold Coast, and the Sunshine Coast) maximise the possible cycling legacy. In terms of methods, an interpretive review was undertaken, using systematic approaches for scholarly literature collection through *Scopus, Web of Science, and Google Scholar*. A set of additional grey literature materials from industry and media reports were sourced using *Google* and *TRID (Transport Research International Documentation)*. Conceptually, there are five number types of cycling legacy that are identifiable from the literature: i) cycling infrastructure; ii) cycling participation; iii) cycle tourism; iv) social legacy of cycling; and, v) dedicated cycling regulations. Some examples of these legacies from past Summer Olympics and Paralympics are provided. There are questions as to what extent host cities achieve their objectives in terms of cycling legacy, with very few evaluations undertaken. The results suggest that Southeast Queensland should better frame and plan for its cycling legacy and set out a realistic but ambitious strategy to achieve more. A possible outline of a *Brisbane 2032 Cycling Legacy Plan* is provided.

Keywords: Bicycle, cycling legacy, mega-events, Olympics, cycling legacy plan

1 Introduction

The field of transportation intersects with the Olympics and other mega-events in a number of ways. There are the all-important issues of servicing the transport demands of so many spectators, athletes, and officials (Currie & Shalaby, 2012; Kassens-Noor, 2013a, 2013b), and the tourism transport capacity issues for host cities and countries, including airport capacity (Jago et al., 2010b). A key focus is often on the transport infrastructure needed for the Games, most often on high-cost mass public transport to stadiums (Borghetti et al., 2023). A lesser focus is placed on the planning of active transport infrastructure and services. In part to legitimise massive expenditures on stadiums and to justify urban disruption, cities and bodies such as the International Olympic Committee often speak to the 'transport legacy' that mega-events leave behind. But what are the benefits for active transport modes, and especially for cycling?

Existing research on cycling legacy from major or mega-events is quite limited. However, there are a number of legacies claimed by previous host cities. Gaps in knowledge include the various types of cycling legacy that may be obtained, the real-world outcomes of such events, and strategies and approaches that can be employed to effectively achieve these legacies.

These gaps matter as future host cities, such as the South East Queensland conurbation, are increasingly under pressure to plan for meaningful transport legacy from their mega-events at a time when the overall investment and budgets are being dramatically curtailed in what the IOC (International Olympic Committee) calls 'the New Norm' (IOC, 2018).

The paper is organised as follows. Firstly, the main objects-of-inquiry in mega-events and transport legacy are defined to provide a robust underpinning to the following analysis. Second, the methods are provided in more detail. Third, the results of the review are outlined, including the new typology of cycling legacy that cities seek to attain. Some key lessons of what to avoid and what to pursue start to emerge at this point. Fourth, a discussion is provided, summarising the contributions of the paper to the field of transport studies and outlining a progressive research and planning agenda for the 2032 Games. Fifth, a possible outline of a *Brisbane 2032 Cycling Legacy Plan* is provided.

2 Background

2.1 Mega-events

Events can be categorized based on their scale and impact across multiple dimensions. Mega events are large-scale, short-term events that have long-term consequences and can transform a city by stimulating development and providing nation-branding opportunities (Berridge, 2012; Jago et al., 2010a; Roche, 2008). Examples of mega-events include the Olympic and Paralympic Games, FIFA World Cup, and World Expos (Horne, 2007; Talavera et al., 2019). These events are crucial for decision-makers, administrators, and policymakers, as they bring both challenges and opportunities for the host city (Karadakis et al., 2010; Knott et al., 2015; Preuss, 2015).

Mega-events are known to have various dimensions. They have four dimensions including visitor attractiveness, mediated reach, costs, and transformative impact (Müller, 2015) These events attract a large number of visitors. A good example is the 2010 Shanghai World Expo, with over 73 million tickets sold. They are broadcast and watched by a wide audience worldwide. However, these events come with large costs and massive investments, including infrastructure and event organizing costs. They have a significant impact on the built environment and the population of the host city and often leave a lasting legacy for the host city (Lienhard & Preuss, 2014; Müller, 2015; Roche, 2002, p. 1)

In contrast, major events are large in scale but small compared to mega-events. They generate interest outside the host country but may not have the same global reach as mega-events. Major events' costs and infrastructure requirements are significant but typically lower than those of mega-events (Lienhard & Preuss, 2014; Müller, 2015). Examples of major events include large city festivals and sporting events such as the NFL Super Bowl in the USA. Understanding the scale and dimensions of events is crucial for host cities to effectively plan, manage, and leverage the opportunities and challenges associated with hosting such events (Wilson, 2020).

2.2 Legacy

A legacy refers to the lasting impact or effects of an event or action (Getz, 1991, 2005; Preuss, 2007). In the context of the Olympic and Paralympic Games, legacy is any outcomes that affect people and/or space caused by structural changes that stem from these Game. Structural changes can include urban development, environmental enhancement, policies and governance, human development, intellectual property, and social development (Preuss, 2019; Scheu et al., 2021). The IOC has defined five categories of mega-event legacies: sporting, social, cultural, and political, environmental, economic, and urban and infrastructural legacies. Each encompassing specific types of legacies (IOC, 2013; Kassens-Noor et al., 2015). Legacies can be planned or unplanned, and they can have both tangible/intangible and positive/negative effects (Dawson & Jöns, 2018; Dickson et al., 2011; Grix et al., 2017; Preuss, 2007; Scheu et al., 2021). Tangible effects, such as a change in infrastructure, or intangible

effects, include better-skilled people, knowledge and sports governance (Chappelet, 1970; Preuss, 2019). A planned legacy refers to the intentional and deliberate changes that are made in preparation for a mega-event. An unplanned legacy refers to the unintended or unforeseen changes that occur because of hosting a mega-event, such as increased traffic congestion as a result of planned infrastructure development (Preuss, 2015).

Legacy has become a critical principle in justifying the high costs of hosting mega-events. It allows a host city to leverage the short-term benefits of hosting a mega event into long-term sustainable development (Getz, 1991, 2005; Hiller, 1999; Preuss, 2007). Legacy assumes to provide an opportunity for cities to transform and improve, leaving a lasting positive impact on the community, economy, and overall quality of life. According to the International Olympic Committee IOC (2018), legacy in different disciplines must be a priority from the very start of Games planning, at the creation of the Games vision through to final delivery and well beyond.

