

# Olympic Public Transportation Investments, Legacy, and City Prosperity: An Empirical Look at the 2000-2016 Summer Games

By Kennedy Magee\* & W. James Weese<sup>‡</sup>

*The complexity of hosting the Olympic Games has grown throughout its history. The financial risks to cities vying for the hosting rights are often viewed as excessive and consequently, fewer bids are being submitted in modern times. Critics suggest that public funds would be better spent supporting other social programs. However, history has demonstrated that host cities can use the Games to expand and modernize public transport systems to efficiently move people, increase accessibility, reduce personal travel and garner environmental benefits like improved air quality and less noise pollution. The authors examined the five Summer Olympic Games host cities between 2000-2016 using the City Prosperity Index (CPI) to measure city performance across six indexes to determine the accrued public transit benefits of hosting the Games. The authors hope this paper can provide a clear path forward for future Olympic bidders and city officials.*

**Keywords:** *Olympic Games, City Prosperity Index, public transportation, investments*

## Hosting Olympics as the Stimulus for Urban Development

The first Olympic Games were constrained by financial limitations and held in venues that were only upgraded as needed (Liao and Pitts 2006). The first Games needed more results in minimal urban development legacies. For example, the first Olympic Games staged in Athens in 1896 resulted in restoring a 2000-year-old stadium and the refurbishing a downtown building. Paris hosted the Games in 1900 and used natural settings, which led to situations like swimmers competing in the muddy Seine River. The Olympic Games were still in their infancy, and financial support for major public infrastructure upgrades was not considered a priority.

The second era of Olympic urbanization was marked by the building the White City Stadium for the 1908 Olympic Games in London (Liao and Pitts 2006). The stadium was the first example of Olympic urbanism. The example showed the world the kind of infrastructure change that hosting the Olympics could bring to a city. Stadium development seemed to be the significant infrastructure benefit of hosting the Games (Liao and Pitts 2006). The inclusion of an Olympic Village for the 1932 Olympics marked a new era of Olympic urbanization development due to hosting the Games. The Olympic Village was envisioned as a

---

\*Graduate Student, School of Kinesiology, Faculty of Health Sciences, Western University, Canada.

<sup>‡</sup>Professor, School of Kinesiology, Western University, Canada.

temporary structure in these Games, designed exclusively for male competitors (Liao and Pitts 2006). However, the most significant change in Olympic urbanization was evident in the 1936 Games staged in Germany. The 1936 Olympic Games, while staged for political gain, showcased the transformative powers of hosting the event. Significant governmental support was invested in creating venues, parks, and public spaces designed to remain in place long after the Games were concluded. This trend continued through the 1960 Olympic Games held in Rome. Infrastructure improvements tied to hosting these included upgrades to the water supply system, construction of new hotels, improved street lighting, and upgrades to urban landscaping. According to Liao and Pitts (2006), this host became the first to use the Games to enrich their public transit system (e.g., a new highway system to connect sites and the construction of a new airport). The trend continued. Gordon (1983) noted that the organizers of the 1964 Olympic Games in Tokyo used the Games to address its transportation issues with significant infrastructure investments (e.g., a new multi-hierarchy transportation system consisting of roadways, 73km of subway line, 13.2km of monorail, and access to a 500km bullet train line which connected several major cities across Japan. The trend was in place, and one of the major selling points for bidding for the Games became the influx of resources that would help cities address their public transportation issues.

For example, the 1968 Games held in Mexico City resulted in a new metro system for the city (Liao and Pitts 2006). The Munich Olympic Games in 1972 resulted in upgrades to the city's public transportation system and other urban upgrades. The 1976 Olympic Games held in Montreal forced the city to build 20km of new metro lines, construct a new airport terminal, and upgrade many highways in addition to a new Olympic Stadium. Significant cost overruns resulted in significant municipal, provincial and national debt. The lessons were learned, and the following two host cities (i.e., Moscow and Lake Placid) proposed and spent much less on urban development and civic infrastructure as part of their Games hosting strategy. Host cities such as Seoul (1988) and Barcelona (1992) altered this trend. They used the hosting of the Games to clean up targeted areas of the city, regenerate their urban landscape, and showcase their cities to the world as attractive tourist destinations. This trend changed four years later, as evidenced by the 1996 Olympic Games staged in Atlanta. New and refurbished sports infrastructure was the focus, which came at the cost of reduced urban development. The underinvestment in public transit emerged as the most criticized part of the Games experience.

Urban transformations and upgrades to public transit became a higher priority for potential host cities. Cities and countries took notice of this opportunity, so the number of bids for the right to host the Games soared. Civic leaders knew that hosting the Games would provide the resources to address this need, and on a schedule that would only be possible with the pressure of hosting the Games. The 2010 Games held in Vancouver is a sterling example of this scenario. The Canada Line rail system was constructed for the Games and designed to link the airport with the downtown region. The Canada Line continues to serve the city well and

provides cost-efficient and environmentally responsible transportation to 112,000 people daily (City of Vancouver n.d.).

Public transit has long been used in urban areas to increase the efficiency of moving large groups throughout the same densely populated area. Transportation habits and patterns since the end of the 19<sup>th</sup> century have influenced Europe and North America's sprawling land use tendencies (Arbury 2005, Brueckner 2000). Brueckner (2000) commented on the negative impacts of excessive expansion by noting the adverse effects of farmland open spaces, promoting long commutes, which increase pollution, the erosion of downtown centres and the weakening of social bonds facilitated by proximity. Urban sprawl isolates those who do not own a car to participate meaningfully in society.

Cities planners must shift their focus toward creating viable and sustainable transportation options, and increasing public transit is the solution. Finding the funding to build the infrastructure is usually the barrier. Public transit is needed in urban settings. Hosting the Olympic Games is a strategy that can be used required to access new sources of revenue to build more public transit quickly and economically (Kassens-Noor 2013, Richter 2012). However, is this a realistic outcome? Is hosting the Summer Olympic Games worth the risk? Bid Committees and advocates tend to cherry-pick examples that support the benefits and minimize the risk. A more empirical analysis is warranted and serves as the justification for this research.

The researchers studied the situations that transpired at the Summer Olympic Games held from 2000-2016. Were public transit issues addressed through the hosting of the Games? Do citizens have better access and public transportation service due to these investments? The researchers set out to analyze the situation and draft their conclusions. They analyzed the host cities before hosting the Games, and after the Games to determine if significant, sustainable change was realized. They measured social good using the City Property Index (CPI). The CPI was created by the UN-Habitat in 2012 to analyze a city's prosperity performance and guide future policy decisions (Martinez 2012, UN-Habitat n.d.). This metric is different from others in that it exclusively looks at city performance instead of country performance, and it analyzes cities along various indexes that measure aspects beyond traditional economic analysis.

The CPI is measured across six indexes, all provided as values out of a maximum of 100. The six indexes are (a) productivity; (b) infrastructure development; (c) environmental sustainability; (d) quality of life; (e) equity and social inclusion; and; (f) urban governance and legislation. Within each index is a series of measures aggregated and averaged to provide a single score for the index. The CPI has a list of essential and extended actions; the extended measures offer a deeper analysis of the city and should be used when possible.

## Case Studies: 2000-2016 Summer Olympic Games - 2000 Sydney Olympics

### *Sydney: Before the Olympics*

Sydney is the biggest city in the state of New South Wales (NSW), Australia. It has been considered the centre of finance, marketing, and commerce in Australia since the early 1900s (Pringle n.d.). The area was established as a penal colony with the arrival of Lord Sydney in 1788, who described the area as having the finest harbour in the world. Sydney is now one of the most ethnically diverse cities in the world, containing people from more than 180 nationalities.

Early in its history, when the population was relatively low, much of the travel within the area was done over water on the harbour, with competition emerging between private and public modes of transport (Wotherspoon 2008). The first railway to Sydney opened in 1855, designed to connect the city to Parramatta in the west, spurring suburban developments along the line. Eventually, residents started to become frustrated with the limitations of the line and the fact that it only went some of the way into Sydney, making commuting and commerce rather tricky.