2.3 Transport legacy

Transport legacy falls under the broader category of urban and infrastructural legacies (Kassens-Noor, 2013b; Preuss, 2019). Transportation plays a pivotal role in mega events by facilitating travel, providing venue access, managing athlete and spectator transportation, coordinating goods transportation, and implementing traffic management measures. Hosting mega-events, such as Olympics and Paralympics Games, can serve as a catalyst for enhancing urban transport systems and leaving a lasting transport legacy (Berridge, 2012; Kassens-Noor, 2013b). The objectives cities may have for creating a transport legacy extend far beyond just improved transport infrastructure and may include increased accessibility, greater public and active transport use, economic development, health, sustainability, and cycle tourism benefits. The transport legacy is often interpreted as a key component justifying hosting mega-events and encompasses a wide range of changes, from physical and infrastructural improvements to governance and management practices (Pereira, 2018)

2.3.1 Transport legacies: good and bad examples

The past Olympic and Paralympic Games have left both positive and negative transport legacies. The Beijing 2008 Olympic Games, for instance, left a positive legacy in several areas, including sports, education and culture, environment, and urban development. Regarding transportation, Beijing tripled the capacity of its Capital Airport, Expanded its metropolitan road and motorway network and bus system, and extended and renovated its metro system (Bovy, 2009). Notably, Beijing improved its transport network for the 2008 Games, increasing public transport capacity by 4.5 million ahead of the event. One major transportation infrastructure project was the new railway connecting the airport to the city center (Bovy, 2009; International Olympic Committee, 2019b). In 2001, Beijing had only two metro lines, but by 2008, it had eight. The metro length in Beijing increased by 522.2% during the decade-long Olympic effect from 2001 to 2010 (Hu, 2024).

Similarly, the 1992 Barcelona Olympic Games was a driving force in the city's renewal, with transportation playing a pivotal role. A key part of this was the creation of Barcelona’s waterfront, a new 3-5km beach and promenade replacing the old industrial area along the seafront, with the aim of making the beach accessible to the local population and tourists. There was also a redevelopment of the railway network and upgraded stations, expansion of the airport with new terminals, and a connecting train from the airport to the city. Furthermore, ring roads, most notably the Rondas, were constructed, and several road sections were used by pedestrians and cyclists. The transport legacy of the 1992 Barcelona Olympics not only enhanced mobility and accessibility within the city but also positioned Barcelona as a leading tourist destination, with tourist numbers increasing from 1.7 million in 1992 to 7.4 million in 2011 and 8.3 million in 2015. The transport legacy accompanied the economic and cultural revitalization of Barcelona in the years following the Games (International Olympic Committee, 2019a; Kassens-Noor, 2013b; Montgomery, 2021)

On the other hand, not all transport projects associated with the Olympics have left a positive legacy. The London Emirates Air Line Cable Car, intended as a novel addition to London’s

infrastructure for the 2012 Olympics, failed to leave a positive transport legacy. This cable car across the River Thames was meant to act as a transportation link between two critical Olympic venues and enhance the city's image and reputation. However, according to Transport for London (TFL), the Emirates Air Line cable car appeared to have only four regular commuters using the service in October 2013 (Chamberlain, 2013).

The Athens 2004 Olympics and related infrastructure projects, including metro and light rail investments, contributed to Greece's debt crisis. The excessive spending on Olympic venues and infrastructure left Greece with a substantial financial burden that worsened the country's economic woes (CNBC, 2010). The costs to the state were over 9 billion euros ($11.6 billion) (Council on Foreign Relations, 2018). Many Olympic venues are now vacant and fenced off with private security guards. The Athens example reminds host cities and nations to prioritize responsible investment strategies, leverage existing infrastructure where possible, and implement measures to ensure the long-term viability and utilization of any new infrastructure developed for mega-events.

2.4 Cycling legacy

Cycling legacies can extend across a number of domains, including the sport of cycling itself, community participation in cycling, and as a mode of transportation. Together, these make cycling legacy worth pursuing for any Olympic Games host city. Cycling, as a sustainable mode of transportation (Kingham & Tranter, 2015; Pucher & Buehler, 2012), a leisure and tourism activity (Buning & Gibson, 2018; Lamont, 2009), and a means of enhancing mental and physical we-being (Black & Street, 2014; Garrard et al., 2012; Litman, 2013; Pucher & Buehler, 2010; Rissel, 2015), is well-suited to become a key legacy of the Games. The environmental benefits of cycling, such as reduced air and noise pollution, and lower greenhouse gas emissions (Fraser & Lock, 2011; Smith et al., 2017), align with the goals of mega-event like the Olympics, which increasingly emphasize sustainability. Moreover, the cost-effectiveness of cycling infrastructure, being significantly less expensive than new public transport infrastructure (Macmillan et al., 2014; Smith et al., 2017), fits within the IOC's "New Norm" initiative -a set of reforms aimed at optimizing resources and reducing the environmental impact of the Games (IOC, 2018; VanWynsberghe et al., 2021). This makes cycling a strategic focus for legacy planning.

When exploring the idea of cycling legacy, it is valuable to reflect on the possible themes that could be considered. These include increasing ridership and ensuring safety, fostering a bicycle-friendly culture, enhancing infrastructure, promoting bicycle tourism, and implementing urban improvements that facilitate cycling events. For instance, initiatives such as bike-sharing programs and cycling education campaigns can be tailored to the unique context of the Games, encouraging both residents and visitors to adopt cycling as a mode of transport during and after the event. Additionally, promoting cycling as a core component of the Games' identity-through community events and stakeholder engagement-can help establish a lasting cultural shift towards cycling. By embedding these strategies within the broader context of the Games, host cities can leverage the event as a powerful catalyst for sustainable urban development and long-term public health improvements, ensuring that cycling remains a central and enduring part of the Olympic legacy.

2.4.1 A potential example of cycling legacy for Brisbane 2032

The proposed design for Grey Street in South Bank, Brisbane, as outlined in the Future South Bank Master Plan draft (2022), is a good example of what cycling legacy could be. South Bank prepares to welcome the world during the Brisbane 2032 Olympic and Paralympic Games, and Grey Street will undergo a transformative upgrade, turning into a vibrant green street. As part of this transformation, the existing unsafe and uninviting bicycle lanes (Figure 1) will be replaced by bi-directional active travel lanes with integrated wayfinding signage and cycle facilities (Figure 2). Here, improving cycling infrastructure is part of a larger initiative to address problem areas and deliver a lasting tourism legacy out of the Games. The Grey Street project

exemplifies how hosting a mega-event can drive positive change, leaving behind a lasting cycling legacy that will benefit the entire city long after the Games.

Figure 1: Grey Street, Brisbane - today (Google Maps)

Figure 2: Transformed Grey Street includes active transport, ample shade, and a comfortable activated public space (South Bank Corporation, 2022)

But how have past Games pursued cycling legacy?

3 Methods

To gain a picture of what the field has already learned about cycling legacy, an interpretive review was conducted. This review goes beyond merely summarizing data and involves analyzing and interpreting literature critically to generate new insights, concepts, and theories from the existing knowledge (Depraetere et al., 2021; Dixon-Woods et al., 2006). By using the interpretive review approach, new theories can be developed, such as a typology of cycling legacy, by interpreting the data obtained. The development of such theoretical ideas is considered a valuable contribution to the transportation field (De Vos & El-Geneidy, 2022; Wee & Banister, 2016).

The review process began systematically by exploring Scopus and Web of Science using a combination of keywords and concepts within the title, abstract, and keywords of articles. The search was limited to only English-language scholarly articles, books, and conference papers. Table 1 shows an overview of the search strategy and its outcomes, including the search terms used in each database, the number of papers revealed at the first search, papers remained after duplicates removed, and the final selection of papers for further review. The selection process involved a two-stage screening. First, titles and abstracts were reviewed for their relevance to this study, and then full texts of the selected publications were examined. To the best of our knowledge, no study specifically targeted cycling legacy. Only 23 articles were recognized as highly similar. Next, a thorough search was conducted through Google Scholar, TRID, and Google using relevant search terms such as “bicycle” OR “cycling” OR “active transport” AND “legacy” OR “Olympic” OR “mega-event” to gather practical insights. This stage adopted the search strategy used by Je et al. (2022) in their study. Initially, the first 200 hits were reviewed for inclusion in the study due to the vast volume of results. After 200, continued reviewing sources for relevance until 25 consecutive unrelated hits were identified (Je et al., 2022). Throughout this process, duplicates were removed to ensure the uniqueness of the sources included in the study.

Table 1 :**Search keywords and papers selected**

Database	Keywords	Papers revealed	Remained papers after duplication removed	Papers selected
Scopus	Bicycle AND legacy	18	35	7
	Bicycle OR cycling OR "active transport*" AND "mega-event*"	11		
	Bicycle OR cycling OR "active transport*" OR e-bike* OR micromobility AND "mega-event*" OR Olympic* OR legacy AND tourism OR tourist* OR “cycle tourism” OR “bicycle tourism” OR “bike tourism” OR “bike riding” OR “bike rider*”	8		
Web of Science	Bicycle AND legacy	14	64 (After removing 15 duplicates common with Scopus, 64 papers remained)	16
	Bicycle OR cycling OR "active transport*" OR e-bike* OR micromobility AND "mega-event*" OR Olympic* OR legacy AND tourism OR tourist* OR “cycle tourism” OR “bicycle tourism” OR “bike tourism” OR “bike riding” OR “bike rider*”	35		
	Bicycle OR cycling OR "active transport*" AND "mega-event*"	43		

3.1 Brisbane cycling context

Brisbane is the third largest city in Australia, with a metropolitan population of almost 2.5 million people (Australian Bureau of Statistics, 2018, as cited in Pojani & Khalaj, 2024, p. 2). The city has a subtropical climate that is usually good for cycling throughout the year. However, heavy rain during the wet season can make it less safe and comfortable. Brisbane's hilly topography requires well-designed bike paths to make cycling accessible for all fitness levels (Bean et al., 2021; Butterworth & Pojani, 2018).

Brisbane faces several challenges in promoting cycling. The city has a relatively low-mode share for cycling compared to cities like Paris, with Parisian used bicycles for 11.2% of their trips just inside the city center in 2023 (Frost, 2024). Brisbane’s urban sprawl and high reliance on cars (Fabre et al., 2023), with 90% of all households owning a car (ABS, 2018, as cited in Pojani & Khalaj, 2024, p. 3) and high posted street speeds deter cycling conditions in the city (Burke & Bonham, 2010; Summers, 2017). In addition, public transportation use is relatively low despite the presence of adequate service in the inner city compared to the limited ones in

the suburbs (Pojani & Khalaj, 2024). All these challenges, along with the absence of a connected low-risk/low-stress cycling network, further complicate efforts to promote cycling.

4 Types of cycling legacy

Cycling legacy can be categorized into five key areas: i) cycling infrastructure; ii) cycling participation; iii) cycle tourism; iv) social legacy of cycling; and, v) dedicated cycling regulations. Host cities seeking to achieve cycling legacy need effective, holistic strategies across these types (Brown et al., 2015). A city promoting cycling alone, without improving infrastructure, may not improve long-term participation. Another city improving infrastructure, without improving policy or regulation, will also have sub-optimal outcomes.

An important Norwegian study assessed the impact of the 2017 World Road Cycling Championship on cycling participation and transportation mode choices among residents in Bergen. The study used a longitudinal survey approach, to evaluate changes in physical activity levels and mode choices. It found that major sporting events alone may not lead to sustained increases in cycling or active travel habits, and complementary interventions, policies, and infrastructure improvements are likely needed to leverage the potential legacy effects of such events (Denstadli & Solberg, 2023).

4.1 Cycling infrastructure

The first theme to emerge from the literature is **infrastructure**. To promote cycling, a city must first improve its infrastructure, including on-road and off-road facilities, end-of-trip amenities, and green bridges (Forsyth & Krizek, 2010; Hull & O'Holleran, 2014; Pucher et al., 2010). In an Olympic city, enhancing cycling infrastructure is crucial, as inadequate infrastructure can lead to significant challenges. For instance, the lack of secure bicycle parking at Olympic venues in London and Rio de Janeiro Games led to increased bicycle thefts (Chen et al., 2022). A well-designed cycling infrastructure enhances connectivity between diverse venues, increases safety and accessibility (Pucher & Buehler, 2016), and encourages cycling.

A prime example of this is the London 2012 Olympics, which had a lasting impact on the city's cycling and walking infrastructure. In preparation for the Games, London created at least 60 related projects to promote greener travel and upgrade pedestrian and cycling routes (IOC, 2013). One notable initiative was the Greenways for the Olympics and London (GOAL) program, which aimed to create a London-wide walking and cycling network of greenways (dcms, 2010). Another significant infrastructure project was the Lee Valley VeloPark, which brought together the four Olympic cycling disciplines, including velodrome, BMX, road and mountain biking. This cycling centre is considered a cycling legacy, hosting numerous cycling events annually and providing opportunities for both elite athletes and the general public to participate in cycling (Lee Valley Regional Park Authority, 2022)

Similarly, the upcoming Paris 2024 Olympics presents an opportunity to leave a cycling infrastructure legacy. Paris has added 60 km of bike paths called "Olympists", installed 10,000 temporary bike racks near Olympic venues, and introduced 3,000 extra hire bikes (Vélib bikes) to connect all the Games (Paris, 2024). An example is the Paris Cycling and Pedestrian Bridge over the A1 Motorway. This infrastructure project aims to improve transportation and connectivity in the city, serving as an integral component of the larger transportation plan for the Paris 2024 Olympics. However, its impact extends beyond the Games, contributing to a broader effort aimed at improving mobility, reducing traffic congestion, and enhancing the overall quality of life for residents and visitors during and after the 2024 Olympics (Laubressac et al., 2023).