At one point in its history, Sydney had one of the largest tramway networks in the world, servicing over 400 million journeys per year on 291km of dedicated track (*Sydney's transportation history*, 2022). The tramway peaked in 1923 and eventually gave way to the bus system, which was introduced alongside the tramway in 1905 (*Sydney's transportation history* 2022). Despite the popularity of these systems, Sydney remained mostly a walking town, evidenced by the 56% of trips taken to work by foot, compared to the 19% by tram/bus and 11% by train (Wotherspoon 2008). Sydney tried to modernize its tram system in early 1900, but beyond WW1, it saw little expansion and did not grow beyond 1922. Eventually, in 1917, the government began construction on new sections of underground rail for the city. Planners included the option for extensions to the northern and eastern suburbs, and the lines would eventually be fully electrified. The trams were eventually overtaken and replaced by the motorbus. Many Sydney residents soon turned to the rising popularity of cars and abandoned other forms of travel, which altered planning decisions in Sydney for years. As a result, Sydney had an underdeveloped and underutilized public transit system. Hosting the Olympic Games was seen as a way of addressing the issue. The Sydney Bid Committee understood that traffic congestion would be a weakness in their bid (Hensher and Brewer 2006) and that the city needed to modernize its public transit system.

### *Sydney: Investments in Public Transit*

Unfortunately, Sydney officials did not significantly invest in public transit upgrades for the Games. The only significant investments in their transit system were a 10km rail line between the Central Business District (CBD) and the airport, a 5.3km rail link, and a brand-new Olympic Park station to serve the venues (Bovy 2019). The rail link provided access to the main Olympic site from the Olympic Park Line and opened a few years before the games while costing A\$95 million

(Richter 2008). One kilometre of the link was installed underground and was connected to the four-platform Olympic Park station. A \$12 million interchange was created to shuttle passengers between the new link and the western line, which became a transport hub.

Freight train traffic necessitated a A\$31 million flyover junction to separate freight and passenger trains (Richter 2008). A central rail line to the airport opened in 2000 and had five total stations (four underground). The four underground stations were privately owned and operated. Securing private investment for these projects allowed Sydney to offset some of the cost of their investment. Given the level of car ownership in the city, it is surprising that they bypassed this opportunity to invest significantly in their transportation system.

### *Sydney: Olympic Public Transit Legacy*

The Sydney Olympics left behind a questionable transport legacy due to their lack of long-term planning around their infrastructure investments. Sydney officials hoped that showing how well the transport system could perform would convince more residents to switch permanently to public transit for their average daily trips (Kassens-Noor 2010). In her analysis, Kassens-Noor questioned the impact of the poorly planned rail infrastructure. The infrastructure left residents wanting to understand due to the chronic low ridership of the Olympic loop. Government officials justified its existence with the once-a-year Royal Easter Show, which takes place on the Olympics site.

The Sydney Olympic Games witnessed high use of the public transit system and multi-modality during the Games, but they were not sustained. During the Games, all public transit was free for 24 hours for ticket holders and accredited individuals (Bovy 2019, Mulley and Montou 2015), and 95% of spectators used the service (Bovy 2019).

Mulley and Montou (2015) noted that the Sydney suburban rail network was the backbone of their transportation system, while the bus network sought to fill in the gaps between rail lines. Unfortunately, the trains still did not cover the whole city, leaving entire areas that had to rely on a bus network. At the time of the Olympics, all these modes were planned by separate organizations, which resulted in different timetables, fare scales, and tickets not being transferrable between the different modes. This made mobility very difficult for those who relied on public transit.

Mulley and Montou (2015) monitored public transit use following the 2000 Games and found disappointing results. Much of the issue with the Sydney transportation system lay in its focus on single-seat journeys. They noted that an integrated “fare” system was required. Sydney civic leaders and transportation advocates highlighted this while the bid was being prepared, but it was not realized until 2010, 10 years after the Games were staged. When the “MyZone” program was launched (since replaced by the “Opal” integrated smart card (Dixon et al. 2018b, Mulley and Montou 2015). However, the payment system remains disjointed for passengers transferring between travel modes, a requirement for many who live in Sydney. Greater coordination and symmetry remain an issue,

although there seem to be recent changes implemented to help eliminate the issue (Shakibaei 2022).

Analysis by Dixon et al. (2018b) from Deloitte Insights showed how bus and rail use increased by 36% and 24%, respectively, from 2009 to 2018 while private vehicle miles only increased by 6%. A follow-up analysis done by Dixon et al. (2020b) on Sydney's transportation system outlined many of the upgrades made to the system between 2018 and 2020 resulted in public transit mode share increasing (i.e., up 2% from 2018 to 27%) but this volume remains comparatively low. A reduction in the cost of the monthly transit pass was also seen as a stimulus that worked to increase use patterns (Dixon et al. 2020b). The city has areas to improve. The high car ownership in Sydney and the convenience that automobiles provide continue to be a barrier to enhancing the share of public transit (Nguyen 2019). Although Sydney has invested heavily in public transit, it still sees a modest percentage of only 25% which is relatively low (Dixon et al. 2018b).

The public transit legacy of hosting the 2000 Olympics in Sydney was comparatively small compared to other Olympic hosts. Like other host cities, civic leaders could have addressed the transportation issues plaguing the city through hosting the Games. One can conclude that the Sydney Games of 2000 had a minimal transport legacy.

## **2004 Athens Olympics**

### *Athens: Before the Olympics*

Athens is a tourist destination attracted by its rich history, Greek architecture, museums, and culture (WorldData.info n.d.). Each year millions of tourist travel to the historical city of Athens, they knew that it was the first city to host the modern Olympic Games in 1896. Athens won the bid to host the Olympic Games again in 2004. Modernizing their public transportation systems was a high priority for the city, and hosting the Games was seen as a strategic step in addressing the need. Bovy (2004) discussed how Athens' public transit was substandard for a capital city of 4.5 million people and a private car ownership rate of 415 vehicles per 100 inhabitants. Frantzeskakis and Frantzeskakis (2006) noted that only 30 percent of daily transportation in Athens was done using public transit. Athens urgently needed an upgraded public transit system to support the Games and everyday life in Athens following the Games. They were securing the Games provided that opportunity.

### *Athens: Investments in Public Transit*

Athens officials used the hosting of the Games to stimulate significant upgrades to its aging public transit system. The city doubled its metro and high-performance rail system in less than five years (Bovy 2004). The Games provided the impetus. Athens officials also significantly used the Games to upgrade their road infrastructure and added 140km of main roadways to prepare for the Games.

Civic leaders focussed on upgrading/extending three metro lines, building a new suburban rail line, and building a new coastal tramway (Bovy 2004, Frantzeskakis and Frantzeskakis 2006). The first upgrade was Isap Metro Line 1, which connected Piraeus to the city center and the suburb of Kifissia (Bovy 2004). The oldest line in Athens, Metro Line 1, was significantly upgraded and modernized, making it safer for patrons and increasing the capacity to 26,000 passengers per hour in each direction. The Attiko Metro Line 2 and Line 3 were also extended to some of the suburbs of Athens (Line 2 was developed by 2.5km with two new stations, and Line 3 was extended by 6km with an additional two stations). Part of the new suburban rail line allowed Line 3 to connect to the newly constructed airport, shortening the 38km commute to 20 minutes. A new 32km section of suburban rail linked an airport with Greece's central railway station. The final piece of the Athens public transit upgrade was the 27 km tramway system (i.e., Athens Light Rail System) which was constructed with two lines connecting Glyfada, the city centre, and the Faliro area. At the time, the plan was to have these two lines be the building blocks for a more extensive tramway system in the years following the Olympics.

The operation budget for the Olympic transportation system operation was €105 million (Bovy 2004). The upgrades to the metro system were estimated to cost €2 billion due to complications with legal settlements and archaeological finds (Martinet and Allaire 2012). The upgrades to the public transit system cost an estimated \$2.45 billion USD (Kassens-Noor 2015). However, these significant investments made into public transit infrastructure were a huge step forward for the city. The staging of the Games helped the city leaders significantly upgrade an area of need by constructing a public transit system capable of moving high volumes of people around the city in a practical, economical, and environmentally responsible manner.