4.2 Cycling participation

The second theme that emerged from the literature is **participation.** This concept extends beyond the Games themselves, offering opportunities to boost ridership before, during and after the event. The Games and surrounding atmosphere can inspire individuals of all ages and backgrounds to incorporate cycling into their daily lives (Potwarka et al., 2018; Teare et

al., 2020). Cycling participation can occur for various purposes, including sports, transportation, and leisure. Engaging in cycling, in any form, promotes an active lifestyle, contributing to better physical and mental health and well-being (Götschi et al., 2016; Rissel, 2015).

To effectively increase cycling participation, cities must identify and address barriers to cycling through comprehensive strategies (Bauman et al., 2008; Parkin et al., 2016). Among these strategies, the creation of protected and segregated bicycle infrastructure is especially important, as it is strongly favored by cyclists and has demonstrated a significantly higher impact on ridership than other infrastructure types (Buehler & Dill, 2016; Winters & Teschke, 2010). Initiatives such as cycling events, inclusive bicycle programs, infrastructure improvements, and limitation on car use, can help create an environment that supports and encourages cycling across various segments of the population, both during and after the Games (Pucher et al., 2010). In this context, the “safety in numbers” effect happens, as a growing number of cyclists on the road increases perceived safety, which in turn encourages even more people to take up cycling (Elvik, 2009; Jacobsen, 2015).

Previous Games have demonstrated increases in cycling participation. London’s 2012 Games led to increased bicycle sales, the formation of new cycling groups and clubs such as *Go-Ride*, and an increase in overall participation (Grous, 2012). This increase in interest was reflected in British Cycling membership, which has tripled by 2022 since the 2012 Games (Peacock et al., 2022). The Great Britain cycling team’s performance and visibility during the Games were influential in increasing cycling participation especially sports cycling. The new cycling clubs nurtured over 60 per cent of the riders on the road to Rio 2016 (British Cycling, 2013)

4.3 Cycle tourism

The third theme is **cycle tourism.** The Brisbane 2032 Olympic Games will attract many tourists and visitors to Southeast Queensland and present an opportunity to promote cycle tourism. It provides diverse types of engagement with bicycles for tourists, from those travelling to the city by bike to those coming to explore the city’s cycling opportunities (Duran et al., 2018; Lamont, 2009). Scenic routes, natural landscapes, and appropriate infrastructure are the key factors attracting cycle tourists (Bakogiannis et al., 2020). The first benefit this will bring to the region is the tourist dispersal, distribution of tourist activities and the economic benefits derived from tourism spending across a wider area (Eugenio-Martin et al., 2004; Pablo-Romero & Molina, 2013). Additionally, promoting cycle tourism aligns with the slow tourism concept, which brings advantages such as fostering cultural exchange, engaging with local communities, and gaining authentic experiences (Caffyn, 2015; Gazzola et al., 2018). Furthermore, by providing desirable cycling experiences for tourists during the Games, Brisbane can enhance its image worldwide as a cycling-friendly destination (Berridge, 2012) . A positive and unique city image can serve as a precious legacy, attracting cycle tourists even after the event. By leveraging the Games as a platform to showcase Brisbane's cycling infrastructure and amenities, the city can position itself as a desirable destination for cycle tourism, further contributing to its economic and cultural legacy.

4.4 Social legacy of cycling

The fourth theme is **social legacy**. Establishing a lasting cycling legacy goes beyond just infrastructure development. It requires a fundamental shift in people’s attitudes and mindsets towards embracing cycling as a habitual behavior (Pojani et al., 2017; Willis et al., 2015). The Olympic Games can serve as a powerful motivator for this social and cultural change, fostering a bicycle-friendly culture and paving the way for cycling to become a habitual and widely accepted part of daily life. By showcasing cycling as a viable and enjoyable mode of transportation, the Games can help normalize cycling for people of all ages and backgrounds, challenging preconceptions and promoting positive attitudes towards cyclists.

4.5 Dedicated cycling policies and regulations

The fifth theme that emerged from the literature is **policies and regulations**. The role of policies is crucial in encouraging bicycling (Pucher et al., 2010). Hosting the Olympic and Paralympic Games can be a motivator for defining and implementing specific regulations and policies to promote cycling. One such policy could involve establishing traffic calming zones, such as 30 km/h zones in residential areas and around cycling infrastructure. This approach improves safety for cyclists and pedestrians, creating a more bike-friendly urban environment (Litman, 1999; Pucher & Dijkstra, 2000). Additionally, car-free zones, helmet laws, integration with public transportation, bike-to-work days, etc, are the policies and regulations work best when implemented together as part of an integrated approach to creating a cycling-friendly environment (Harms et al., 2016; Pucher & Buehler, 2007; Pucher et al., 2010).

5 Ways forward

Creating a legacy out of the mega-events is of substantial importance for both the International Olympic Committee and host cities, as it serves as a crucial means to legitimate the immense investment and effort required to organize the events. This study provides a typology of cycling legacy, including previous host experiences and potential initiatives. For cycling to gain a meaningful legacy from mega-events will require harnessing these findings and deliberately planning for strong outcomes. Given that a cycling legacy extends beyond transportation alone, it necessitates concerted and collective efforts across various sectors, including urban planning, transportation, tourism, and sports.

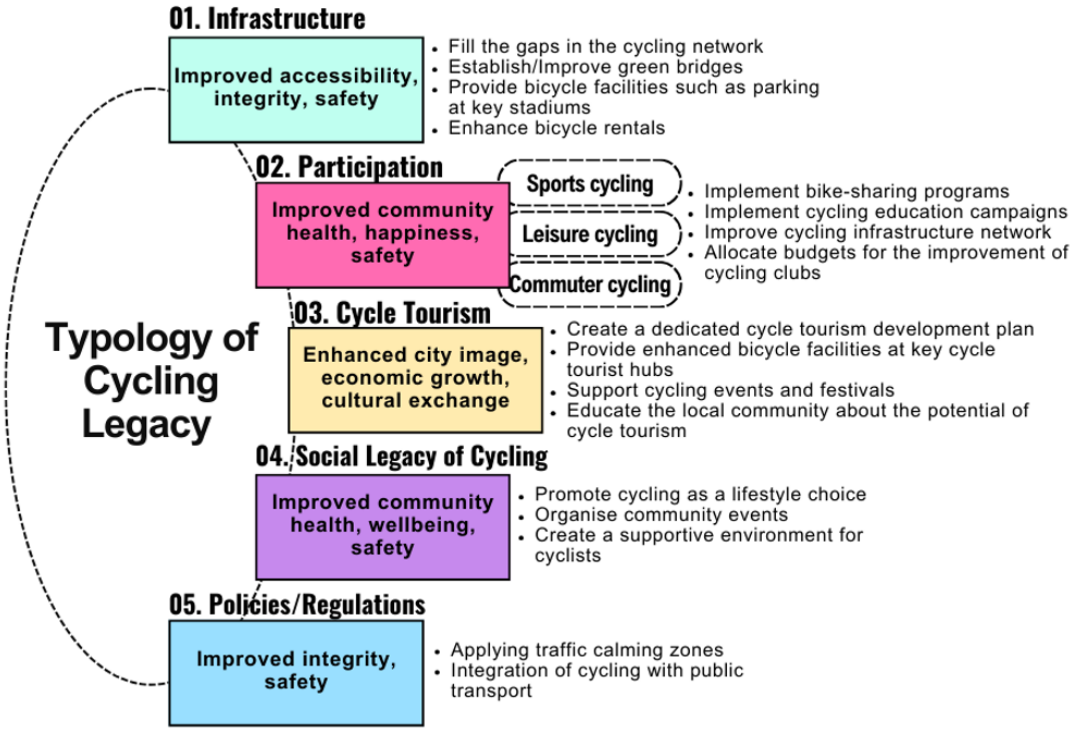
5.1 What might a “cycling legacy plan” look like?

Figure 4 provides a potential cycling legacy plan for Brisbane 2032. A comprehensive approach is essential to achieve better outcomes for cycling and active transport through the cycling legacy plan. This approach should encompass a coherent research program and a well-structured planning process. For research, the key needs are:

- Priority research and planning to clearly define desired cycling legacy objectives across five identified categories (infrastructure, participation, cycle tourism, social legacy, and regulations/policies)
- Working with stakeholders to develop preliminary options to address the cycling infrastructure legacy, including exploring ways of integrating cycling infrastructure into urban planning and development strategies, implementing urban improvements that facilitate cycling events, and analysing audits, investigations, and budgets that need to be allocated.
- Selecting preferred options and prioritising them for cycling legacy, including 1- ways to increase participation in all three cycling purposes and 2- evaluation of the impact of cycling clubs and educational campaigns aimed at increasing cycling participation during and after mega-events
- Formalising a cycle legacy plan

For planning processes, a commitment needs to be made to develop a cycling or active transport legacy plan with dedicated resources, personnel, and sufficient time. Ideally, the legacy plan should be developed through a collaborative effort involving both state and local governments across the Southeast Queensland region, urban planners, transportation authorities, cycling advocacy groups, and community representatives. In addition, a well-structured framework for monitoring and evaluation should be established to assess the progress, effectiveness, and impact of cycling legacy initiatives, enabling continuous improvement and ensuring that the legacy plan remains responsive to evolving needs and challenges.

Figure 3: A typology of cycling legacy to support host city planning



5.2 Limitations

This study has numerous limitations. This is a desktop review and does not provide additional insights and perspectives of the many industry experts involved in these mega-events. Their experiences could potentially provide additional considerations that are not reflected in the resources. Furthermore, the materials sourced excluded non-English publications and underplayed the significance of the cycling legacy that may have been achieved from events such as the Beijing and Tokyo Olympics Games.

5.3 Other research needs

Beyond the issue of a Brisbane 2032 Cycling Legacy Plan, there remain a number of other research agendas for the field. These include resolving the interrelationships between different types of cycling legacies and the factors that contribute to their success or failure. Studies using a mixed-method approach combining quantitative data analysis and qualitative insights may be helpful in answering questions about the effectiveness of various cycling legacy initiatives and policies. Longitudinal studies may be more helpful in clarifying the overall transport legacy outcomes of the Summer Olympics and Paralympics and other mega-events in future, especially in terms of travel behaviour change and participation rates at the sub-regional level and in key travel markets.

References

Bakogiannis, E., Vlastos, T., Athanasopoulos, K., Vassi, A., Christodoulopoulou, G., Karolemeas, C., Tsigdinos, S., Kyriakidis, C., Noutsou, M.-S., & Siti, M. (2020). Exploring motivators and deterrents of cycling tourism using qualitative social research methods and participative analytical hierarchy process (AHP). *Sustainability*, *12*(6), 2418.

Bauman, A., Rissel, C., Garrard, J., Ker, I., Speidel, R., & Fishman, E. (2008). *Cycling: Getting Australia Moving: Barriers, facilitators and interventions to get more Australians physically active through cycling*. Cycling Promotion Fund Melbourne.

Bean, R., Pojani, D., & Corcoran, J. (2021). How does weather affect bikeshare use? A comparative analysis of forty cities across climate zones. *Journal of Transport Geography*, *95*, 103155. https://doi.org/https://doi.org/10.1016/j.jtrangeo.2021.103155

Berridge, G. (2012). The promotion of cycling in London: The impact of the 2007 Tour de France Grand Depart on the image and provision of cycling in the capital [Article]. *Journal of Sport and Tourism*, *17*(1), 43-61. https://doi.org/10.1080/14775085.2011.635018

Black, P., & Street, E. (2014). The Power of Perceptions: Exploring the Role of Urban Design in Cycling Behaviours and Healthy Ageing. *Transportation Research Procedia*, *4*, 68-79. https://doi.org/https://doi.org/10.1016/j.trpro.2014.11.006

Borghetti, F., Longo, M., Mazzoncini, R., & Somaschini, C. (2023). Preliminary evaluation of infrastructure and mobility services in mega-event: the Italian case study. *Transportation Research Procedia*, *69*, 464-471. https://doi.org/https://doi.org/10.1016/j.trpro.2023.02.196

Bovy, P. (2009). Beijing 2008 olympic games success: Massive public transport developments and major road traffic reduction. *Public Transport International*, *58*(3), 52–55. (International Association of Public Transport (UITP))

British Cycling. (2013). *OLYMPIC LEGACY GETS YOUNGSTERS ON THEIR BIKES*. https://www.britishcycling.org.uk/go-ride/article/20130806-goride-news-Olympic-legacy-gets-youngsters-on-their-bikes-0

Brown, G., Lee, I. S., King, K., & Shipway, R. (2015). Eventscapes and the creation of event legacies. *Annals of Leisure Research*, *18*, 510 - 527.