#### *Athens: Olympics Public Transit Legacy*

The impact of the new airport or the upgrades made to the road network fall beyond the scope of this research. It has made a difference, although Athens still struggles with traffic congestion (Kassens-Noor 2015). Some question the state of the Athens public transit system if they had yet to host the Games and access new funding sources. Martinet and Allaire (2012) suggested that Athens would likely only have received its public transit upgrades if it had hosted the Games. Olympics. Critics often point to the exorbitant cost of the Games for Athens as the reason why they should not have hosted. Admittedly, much of the spending was on cost overruns and “white elephant” competition venues which could have been avoided with better planning. However, upon closer examination, their investments in public transit have made a difference and paid long-term dividends.

Kassens-Noor (2015, p. 5) noted that “since the metro’s new line inauguration, the underground train has become an integral part of Athens’ life.” She concluded that there had been no comparable development since hosting the Games despite many grandiose plans. One of the significant purposes of increasing public transit was to induce development along the created lines. The suburban railway is

underutilized since it shares the same track going to the airport that one of the metro lines uses, which in her view, makes that section redundant.

Kassens-Noor (2015) further delved into the intangible transport legacies left by hosting the Olympic Games. She discussed foremost the additions to the pre-existing bus network; four new bus lines, expanding the express bus lines, eleven new feeder lines servicing the suburban rail, and the overall bus network expansion by 180km. This has left a legacy in the inner city, where 50% of people are transported by bus (and only comprises 3% of the city traffic). Public transport modes improved in downtown Athens due to the Olympic-expanded bus lanes used both day and night. A new bus and trolley fleet will serve the city for years. Kassens-Noor (2015) reported a 13% increase in ridership across all modes of public transit, and rider share reached 38% in 2007 (three years after the Olympics) before rising to 43% in 2011. While these data are promising, very little change in car ownership and usage has transpired due to the habits of Athenians and the public's stigma surrounding public transit.

Hosting the Games stimulated the integration and coordination of the transport agencies during the Olympics, but the change has not been sustained. An integrated Athens-central transport agency should have resulted. It worked during the Games when many people needed to be efficiently transported around the city. Still, unfortunately, city officials sat idle when public transit officials returned to the ways of the past following the Games (Kassens-Noor 2015). This has proven to be a lost opportunity for hosting the Games.

Other analysts have been more positive. Martinet and Allaire (2012) suggested that the new infrastructure increased public transit mode share by 10% from 2003-2006. Hosting the Games and investing in public transit made a difference. This researcher pointed to other positive developments to the transit system due to hosting the Games (e.g., the extension of dedicated bus lanes, city centre tram lines, and metro lines combined with the renewal of the bus fleet).

In conclusion, Athens maximized the upgrades to their transportation system that citizens and tourists have used since hosting the Games. Naturally, and in hindsight, they could have done more to integrate the systems fully on a long-term basis. However, all told, Athens is considered a success story relative to how the city hosted the Games to modernize and expand its public infrastructure. A more integrated system and a social marketing campaign to get citizens to reduce their dependence on cars could help ensure long-term benefits for the hosting experience.

## **2008 Beijing Olympics**

### *Beijing: Before the Olympics*

One of the largest cities in the world and the capital of China, Beijing was selected as the host of the 2008 Olympics in July of 2001 after a failed bid to host the 2000 Olympics (GamesBids 2022). Beijing is famous for its rapid urbanization at the turn of the 21<sup>st</sup> century, and the trio of Olympic bids since shows the desire of China leaders to showcase its economic prowess to the world.



Beijing is an industrial city, containing 120 of the 130 national industrial sectors and 67.3% of the city's economic base emerging from heavy industry (Wang 2011, as cited in Yamawaki and Tomaz 2019). Throughout much of the city's history, industrial growth was the primary concern, and little thought was put into housing or transportation standards. These attitudes shifted with China's rapid urbanization in the late 20<sup>th</sup> and early 21<sup>st</sup> centuries.

The first subway line was built in 1965, albeit for military purposes (Yamawaki and Tomaz 2019). The line underwent multiple changes and was finally opened to the public in 1981. It was mainly used to transport those who had migrated from the countryside to the city and had settled in cheap suburban housing to and from their jobs in the city center. A lack of coordination between land use and transportation systems made citizens highly dependent on private transportation. A plethora of automobiles on the roads created gridlock, so some bus lines took four times longer to complete their routes. This congestion led to Beijing expanding its ring road system and adding five new highways in 2008 to facilitate traffic.

Before the Olympic bid, Beijing only had two metro lines serving the city's center (Yamawaki and Tomaz 2019), and most public transit occurred via an extensive bus network (Doneliza 2012). This was not acceptable for hosting the Olympic Games or the future development of Beijing. China realized that it needed to make a change, and hosting the Olympic Games of 2008 allowed city leaders to make the change.

#### *Beijing: Investments in Public Transit*

Beijing invested heavily in public transit after winning the bid to host the 2008 Olympics. Over \$USD20 billion was spent on the total transportation system in the seven years leading up to the Games (Bovy 2009), and a significant portion of USD 9B was spent on public transit (Hays 2010). The public transit system was expanded by 143.61km of new line, and passenger load capacity was expanded to up to 200,000 on the 1,420 vehicles (Yamawaki and Tomaz 2019). Three new lines on the Beijing subway system increased the system's reach by 40% to 200km (Cortes IV 2008). The new lines cost \$3.3 billion USD and were constructed on time for the Games (Cortes IV 2008). The Olympic Rail Transit Network Command Centre was installed in July of 2008 for the Games, and a newly constructed rail line to the airport now delivered passengers to the downtown area in 30 minutes (Beijing Organising Committee for the Games of the XXIX Olympiad and Beijing Organising Committee 2008). Ironically, many of the public transit expansions at the time did not serve Olympic venues, despite being included in the financial package for the Olympics.

#### *Beijing: Olympics Transport Legac*

Beijing had a long-term plan and put the needs of the city first. They developed and implemented a robust public transit plan to serve the city better with more efficient transportation (Yamawaki and Tomaz 2019) and used the hosting of the Games as the catalyst for change. The urban rail system consolidates

access to the new city centre areas. All but one of the SEZs experienced significant growth from 2004 to 2008 over the 2001 to 2004 period when the subway system was expanded. Public transit infrastructure excitement played some role in the development of these zones.

Beijing needed to make public transit an attractive alternative to private transportation. Hosting the Games and investing in more public transit appeared to work. Mao (2008) pointed to increasing the cost of parking in the city center, improving the efficiency of the transit design hubs, giving transit vehicles more priority over private traffic, and enhancing government information about the importance of using public transit were the specific reasons.

Beijing's public transit share of modal transport was 28.2 in 1986, 26.5 in 2000, and 29.8 in 2005 (Mao 2008). This shows a decline in popularity before the commitment to further investment, which led to a modest increase in mode share in the lead-up to the games. This trend continued in the years following the Olympics. However, Dixon et al. (2018a) suggested that despite the significant investments in public transit, mode share remained relatively low (i.e., 36%), and use still commanded 28% of the traffic share.

Were there transportation benefits for Beijing as a result of hosting the Games? Beijing would have undoubtedly upgraded its metro system without hosting the Games. The only investment in public transportation for the Olympics was the Olympic line built to service the Olympic Green SEZ (Doneliza 2012). Legislation has changed use patterns, not access to new transportation services, for example. Beijing bans private cars from entering the 5<sup>th</sup> Ring road for one of the workdays each week based on the last digit of their license plate (Mao et al. 2016). This makes it hard to compare traffic metrics since the city has built-in artificial governors to control congestion that only exists in other cities. Regardless, Beijing made significant and lasting upgrades to its public transit system that should provide tangible benefits to city residents for decades to come, especially with legislative policies supporting the greater use of public transit.

## **2012 London Olympics**

### *London: Before the Olympics*

Founded by the Romans in 43 AD, London flourished during the Victorian era, its population boomed, and by the end of the nineteenth century, it had become a world city and an important trade hub as the British Empire rose to prominence (Civitas n.d.). The town historically used omnibuses as the first mode of public transit, which evolved into the use of motorbuses as they rose to prominence in the early 1900s (Transport for London n.d.). The lack of a monopoly over bus services resulted in fierce competition and rapid expansion of bus lines. Through the 20<sup>th</sup> century, the bus network in London underwent many changes and authority organizations before finally evolving into the current Transport for London (TFL) organization.

London's first underground railway was built in 1863 with six stations (Railway Technology 2006). The following 50 years saw much of the central network completed with shallow tunnels fitted with covers and vents while new technologies allowed for deeper tunnels making the following 50 years marked by the expansion of the lines into suburban neighbourhoods to further connect the city. No new lines were built over 60 years until 1968. The Victoria Line opened for the first time, followed by the Jubilee Line opening in 1979 and expansion to the docklands in 1999. The Docklands Light Railway (DLR) was opened in 1987 to help redevelop the Docklands area, containing 11 trains along 15 stations. Four extensions were completed along the system between its inception and when London was making its bid for the 2012 Olympics. The railway operates on a private franchise model, with TFL responsible for managing the relationship and the DLR.

London once had an extensive tram network that was phased out in the 1950s in favour of cars and buses (Transport for London n.d.). Trams were re-introduced in Croydon in 2000 to combat congestion and make the city more interconnected. Some of the routes followed old unused rail lines, and the system was run by a private entity which was eventually bought out in 2008 by Transport for London, who purchased more trams to allow for better frequency of service.

However, only some people paint the same optimistic picture of the state of the London transportation system. When London was making its bid for the 2012 Games, its public transit system was described as "obsolete" (Bovy 2013). Wolmar (2004) described the pre-Games transportation system as overcrowded and plagued by poor planning and route scheduling. The city lacked transport lines that Londoners desperately needed, including the East London Line. London needed more public transit infrastructure and needed it on a short timeline. This was a perfect time to bid for the Games and access revenue sources to improve the system.

#### *London: Investments in Public Transit*

London undertook a bold plan to bolster their public transit systems, specifically their rail network. Stratford received a new international station with a high-speed Javelin stop seven minutes from St Pancras station (Bovy 2013). The Stratford regional station was vastly improved along with the King's Cross-St Pancras station (Bovy 2013, Transport for London n.d.). The Dockland Railroad was extended to Woolwich and Stratford International and saw a 50% increase in capacity. They added capacity to the Central and Jubilee Lines and upgraded to 30 trains per hour at peak times. The "orbital" London rail network was completed, and London Overground (the above-ground rail network in London) was refurbished on the East London and North London lines. Southfields and Green Park were given step-free stations to aid in accessibility. Refurbished piers, simplified maps and timetables, and Oyster pay-as-you-go fares aided commuter services along the Thames. Rail transport was extended throughout London, and all the venues were accessible by at least one metro station (Bovy 2013). The Crossrail project was in its planning stages at the time of the Olympics but was not

deemed essential in the transportation plan, though it is being completed now (Railway Technology 2006). London placed a high priority on its public transit system and used the opportunity of the Olympics well to provide the city with a once-in-a-generation upgrade to the system.

### *London: Olympics Transport Legacy*

Congestion and the need for an upgraded public transit system remained an issue as the city assembled its bid to host the 2012 Games. Significant public transportation upgrades were weaved into the bid documents. The strategy paid off. The public transport system, updated and expanded for the Games, performed admirably and remained a legacy of hosting the Games. Branded as the “Public Transport Games,” the host planners ensured that the hosting of the Games resulted in a public transit legacy. The mayor was committed to reversing the trend of underinvestment in East London and providing tangible benefits to the city’s most disadvantaged residents. The legacy plan included the proposal of the Mayoral Development Commission (MDC), which would absorb power from many Olympic planning bodies to become the sole authority for catalyzing regeneration in the area (Dept. for Culture, Media and Sport 2010). There were many actionable items presented in the plan. However, many of them lacked specificity and would have easily confused the level of commitment being made by London city officials.

London officials ensured that East London gained a rail system that proved its efficiency during the Olympics and long after the completion of the Games (Bovy 2013). The system was designed with growth in mind; planners ensured reserve capacities for medium- and long-term development. It was vital to recognize that the community’s needs will sometimes be dynamic, requiring a system that can adapt alongside them. The trains purchased for the Olympic Games will still be in use in 2042, and the lines extended to support travel during the Olympics will still be in use in 2112, a century after they were installed (IOC 2021).

Despite the significant infrastructure improvements, London has yet to experience the spiked public transit usage that it anticipated. The 29% mode share of public transit is still relatively low, given the investments made into the system (Dixon et al. 2020a). The monthly cost of a transit pass has increased from \$159 in 2018 to \$190 in 2020 (Dixon et al. 2020a). London could have scored better in the affordability of public transit score on the CPI with a 67.14 out of 100. They were the highest-scoring city studied for the length of mass transport network (48.95/100), though the mediocre score on the metric shows that they still have a way to go. If the system is not affordable, it does not matter how much infrastructure there is. Public Transit mode share has continued to rise throughout the years. Mode share statistics show that by Q4 in 2019, public transit mode share had increased to 35.6% compared to the 29% in 2015 (Mayor of London and Khan 2020). Continued investments into the system allowed it to improve steadily, while the commitment to maintaining the MDC has allowed the city officials to continue with infrastructure and neighborhood developments (Law Insider n.d.).

Overall, London hosted the Games to address underserved areas of the city with sound public transit investments.

## **2016 Rio de Janeiro Olympics**

### *Rio de Janeiro: Before the Olympics*

Before the Olympics, Rio de Janeiro had an overstretched and disconnected transit system. The geography of the city makes planning for public transit very difficult. Rio de Janeiro contains the world's largest urban park -Tijuca National Park, in the city's centre (Bovy 2017). The park extends for 105 square kilometres of sprawling mountainous sub-tropical forest, with mountainous topographical features dividing the city into four distinct areas. Serving the residents through public transit has proven to be a challenge.

According to the bid committee officials (Rio 2016 Bid Committee, The Olympic Studies Centre 2009), when organizers began assembling their bid in 2008, they concluded that Rio de Janeiro lacked public transport infrastructure for a city of its size and geographic characteristics (e.g., 37 km of metro, 225km of suburban rail, and 749km of roadways and arterial roads). A lack of system integration was also problematic and led to low ridership. Rio de Janeiro officials hoped to transform their public transit system by hosting the Games. Planning decisions made for the Olympics helped catalyze the public transit connections that now exist across the city. Civic leaders decided to locate the Olympic venues across all four city centers to encourage development across the whole city, which led to the necessitation of transport development between all four areas (Bovy 2017).

### *Rio de Janeiro: Investments in Public Transit*

Rio prioritized public transit in their Olympic bid and made significant investments in the system to add many new lines and higher capacities. The candidature files for Rio for the World Cup and the Olympics showed a plan to create a high-capacity transport ring that would connect critical areas in the city and benefit “low-income workers” the most: the group most likely to live on the edges of the city and have long commutes in to work (Pereira et al. 2019). They spent \$4.5 million in the years leading up to the games on public transit infrastructure and programs. Cost overruns and political corruption drove up this significant figure.

For the most part, Rio over-delivered on most of the public transportation promises outlined in their bid. The rapid rail line (RRL) connecting Barra to the South Zone was one exception (Bovy 2017, Rio 2016 Bid Committee, The Olympic Studies Centre 2009). It was replaced by the rapid bus line (i.e., RBL) that extended an additional 79km of lines from the promised rail line. The light rail system was developed after the original bid, and the new metro line extended 11km in 2016.

The primary public transit upgrades were centred around four systems, namely: (a) a new BRT system; (b) an extension of the metro; (c) suburban rail upgrades, and; (d) a new light rail system (Bovy 2017). The new BRT system was extensive, covering 122 km and composed of three lines. There were plans to have the system extended to 150km by 2018, making the system one of the largest under centralized control. They developed 15km of new metro line to connect Barra da Tijuca with the South Zone of Rio. A 30km stretch of the suburban rail significantly improved service and mobility, while six new stations underwent significant renovations. The final upgrade to the city's infrastructure was the new 15km light rail system built to link the airport with the city's central bus terminal; there were plans to put in a second line in 2017-18 to double capacity.