Buehler, R., & Dill, J. (2016). Bikeway Networks: A Review of Effects on Cycling. *Transport Reviews*, *36*(1), 9-27. https://doi.org/10.1080/01441647.2015.1069908

Buning, R. J., & Gibson, H. J. (2018). The role of travel conditions in cycling tourism: Implications for destination and event management. In *Sport Tourism and Sustainable Destinations* (pp. 13-31). Routledge.

Burke, M. I., & Bonham, J. (2010). Rethinking oil depletion: what role can cycling really play in dispersed cities? *Australian Planner*, *47*(4), 272-283. https://doi.org/10.1080/07293682.2010.527291

Butterworth, E., & Pojani, D. (2018). Why Isn't Australia a Cycling Mecca?

Caffyn, A. (2015). Advocating and Implementing Slow Tourism. *Tourism Recreation Research*, *37*, 77-80. https://doi.org/10.1080/02508281.2012.11081690

Chamberlain, D. (2013). *Only four regular commuters using Emirates Air Line cable car, TfL admits*. SNIPE. Retrieved 18 April from https://snipelondon.com/scoop/only-four-regular-commuters-using-emirates-air-line-cable-car-tfl-admits

Chappelet, J.-L. (1970). Mega Sporting Event Legacies: A Multifaceted Concept.

Chen, Y., Riddell, J. R., Hill, J. B., Chen, P., Piquero, A. R., & Kurland, J. (2022). Gold, silver, and bronze: Measuring the impact of the Beijing 2008, London 2012, and Rio de Janeiro 2016 Olympics on crime [Article]. *Journal of Criminal Justice*, *78*, Article 101880. https://doi.org/10.1016/j.jcrimjus.2021.101880

CNBC. (2010). *Did 2004 Olympics Spark Greek Financial Crisis?* Retrieved 15 April from https://www.cnbc.com/id/37484301

Council on Foreign Relations. (2018). *1974 – 2018 Greece's Debt Crisis* Retrieved 25 April from https://www.cfr.org/timeline/greeces-debt-crisis-timeline#:~:text=Greece%20Hosts%20Olympic%20Games,-An%20athlete%20dives&text=Greece%20hosts%20the%202004%20summer,(110.6%20percent)%20for%202004.

Currie, G., & Shalaby, A. (2012). Synthesis of Transport Planning Approaches for the World's Largest Events. *Transport Reviews*, *32*(1), 113-136. https://doi.org/10.1080/01441647.2011.601352

Dawson, J., & Jöns, H. (2018). Unravelling legacy: A triadic actor-network theory approach to understanding the outcomes of mega events. *Journal of Sport & Tourism*, *22*(1), 43-65.

dcms. (2010). *Plans for the legacy from the 2012 Olympic and Paralympic Games*. m. Department for culture, and sport.

De Vos, J., & El-Geneidy, A. (2022). What is a good transport review paper? *Transport Reviews*, *42*(1), 1-5. https://doi.org/10.1080/01441647.2021.2001996

Denstadli, J. M., & Solberg, H. A. (2023). I want to ride my bicycle! Or not? Health and transportation legacies of the 2017 World Road Cycling Championship. *European Sport Management Quarterly*, *23*(2), 334-350. https://doi.org/10.1080/16184742.2020.1862272

Depraetere, J., Vandeviver, C., Keygnaert, I., & Beken, T. V. (2021). The critical interpretive synthesis: an assessment of reporting practices. *International Journal of Social Research Methodology*, *24*(6), 669-689. https://doi.org/10.1080/13645579.2020.1799637

Dickson, T. J., Benson, A. M., & Blackman, D. A. (2011). Developing a framework for evaluating Olympic and Paralympic legacies. *Journal of Sport & Tourism*, *16*(4), 285-302.

Dixon-Woods, M., Cavers, D., Agarwal, S., Annandale, E., Arthur, A., Harvey, J., Hsu, R., Katbamna, S., Olsen, R., Smith, L., Riley, R., & Sutton, A. J. (2006). Conducting a critical interpretive synthesis of the literature on access to healthcare by vulnerable groups. *BMC Medical Research Methodology*, *6*(1), 35. https://doi.org/10.1186/1471-2288-6-35

Duran, E., Sevinç, F., & Harman, S. (2018). CYCLE TOURISM AS AN ALTERNATIVE WAY OF TOURISM DEVELOPMENT IN ÇANAKKALE, TURKEY. *Journal of Awareness*.

Elvik, R. (2009). The non-linearity of risk and the promotion of environmentally sustainable transport. *Accident Analysis & Prevention*, *41*(4), 849-855. https://doi.org/https://doi.org/10.1016/j.aap.2009.04.009

Eugenio-Martin, J. L., Martín Morales, N., & Scarpa, R. (2004). Tourism and economic growth in Latin American countries: A panel data approach.

Fabre, A., Howes, M., & Deweerdt, T. (2023). Best practice in urban transport decarbonisation: a case study of three initiatives in Brisbane. *Australian Planner*, *59*, 64 - 85.

Forsyth, A. N. N., & Krizek, K. J. (2010). Promoting Walking and Bicycling: Assessing the Evidence to Assist Planners. *Built Environment (1978-)*, *36*(4), 429-446. http://www.jstor.org/stable/23289968

Fraser, S. D., & Lock, K. (2011). Cycling for transport and public health: a systematic review of the effect of the environment on cycling. *The European Journal of Public Health*, *21*(6), 738-743.