### *Rio de Janeiro: Olympics Transport Legacy*

Rio made significant investments in their public transit infrastructure, but questions remain about the impact of the assets and subsequent policy decisions. A severe economic downturn resulted in a 70% drop in the budget of the Secretary of Transport (Pereira et al. 2019). A significant decline in the ridership of the public transit system followed (France 2016). In 2016, there needed to be more clarity about the status of the public transit system. Fifty-one lines were removed while 25 new ones were added, and 26 more had their lines shortened or altered (France 2016). Pereira reported a darker picture, with 70 bus lines being eliminated (out of 485), 41 rerouted or shortened, and only 16 new lines created (Pereira et al. 2019). The economic challenges and commensurate impacts on public transit investment led to widespread criticism of the government and civil unrest. Some experts claim increased violence in Rio has led to more people avoiding busses due to heightened security threats (France 2016).

Only a year after hosting the Games, there were widespread criticisms of the cost overruns of the infrastructure projects and the corruption within contracted companies and politicians that decide who gets the construction bids (Sandy 2016). A criminal probe named "Operation Car Wash" investigated many of the firms contracted to build the infrastructure projects for the Olympics. The results determined that a cartel of construction companies offered significant bribes to hundreds of politicians across the political spectrum, leading to substantial cost overruns. Internal documents released by Odebrecht, the company contracted to work on the new subway line- showed that bribes were made to 316 politicians across 24 parties. It also found that Odebrecht had a specialized department specifically mandated to handle the bribe payments.

Quiroz and Legroux (2014) discussed how the "transportation revolution," as labelled by the Rio government, is a one-sided focus that ignores the other issues surrounding the issue of urban mobility, often overestimating the benefits of limited mobility projects. Quiroz & Legroux highlighted one of the principal problems with how planners and city officials handled the 2016 Olympics. They were too focused on the short term and tended to ignore the main issues plaguing the city and their root causes. Rio was beset by traffic congestion and did little

outside of the public transit investments to stimulate public transit solutions. Car use rose from 1.6 million vehicles in 2000 to 2.5 million in 2011.

One of the significant points of criticism came from the modal choice that was made when the Rio government decided to do most of its public transit upgrades through a bus rapid transit (BRT) system. Interviews done by Jean Legroux (Queiroz and Legroux 2014) indicated that public opinion did not favour the BRT system due to its low capacity and lack of ability to match the needs of a developing city. Kassens-Noor et al. (2016) concluded that the BRT planning did not take the origin and destination studies into account, which were based on urban densities and employment centers (Governo do Rio de Janeiro 2013, as cited in Kassens-Noor et al. 2016). The BRT that was implemented was used to promote road widening and ultimately created more space for cars in areas where expropriation was necessary for construction (Queiroz and Legroux, 2014). In many cases, these researchers noted that additional lanes were not needed for the BRT system, and the expropriation of people living alongside the road was carried out to create room for cars and not the BRT system.

Pereira et al. (2019) suggested that average access to schools and jobs by public transit fell by 4.5% to 6.1% between 2014 and 2017 in Rio. They found that the investments alone should have improved access and rationalized that the drop was likely due to the rationalization of using bus lines and recent cuts/changes in service. Additional analysis found that schools were more adversely affected by the policies than jobs were and that most of the accessibility losses were in poorer neighbourhoods, while most of the accessibility gains were in wealthier neighbourhoods. A cluster analysis showed how the light-rail system did not significantly improve access to jobs or schools, while the new metro line in the south of the city improved access for various poor and wealthy neighbourhoods. The results of this study show that there is still hope for Rio. The infrastructure upgrades improved access independently, but they also needed to be followed with sound policy decisions that ensure accessibility and affordability for all users.

Ribeiro and Almeida (2021) painted a dim picture of the public perceptions of the public transit system. They conducted cross-sectional surveys before and after the 2016 Olympic Games on citizens who lived in Rio de Janeiro to assess their perceptions of the transport legacy left by the Olympics. Resident perceptions were measured against five main factors concerning the public transit system, namely: (a) planning; (b) infrastructure; (c) insecurity; (d) public transit information, and; (e) urban mobility. The results showed that the Olympics negatively impacted resident perceptions of the public transit system, decreasing across every factor except public transit information. Perceptions can vary widely based on innumerable complex and interconnected factors. However, when combined with other research echoing the same sentiments, the criticisms against the Rio public transit system appear to be justified.

Rio has a costly public transit system concerning average wages, which makes it burdensome for those lower on the socioeconomic ladder; Rio scored 0 on the CPI index for transport affordability. While the total infrastructure was added significantly, Rio still needs more public transit infrastructure for a city of

its geographic size; it scored 31.54 on the CPI index for the length of the mass transport network.

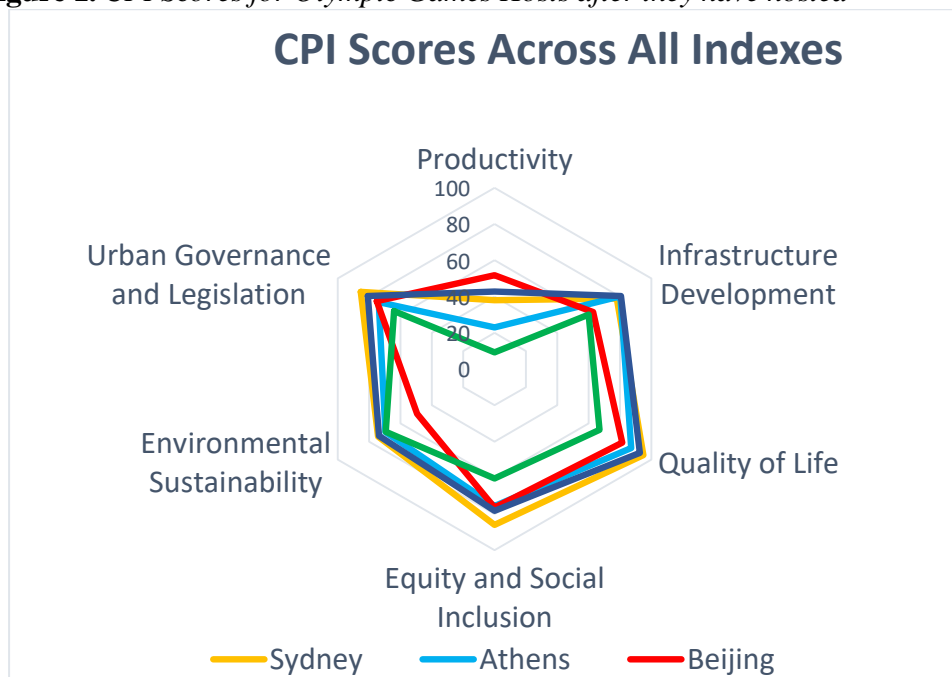
However, it is not all of the results are negative. The hosting of the Olympics and the World Cup resulted in significant upgrades to Rio’s transportation system in a very short period of time (Pereira et al. 2019). Bovy (2017) noted that in 2011 1.1 million daily trips were made on public transit, and this level rose to 2.3 million in 2016. Rio has a reasonably functional public transit mode share compared to other cities; 48% of trips are taken on public transit. All the trains in the city are electrified, which is critical to reducing transport emissions for the city (Rio 2016 Bid Committee, The Olympic Studies Centre 2009). Rio has established a much more competent system than it had in the past, and it should allow the city to continue to develop and improve quality of life so long as competent planning and policy decisions support the system.

### Overall City Performances

#### Comparing the Scores of All Cities

All the scores for the individual indexes were summated and averaged to provide each of the five host cities with a CPI score out of 100. Sydney had the highest cumulative CPI score of (76.04) followed by London (74.78), Athens (68.19), Beijing (66.14), and Rio de Janeiro (54.97). The total CPI score and the score for each index were compared against the spending on public transit investments for the Olympics. The comparison of the total CPI scores is presented in Figure 1.

**Figure 1.** CPI Scores for Olympic Games Hosts after they have hosted





## Discussion

### *Public Transit Spending and System Performance*

There is not a noticeable relationship between public transit spending for the Olympics and overall city prosperity. Increased spending did not necessarily result in better overall prosperity. A larger urban redevelopment strategy was taking place in Beijing at the time of planning for the Olympics, evidenced by the highest spending of any host studied. Meanwhile, Beijing did not have top scores for any index except for the Productivity Index, which showed Beijing outscoring all the other cities by a significant margin. However, the rest of the data do not support a connection between the CPI and public transit spending. This relationship was also shown in the Infrastructure Development Index, the sole index that should be influenced most heavily by investments into public transit. Many of these indexes suggest that public transport spending has little impact on the prosperity of a city.