Frost, R. (2024). *Walking and public transport were still the most popular ways to get around the French capital*. euro news. Retrieved 2 August from https://www.euronews.com/green/2024/04/12/cycling-is-now-more-popular-than-driving-in-the-centre-of-paris-study-finds

Garrard, J., Rissel, C., & Bauman, A. (2012). Health Benefits of Cycling. In J. Pucher & R. Buehler (Eds.), *City Cycling* (pp. 31-56). The MIT Press. http://www.jstor.org/stable/j.ctt5hhjxr.7

Gazzola, P., Pavione, E., Grechi, D., & Ossola, P. (2018). Cycle Tourism as a Driver for the Sustainable Development of Little-Known or Remote Territories: The Experience of the Apennine Regions of Northern Italy. *Sustainability*.
Getz, D. (1991). *Festivals, special events, and tourism*.
Getz, D. (2005). Event management and event tourism.
Götschi, T., Garrard, J., & Giles-Corti, B. (2016). Cycling as a Part of Daily Life: A Review of Health Perspectives. *Transport Reviews*, *36*(1), 45-71. https://doi.org/10.1080/01441647.2015.1057877
Grix, J., Brannagan, P. M., Wood, H., & Wynne, C. (2017). State strategies for leveraging sports mega-events: Unpacking the concept of 'legacy'. *International Journal of Sport Policy and Politics*, *9*(2), 203-218.
Grous, A. (2012). The'Olympic cycling effect': a report prepared for Sky and British Cycling.
Harms, L., Bertolini, L., & Brömmelstroet, M. T. (2016). Performance of Municipal Cycling Policies in Medium-Sized Cities in the Netherlands since 2000. *Transport Reviews*, *36*(1), 134-162. https://doi.org/10.1080/01441647.2015.1059380
Hiller, H. H. (1999). Toward an urban sociology of mega-events. In *Constructions of urban space* (pp. 181-205). Emerald Group Publishing Limited.
Horne, J. (2007). The four 'knowns' of sports mega-events. *Leisure Studies*, *26*(1), 81-96.
Hu, R. (2024). The transformation of Beijing as a dual Olympic city: growth, post-growth, and the reimagining of the capital. *Planning Perspectives*, 1-20. https://doi.org/10.1080/02665433.2024.2324356
Hull, A., & O'Holleran, C. (2014). Bicycle infrastructure: can good design encourage cycling? *Urban, Planning and Transport Research*, *2*(1), 369-406. https://doi.org/10.1080/21650020.2014.955210
International Olympic Committee. (2019a). *Barcelona 1992 Legacy*. IOC. Retrieved 15 April from https://olympics.com/ioc/legacy/living-legacy/barcelona-1992
International Olympic Committee. (2019b). *Beijing 2008 Legacy*. IOC. Retrieved 15 April from https://olympics.com/ioc/theme-beijing-2008-legacy
IOC. (2013). *Olympic Legacy*.
IOC. (2018). *Olympic Agenda 2020: Olympic Games: the New Norm*.
Jacobsen, P. L. (2015). Safety in numbers: more walkers and bicyclists, safer walking and bicycling. *Injury prevention*, *21*(4), 271-275.
Jago, L., Dwyer, L., Lipman, G., Van Lill, D., & Vorster, S. (2010a). Optimising the potential of mega-events: An overview. *International Journal of Event and Festival Management*, *1*, 220-237. https://doi.org/10.1108/17852951011078023
Jago, L., Dwyer, L., Lipman, G., van Lill, D., & Vorster, S. (2010b). Optimising the potential of mega-events: an overview. *International Journal of Event and Festival Management*, *1*(3), 220-237.
Je, J. S., Khoo, C., & Yang, E. C. L. (2022). Gender issues in tourism organisations: insights from a two-phased pragmatic systematic literature review. *Journal of Sustainable Tourism*, *30*(7), 1658-1681. https://doi.org/10.1080/09669582.2020.1831000
Karadakis, K., Kaplanidou, K. K., & Karlis, G. (2010). Event leveraging of mega sport events: a SWOT analysis approach. *International Journal of Event and Festival Management*, *1*, 170-185.
Kassens-Noor, E. (2013a). Managing transport during the Olympic Games. In *Managing the Olympics* (pp. 127-146). Springer.
Kassens-Noor, E. (2013b). Transport Legacy of the Olympic Games, 1992–2012. *Journal of Urban Affairs*, *35*(4), 393-416. https://doi.org/10.1111/j.1467-9906.2012.00626.x
Kassens-Noor, E., Wilson, M., Müller, S., Maharaj, B., & Huntoon, L. (2015). Towards a mega-event legacy framework. *Leisure Studies*, *34*(6), 665-671. https://doi.org/10.1080/02614367.2015.1035316
Kingham, S., & Tranter, P. (2015). Cycling and sustainable transport. In J. Bonham & M. Johnson (Eds.), *Cycling Futures* (pp. 131-152). The University of Adelaide Press. https://www.cambridge.org/core/product/3E379D2F2625D75E5C0F98149D2C9E71

Knott, B., Fyall, A., & Jones, I. (2015). The nation branding opportunities provided by a sport mega-event: South Africa and the 2010 FIFA World Cup. *Journal of Destination Marketing & Management*, *4*(1), 46-56. https://doi.org/https://doi.org/10.1016/j.jdmm.2014.09.001

Lamont, M. (2009). Reinventing the Wheel: A Definitional Discussion of Bicycle Tourism. *Journal of Sport & Tourism*, *14*(1), 5-23. https://doi.org/10.1080/14775080902847363

Laubressac, A., Baldo, D., Thieffry, E., Swamygowda, K., Daull, L., Houli, N., Chen, R., Gemayel, S., Klaric, T., & Dayshoum, Y. (2023). *Assessing the urban legacy of Paris 2024*. https://www.institutparisregion.fr/fileadmin/DataStorage/RD-Formations/Atelier_EUP_Evaluer_l_heritage_urbain_de_Paris_2024/REPORT_Assessing_Urban_Legacy_ENG_12_01_23.pdf

Lee Valley Regional Park Authority. (2022). *10 years on venues*. Lee Valley. Retrieved 22 April from https://www.visitleevalley.org.uk/10-years-on-venues/lee-valley-velopark

Lienhard, P., & Preuss, H. (2014). *Legacy, sustainability and CSR at mega sport events: An analysis of the UEFA EURO 2008 in Switzerland*. Springer.

Litman, T. (1999). *Traffic calming: benefits, costs and equity impacts*. Victoria Transport Policy Institute Victoria, BC, Canada.

Litman, T. (2013). Transportation and public health. *Annual review of public health*, *34*(1), 217-233.

Macmillan, A., Connor, J., Witten, K., Kearns, R., Rees, D., & Woodward, A. (2014). The Societal Costs and Benefits of Commuter Bicycling: Simulating the Effects of Specific Policies Using System Dynamics Modeling. *Environmental Health Perspectives*, *122*(4), 335-344. https://doi.org/doi:10.1289/ehp.1307250

Montgomery, J. (2021). *Barcelona 1992: The Olympic Games and a Paradigm Shift in City Planning Part 3*

Müller, M. (2015). What makes an event a mega-event? Definitions and sizes. *Leisure Studies*, *34*(6), 627-642. https://doi.org/10.1080/02614367.2014.993333

Pablo-Romero, M. d. P., & Molina, J. A. (2013). Tourism and economic growth: A review of empirical literature. *Tourism management perspectives*, *8*, 28-41.

Paris. (2024). Paris. Retrieved 6 August from https://www.paris.fr/pages/en-2024-tous-les-sites-olympiques-seront-accessibles-a-velo-23154#60-kilometres-de-pistes-cyclables

Parkin, J., Ryley, T., & Jones, T. (2016). Barriers to cycling: an exploration of quantitative analyses. In *Cycling and society* (pp. 67-82). Routledge.

Peacock, J., Cobley, J., & Patel, B. (2022). Urological issues in cyclists. *Journal of Clinical Urology*, *15*(2), 118-128, Article 2051415820964982. https://doi.org/10.1177/2051415820964982

Pereira, R. H. M. (2018). Transport legacy of mega-events and the redistribution of accessibility to urban destinations. *Cities*, *81*, 45-60. https://doi.org/https://doi.org/10.1016/j.cities.2018.03.013

Pojani, D., Bakija, D., Shkreli, E., Corcoran, J., & Mateo-Babiano, I. (2017). Do Northwestern and Southeastern Europe Share a Common "Cycling Mindset"? Comparative Analysis of Beliefs toward Cycling in the Netherlands and the Balkans. *European Journal of Transport and Infrastructure Research*, *17*, 25-4525. https://doi.org/10.18757/ejtir.2017.17.1.3178

Pojani, D., & Khalaj, F. (2024). Growth of cycling in Brisbane during the Covid-19 pandemic. *Australian Planner*, 1-11. https://doi.org/10.1080/07293682.2024.2303424

Potwarka, L. R., Drewery, D., Snelgrove, R., Havitz, M. E., & Mair, H. (2018). Modeling a Demonstration Effect: The Case of Spectators' Experiences at 2015 Pan Am Games' Track Cycling Competitions. *Leisure Sciences*, *40*(6), 578-600. https://doi.org/10.1080/01490400.2017.1325796

Preuss, H. (2007). The Conceptualisation and Measurement of Mega Sport Event Legacies. *Journal of Sport & Tourism*, *12*(3-4), 207-228. https://doi.org/10.1080/14775080701736957

Preuss, H. (2015). A framework for identifying the legacies of a mega sport event. *Leisure Studies*, *34*(6), 643-664. https://doi.org/10.1080/02614367.2014.994552

Preuss, H. (2019). Event legacy framework and measurement. *International Journal of Sport Policy and Politics*, *11*(1), 103-118. https://doi.org/10.1080/19406940.2018.1490336

Pucher, J., & Buehler, R. (2007). At the frontiers of cycling: policy innovations in the Netherlands, Denmark, and Germany. *World transport policy and practice*, *13*(3), 8-57.

Pucher, J., & Buehler, R. (2010). Walking and Cycling for Healthy Cities. *Built Environment*, *36*. https://doi.org/10.2148/benv.36.4.391

Pucher, J., & Buehler, R. (2012). Introduction

Cycling for Sustainable Transportation. In J. Pucher & R. Buehler (Eds.), *City Cycling* (pp. 1-8). The MIT Press. http://www.jstor.org/stable/j.ctt5hhjxr.5

Pucher, J., & Buehler, R. (2016). Safer cycling through improved infrastructure. In (Vol. 106, pp. 2089-2091): American Public Health Association.

Pucher, J., & Dijkstra, L. (2000). Making walking and cycling safer: lessons from Europe. *Transportation Quarterly*, *54*(3), 25-50.

Pucher, J., Dill, J., & Handy, S. (2010). Infrastructure, programs, and policies to increase bicycling: An international review. *Preventive Medicine*, *50*, S106-S125. https://doi.org/https://doi.org/10.1016/j.ypmed.2009.07.028

Rissel, C. (2015). Health benefits of cycling. In J. Bonham & M. Johnson (Eds.), *Cycling Futures* (pp. 43-62). The University of Adelaide Press. https://www.cambridge.org/core/product/86FEA0B928FEE7B9C5046B4A621EB63B

Roche, M. (2002). *Megaevents and modernity: Olympics and expos in the growth of global culture*. Routledge.

Roche, M. (2008). Putting the London 2012 Olympics into perspective: The challenge of understanding mega-events. *Twenty-First Century Society*, *3*(3), 285-290.

Scheu, A., Preuß, H., & Könecke, T. (2021). The Legacy of the Olympic Games: A Review. *Journal of Global Sport Management*, *6*(3), 212-233. https://doi.org/10.1080/24704067.2019.1566757

Smith, M., Hosking, J., Woodward, A., Witten, K., MacMillan, A., Field, A., Baas, P., & Mackie, H. (2017). Systematic literature review of built environment effects on physical activity and active transport–an update and new findings on health equity. *International Journal of Behavioral Nutrition and Physical Activity*, *14*, 1-27.

South Bank Corporation. (2022). *Future South Bank Master Plan- Draft*

Summers, L. (2017). The Spatial Ecology of Urban Cycling: Counter-mapping Inner City Imaginaries in Brisbane, Australia. *Liminalities*, *13*(3).

Talavera, A. M., Al-Ghamdi, S. G., & Koç, M. (2019). Sustainability in mega-events: Beyond Qatar 2022. *Sustainability*, *11*(22), 6407.

Teare, G., Potwarka, L., Snelgrove, R., & Drewery, D. (2020). Inspiring Participation in a New Sport Opportunity: Exploring The Role of Event Experience and Spectator Characteristics. *Event Management*, *25*. https://doi.org/10.3727/152599519X15506259856291

VanWynsberghe, R., Derom, I., & Pentifallo Gadd, C. (2021). Legacy and sustainability in the Olympic Movement's new norm era: when reforms are not enough. *International Journal of Sport Policy and Politics*, *13*(3), 443-460. https://doi.org/10.1080/19406940.2021.1898442

Wee, B. V., & Banister, D. (2016). How to Write a Literature Review Paper? *Transport Reviews*, *36*(2), 278-288. https://doi.org/10.1080/01441647.2015.1065456

Willis, D. P., Manaugh, K., & El-Geneidy, A. (2015). Cycling Under Influence: Summarizing the Influence of Perceptions, Attitudes, Habits, and Social Environments on Cycling for Transportation. *International Journal of Sustainable Transportation*, *9*(8), 565-579. https://doi.org/10.1080/15568318.2013.827285

Wilson, M. (2020). Downsizing spectacle. *Planning and Managing Smaller Events*.

Winters, M., & Teschke, K. (2010). Route preferences among adults in the near market for bicycling: findings of the cycling in cities study. *Am J Health Promot*, *25*(1), 40-47. https://doi.org/10.4278/ajhp.081006-QUAN-236