This lack of connection raises questions since literature shows that public transit can provide innumerable benefits to communities and their residents. So why does this relationship fail to appear in these data? Each city had its own history and unique circumstances, while only taking post-event data assumes a similar starting point. Additionally, many circumstances can impact the efficiency of spending dollars, including labour costs, planning efficiency, and political corruption.

Olympic public transport projects often only impact some of the city but focus on a small area needing improvement which leads to an unequal distribution of benefits which lessens any relationship that appears in the data. New research should work to find a way to measure policy decisions and convey their importance quantitatively while taking spending efficiency into account. These data suggest that policy decisions are as crucial as infrastructure spending.

### *Best Practices for Public Transit and the Olympics*

By identifying best practices for public transit investment and planning, cities can maximize the efficiency of their transportation systems while making transportation more easily accessible to all residents. Proper planning results in numerous benefits, such as lower congestion, better air quality, economic prosperity, and improved physical fitness.

A successful public transit system that meets the needs of the city's residents will contain multiple modes of transport. Research by Mulley and Montou (2015) discussed multi-modality, which is when someone uses more than one mode of public transit to get where they need to go. Nielson et al. (2005, as cited in Mulley and Montou 2015) argued for multimodality to build more efficient networks, which allow cities to offer service more frequently for the exact cost. They mention how the cities that have embraced multi-modal trips have also focused on making interchanges between modes as fast and easy as possible. A multi-modal system can connect places in ways that a direct system cannot, so making connections fast and easy for the user allows a city to become very accessible and

connected, assuming that the city has an appropriate amount and placing of public transit infrastructure. Without proper organization and coordination, the multiple modes will have difficulty complementing each other, resulting in a disconnected service. The first recommendation is that cities create a complimentary hierarchy of public transit modes that services the needs of different areas and corridors and strives to make connections between modes as easy and convenient for the user as possible.

Historically, when building public transit projects for the Olympics, the focus has been on satisfying the short-term needs of the Olympic spectators and officials. Planners must start thinking differently when planning public transit infrastructure projects. The thinking must shift towards the long-term needs of the cities, which are not the temporary transit patterns experienced during the Olympics, but rather the long-term established practices that have been developed over time and represent where people travel regularly (Kassens-Noor 2010). The second recommendation is that host cities look at the established movement patterns and then develop transit solutions that meet the current needs of the city with room for the city to continue to grow and add capacity if needed. By focusing on the residents over short-term event spectators, cities can maximize their investment and reduce the likelihood of investing further to fix poor design choices.

When investing in public transit, cities need to fully understand the different modes of public transit and the benefits and drawbacks of each. Beyond having this understanding, they need to match the modes they choose with the city's long-term needs. A poor example of planning was seen in Rio de Janeiro for the 2016 Games, where planners and city officials decided to implement 100km of dedicated BRT lines as the primary form of mass transit. As a result, Rio has locked itself into a fixed capacity system in a rapidly growing city. Planners need to do extensive research on the travel patterns of city residents while combining those patterns with growth forecasts for the city. By looking at the current and long-term needs of residents, planners can select better modes that fit what the city needs. The third recommendation is that city planners make mode choices based on the circumstances and long-term needs of the city, outside of pressure from stakeholders to choose the cheapest and least intrusive option; in many cases, cities require bold solutions to their transportation issues, but there is always pressure to reduce costs.

The area that needs to be addressed by Olympic hosts is the integration of transport entities and the creation of a single transportation authority that carries on knowledge from the hosting of the Olympics. These authorities already exist during the staging of the Games, working to coordinate different agencies to provide a seamless experience for the end user (Kassens-Noor 2010). However, once the Games finish, these authorities are usually dissolved, giving power back to the respective agencies and returning to a normal state where change processes are much more bureaucratic and drawn out. Often, the knowledge gained by the management of Olympic transport officials is lost through the split. She identified how cities can encourage institutional change by planning for a post-Olympics integrated transport system and by establishing “guardians” to exist past the Olympics are gone, and in doing so, ensuring that the set goals and vision are

being met. Mulley and Montou (2015) echoed this sentiment, discussing how it is easier to provide a better interconnection and multi-modal experience when there is coordination between the organizations responsible for providing public transit. They caution that a single organization is not the only route to developing an efficient system, so there is good communication and cooperation between the parties responsible for providing the service. The fourth recommendation is that cities work to keep the planning and coordination power gained during the hosting of the Olympics; this power allows changes to happen much more quickly and efficiently compared to traditional bureaucratic processes.

Kassens-Noor (2015) offered three recommendations for Olympic host cities relative to their transportation system. Cities should emphasize creating a strategic planning approach that will outline the actions that need to be taken and the goals for the city to leave a positive transport legacy. She recommended the establishment of an “entity” that will watch over the progress during and after the Olympics to ensure that goals are being met and the legacy is being upheld while making strategic adaptations when different circumstances arise. Finally, cities should commit time, resources, and personnel to improve the transport system after the Olympics to avoid any post-Games developmental slump. This recommendation follows those given by Kassens-Noor (2015). She called for the establishment of a long-term strategic plan that exists outside of the Olympics. She suggested the appointment of someone who will monitor the progress compared to the project both before and after the Olympics and maintain a focus on infrastructure improvement after the Games have drawn to a close.

#### *Areas of Criticism/Recommendations*

Sydney needed to effectively address their public transit needs due to hosting the 200 Olympic Games. The completed projects did not match the city's needs, evidenced by their chronic low ridership (Kassens-Noor 2010). Though they can be commended for not overspending on expensive upgrades, Sydney missed out on an incredible opportunity to reshape its public transit system for the better. The city should have spent more time studying the travel patterns of its citizens to identify high-capacity corridors where public transit could alleviate pressure from the road network. Sydney did not eliminate financial penalties for mode transfers until 2022 in a city that often requires multiple modes to get from one place to another (Mulley and Montou 2015, Shakibaei 2022). This significantly hampered the desire for residents to switch from private automobiles to public transit, shown in the perpetual high car ownership and low mode share for public transit. Now that Sydney has improved the multi-modal experience, the focus should remain on adding capacity and reach to the system while promoting public transit over private cars.

While Athens should be commended on the amount of infrastructure that it built in the lead-up to the Olympics, it should be equally criticized for the planning of the construction and the post-Olympic period. The lack of assigned responsibilities in the early stages led to cost overruns from the frantic building pace that was required to catch up to the Olympic timeline (Kassens-Noor 2015).

Poor infrastructure planning led to multiple trains running along the same section of track to the airport, making one of them redundant. A lack of foresight saw the ATHOC dissolved after the conclusion of the Olympics, with no central agency destined to take its place, resulting in much of the gained knowledge being dispersed and eventually lost. The Traffic Management Center saw a need for more investment post-Olympics. The Olympic tram line chronically suffers from long travel times and underdevelopment. Athens needs to develop a centralized agency to coordinate multiple institutions and make operations and upgrades much easier to implement.

Citizens of Beijing must deal with an expensive transportation system that, while extensive, places financial strain on the lowest members of society. In the CPI analysis, Beijing scored 15.45/100 on the index for affordability of public transit. Mao et al. (2016) criticized Beijing for the lack of attractiveness of its public transit system in 2008, who cited too much parking in the city center, low efficiency of the system and the hubs, and poor access to transit information as the main causes. Public transit modes showed the lowest ride satisfaction of the five modes studied in 2016. Beijing should focus on increasing the experience for public transit users, making the system more efficient and affordable for the average person. They should also continue to seek opportunities to add to the system, increasing interconnectivity between city districts.

There are a few areas of criticism for the London 2012 Games. The focus on making necessary upgrades and creating a transport legacy for the Games ensured that there were real benefits brought to the residents of London. London had a relatively low score on the CPI index for affordability of transport (67.14). In contrast, the length of the mass transport network index score (48.95) indicated that London needs to continue investing in the size of its public transit network. London needs to keep improving the size and accessibility of the system to present it as a more viable alternative to private cars while working to keep the system affordable for everyone.

Much of the planning and building for the Rio de Janeiro Olympics was rife with corruption and bribes for lucrative contracts, leading to significant cost overruns on public transit projects. While Rio de Janeiro added significant infrastructure and connected areas that were previously only accessible by congested roadways, the mass transport they chose to implement did not fit with the city's long-term goals. Rio locked itself into a fixed capacity system (BRT) that is less efficient than rail and needs to be equipped to deal with a growing population and demand for transport (Quiroz and Legroux 2014). Only some other initiatives were taken on to tackle the problem of congestion, and new transportation lines were used as an excuse to cut existing lines and make changes to the system with poor information relay to residents. The BRT system was used as an excuse to widen roadways and add lanes, increasing the total space devoted to motor traffic under the veil of public transit. The BRT should have considered established movement patterns, limiting the lines' effectiveness. Finally, the cost of the public transit system is burdensome to residents, evidenced by a score of 0 on the CPI index for affordability of transport. Rio planners and officials should study origin-destination studies to determine the best places to invest in further public

transit infrastructure. When the best locations have been decided, higher capacity modes than BRT should be chosen due to their ability to adapt to the city's growth. Rio should make information about the system more easily accessible and should work to reduce the cost of use for residents.

## **Conclusion**

Through examining five modern Olympic host cities and the improvements made to their transportation systems in the name of the Olympics, one of the most significant factors influencing the legacy of an Olympic host is the post-event planning set out in the bidding process. Most of the cities studied should have taken advantage of the hosting opportunity to develop a futuristic and integrated public transportation network for their city. This is a lost opportunity and a shame.

Sydney did not maximize the opportunity of the Olympics, barely adding to its public transit infrastructure and abandoning support for multi-modality after its success during the Olympic period. They can be commended for not creating unmanageable debt for the city, but they should have taken advantage of an opportunity to create a substantial legacy.

Athens had its share of problems but found a way to develop a significant amount of needed public transit infrastructure, leaving the city with the tools to create prosperity in the near and distant future. Unfortunately, many promised developments alongside public transit lines never came to fruition, and a lack of post-event planning led to underutilization and inefficiency of the public transit system. Athens is famous for the debt it incurred from the 2004 Games, but its financial position should be balanced with the incredible physical legacy that was left.

Beijing invested significantly in infrastructure, more than any city studied in this paper. They expertly married the needs of the residents with the needs of the Olympics, mainly using a plan that would be put in place regardless of whether they hosted the Olympics. Though they followed Athens by creating a physical legacy for the city, they made the same mistake of ignoring the importance of policy. The result is that some have seen the public transit in Beijing as inefficient, expensive, and unattractive as a transportation option. Beijing has work to do regarding the attractiveness of its public transit system, but the genuine investments that have been made make improvements possible through policy.

London created a lasting transportation legacy for the city by focusing on a legacy plan and implementing the Mayoral Development Corporation, which oversees the progress of the city's development and can buy/develop land to meet city goals. London improved areas in dire need of public transit upgrades and expansions, emphasizing the entire experience for public transit users. As a result, London has arguably left the best transportation legacy in the history of the Olympics.

Rio de Janeiro made the most significant expansions to its public transit system, surpassing the plans outlined in its bid. Unfortunately, corruption and poor policy decisions have negated the benefits to the city. Public transit in Rio is seen

as expensive and unsafe, and information about the system is not easily accessible. Rio has a long way to go before realizing the expected benefits of their public transit upgrades.

The CPI analysis shows that public transit spending does not necessarily correlate with city performance, even in the infrastructure development index, which contains several measures on public transit. This suggests that other factors influence prosperity, one of which could be policy decisions by city planners and officials. An analysis of best practices suggests that cities need to change the focus from the Olympic user to the city's residents, and that data surrounding their habits and movements should be used to guide public transit decisions and policies. Cities must establish a long-term plan flexible enough to adapt when required but rigid enough to withstand time and the potential for dwindling attention. Individuals should be identified to uphold these plans and ensure that transport legacies are being met. Once the Olympics are gone, cities should establish centralized agencies that retain the coordination and power that the Olympic planning organizations used to develop Olympic projects. All these practices lead toward creating a tangible legacy for a host city that can be measured in the performance of its public transit system. By maximizing legacies, the Olympics can continue to grow, and attention can shift away from problems with hosts to the incredible events and athletic achievements on display.

## References

- Arbury J (2005) *From urban sprawl to Compact City: an analysis of urban growth management in Auckland*. Thesis. Greater Auckland. Available at: <https://www.greaterauckland.org.nz/wp-content/uploads/2009/06/thesis.pdf>.
- Beijing Organising Committee for the Games of the XXIX Olympiad, Beijing Organising Committee B (2008) *Preparation for the Games, New Beijing Great Olympics: official report of the Beijing 2008 Olympic Games (2008)*. Beijing Organising Committee. Available at: <https://stillmed.olympic.org/Documents/Reports/Official%20Past%20Games%20Reports/Summer/ENG/2008-RO-S-Beijing-vol3.pdf>.
- Bovy P (2004) Athens 2004 Olympic Games transport. *Road and Transport* 7(8): 45–48.
- Bovy P (2009) Beijing 2008 Olympic Games success: massive public transportation developments and major road traffic reduction. *International Association of PT* 58(3): 52–55.
- Bovy P (2013) *London 2012: best public transport Olympics ever*. ms, Chexbres.
- Bovy P (2017) *Rio 2016 Olympic Games public transport outstanding legacy and mobility*. Mega Event Transport and Mobility. Available at: <https://www.mobility-bovy.ch/page1/page1.html>.
- Bovy P (2019) Institute for Transport Planning and Systems: IVT Seminar. In *Mega Event Transport and Mobility*. Zurich. Available at: <https://www.mobility-bovy.ch/>.
- Brueckner JK (2000) Urban sprawl: diagnosis and remedies. *International Regional Science Review* 23(2): 160–171.
- City of Vancouver (n.d.) *Population*. City of Vancouver. Available at: <https://vancouver.ca/news-calendar/population.aspx>.

- Civitas (n.d.) *History of London. The evolution of UK's Capital City*. Civitas London. Available at: <https://www.londoncitybreak.com/history#:~:text=London's%20foundation,influence%20of%20its%20major%20port>.
- Cortes IV C (2008, July 19) *Beijing opens new subway lines for Olympics*. Reuters. Available at: <https://www.reuters.com/article/us-china-subway-beijing-idUSSHA30105120080719>.
- Dept. for Culture, Media and Sport (2010) *Plans for the legacy from the 2012 olympic and Paralympic Games*. London, Greater London.
- Dixon S, Hecker M, Ma CJL (2018a) (Rep.) *Deloitte City Mobility Index: Beijing*. Deloitte Insights. Available at: [https://www2.deloitte.com/content/dam/insights/us/articles/4331\\_Deloitte-City-Mobility-Index/Beijing\\_GlobalCityMobility\\_WEB.pdf](https://www2.deloitte.com/content/dam/insights/us/articles/4331_Deloitte-City-Mobility-Index/Beijing_GlobalCityMobility_WEB.pdf).
- Dixon S, Irshad H, Spanjaard L (2018b) (Rep.) *Deloitte City Mobility Index: Sydney*. Deloitte Insights. Available at: <file:///C:/Users/kenne/Downloads/deloitte-au-about-city-mobility-index-sydney-310518.PDF>.
- Dixon S, Milligan T, Smith V (2020a) (Rep.) *Deloitte City Mobility Index 2020: London*. Deloitte Insights. Available at: [https://www2.deloitte.com/content/dam/insights/us/articles/4331\\_Deloitte-City-Mobility-Index/London\\_GlobalCityMobility\\_WEB.pdf](https://www2.deloitte.com/content/dam/insights/us/articles/4331_Deloitte-City-Mobility-Index/London_GlobalCityMobility_WEB.pdf).
- Dixon S, Siddall M, Houghton L (2020b) (Rep.) *Deloitte City Mobility Index 2020: Sydney*. Deloitte Insights. Available at: [https://www2.deloitte.com/content/dam/insights/us/articles/4331\\_Deloitte-City-Mobility-Index/Sydney\\_GlobalCityMobility\\_WEB.pdf](https://www2.deloitte.com/content/dam/insights/us/articles/4331_Deloitte-City-Mobility-Index/Sydney_GlobalCityMobility_WEB.pdf).
- Doneliza J (2012) *Olympic Transportation Planning: the legacies of Barcelona and Beijing*. Thesis. Columbia University Libraries. Columbia University. Available at: <https://academiccommons.columbia.edu/doi/10.7916/D80R9WG2>.
- France R (2016, December 11). *Ônibus Perdem Passageiros Durante a crise*. (Buses lose passengers during the crisis). O Globo. Available at: <https://oglobo.globo.com/rio/onibus-perdem-passageiros-durante-crise-20625497>.
- Frantzeskakis JM, Frantzeskakis MJ (2006) Athens 2004 Olympic Games: Transportation planning, simulation and traffic management. *Institute of Transportation Engineers. ITE Journal* 76(10): 26–32.
- GamesBids (2022, February 28) *Past bid results*. Available at: <https://gamesbids.com/eng/past-bid-results/>.
- Gordon BF (1983) *Olympic architecture: building for the Summer Games*. Wiley.
- Hays J (2010) *Venues and infrastructure for the 2008 Olympics in Beijing: facts and details*. Available at: <https://factsanddetails.com/china/cat12/sub79/item1009.html>.
- Hensher DA, Brewer AM (2004) *Transport: an economics and management perspective*. Oxford University Press.
- IOC (2021, September 2). *Transport improvements and behavioural shifts - Olympic news*. International Olympic Committee. Available at: <https://olympics.com/ioc/legacy/london-2012/transport-improvements-and-behavioural-shifts>.
- Kassens-Noor E (2010) Sustaining the momentum. *Transportation Research Record: Journal of the Transportation Research Board* 2187(1): 106–113.
- Kassens-Noor E (2013) Transport legacy of the Olympic Games, 1992–2012. *Journal of Urban Affairs* 35(4): 393–416.
- Kassens-Noor E (2015) The legacy of the 2004 Olympics for the Athens Transport System. In *Routledge Handbook of Sport And Legacy*, 131–141. Routledge.
- Kassens-Noor E, Gaffney C, Messina J, Phillips E (2016) Olympic transport legacies: Rio de Janeiro's bus rapid transit system. *Journal of Planning Education and Research* 38(1): 13–24.
- Law Insider (n.d.) *Mayoral development corporation definition*. Law Insider. Available at: <https://www.lawinsider.com/dictionary/mayoral-development-corporation>.

- Liao H, Pitts A (2006) A brief historical review of Olympic urbanization. *The International Journal of the History of Sport* 23(7): 1232–1252.
- Mao B (2008) Analysis on transport policies of post-Olympic times of Beijing. *Journal of Transportation Systems Engineering and Information Technology* 8(6): 138–145.
- Mao Z, Ettema D, Dijst M (2016) Commuting trip satisfaction in Beijing: exploring the influence of multimodal behavior and modal flexibility. *Transportation Research Part A: Policy and Practice* 94(Dec): 592–603.
- Martinez C (2012) *Un-habitat launches the City Prosperity Index: HUD USER*. UN-Habitat Launches the City Prosperity Index | HUD USER. Available at: [https://www.huduser.gov/portal/pdredge/pdr\\_edge\\_hudpartrpt\\_100512.Html](https://www.huduser.gov/portal/pdredge/pdr_edge_hudpartrpt_100512.Html).
- Martinet C, Allaire J (2012) (Rep.) *Restructuring the transport network for the Olympic games*. Cooperation for urban mobility in the developing world (CODATU). Available at: [http://www.codatu.org/wp-content/uploads/Ath%C3%A8nes\\_en.pdf](http://www.codatu.org/wp-content/uploads/Ath%C3%A8nes_en.pdf).
- Mayor of London, Khan S (2020) *Transport modal share in London after coronavirus*. London Assembly. Available at: <https://www.london.gov.uk/que-stions/2020/3302>.
- Mulley C, Montou CJ (2015) Not too late to learn from the Sydney Olympics experience: opportunities offered by multimodality in current transport policy. *Cities* 45(Jun): 117–122.
- Nguyen K (2019, October 24). *'it's efficient, it's regular' and it will never be Sydney's PT system*. ABC News. Available at: <https://www.abc.net.au/news/2019-10-24/sydney-will-never-have-world-class-public-transport-says-expert/11632664>.
- Pereira RHM, Banister D, Schwanen T, Wessel N (2019) Distributional effects of transport policies on inequalities in access to opportunities in Rio de Janeiro. *The Journal of Transport and Land Use* 12(1): 741–764.
- Pringle JD (n.d.) History of Sydney. *Encyclopædia Britannica*. Available at: <https://www.britannica.com/place/Sydney-New-South-Wales/History>.
- Queiroz RLC de, Legroux J (2014) From discourse to reality: impacts of Rio's "transportation revolution" on socio-spatial justice. In *The Metropolis of Rio de Janeiro: A Space in Transition*, 343–367. essay, FAPERJ.
- Railway Technology (2006, October 5) *London Olympics Transport upgrade*. Railway Technology. Available at: <https://www.railway-technology.com/projects/london-olympics/>.
- Ribeiro T, Almeida V (2021) The Rio's transport legacy: pre- and post-Games resident perceptions. *International Journal of Sports Marketing and Sponsorship* 22(1): 32–52.
- Richter R (2008, April 1). *Transportation investments in Olympic host cities*. Transport Nexus. Available at: <https://view.officeapps.live.com/op/view.aspx?src=http%3A%2F%2Fwww.transportnexus.com%2Fwp-content%2Fuploads%2F2012%2F04%2Fmastersproject.doc&wdOrigin=BROWSELINK>.
- Richter R (2012, April 19) *Olympic Games and transport infrastructure: an analysis*. Transport Nexus. Available at: <https://transportnexus.com/olympic-games-4/#:~:text=All%20of%20these%20infrastructure%20improvements,development%20was%20similar%20to%20Sydney>.
- Rio 2016 Bid Committee, The Olympic Studies Centre (2009) *Rio 2016 Bid Committee*. Available at: [https://library.olympics.com/Default/doc/SYRA\\_CUSE/38508/rio-2016-candidate-city-dossier-de-candidature-de-rio-de-janeiro-a-l-accueil-des-jeux-olympiques-et-?\\_lg=en-GB#](https://library.olympics.com/Default/doc/SYRA_CUSE/38508/rio-2016-candidate-city-dossier-de-candidature-de-rio-de-janeiro-a-l-accueil-des-jeux-olympiques-et-?_lg=en-GB#).
- Sandy M (2016, March 24) *Brazil corruption: Olympic projects could be connected*. Time. Available at: <https://time.com/4271376/brazil-corruption-scandal-olympics/>.



- Shakibaei B (2022, February 11) *A recent history of Sydney's frequent PT*. Transport Sydney. Available at: <https://transportsydney.wordpress.com/2022/02/11/a-recent-history-of-sydneys-frequent-public-transport/>.
- Transport for London | Every Journey Matters (n.d.) *London's transport - A history*. Transport for London. Available at: <https://tfl.gov.uk/corporate/about-tfl/culture-and-heritage/londons-transport-a-history>.
- Transport NSW Blog (2022, April 4) *Sydney's transport history*. Available at: <https://transportnswblog.com/category/sydneys-transport-history/>.
- UN-Habitat (n.d.) *CPI. UN-Habitat: a better urban future*. Available at: from <https://data.unhabitat.org/pages/city-prosperity-index>.
- Wolmar C (2004, July 2) *Tackling the problems of London's transport system*. Available at: <https://www.christianwolmar.co.uk/2004/07/tackling-the-problems-of-londons-transport-system/>.
- WorldData.info (n.d.) *Development and importance of tourism for Greece*. Worlddata.info. Available at: <https://www.worlddata.info/europe/greece/tourism.php#:~:text=By%20putting%20the%20tourist%20numbers,in%20the%20tourism%20sector%20alone>.
- Wotherspoon G (2008) Transport. In *The Dictionary of Sydney*. Available at: <https://dictionaryofsydney.org/entry/transport>.
- Yamawaki Y, Tomaz J (2019) The transport infrastructure contribution to the urban legacy of the Beijing Olympic Games. *Urbe. Revista Brasileira De Gestão Urbana* 11(10).