Toward a Smart Mobility Framework on Oxford Road

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ABSTRACT

The world's population has increased rapidly, leading to urbanising many ruler areas, and it is estimated that around 75% of people will live in cities by 2050. Therefore, cities will require new urban design methods and smart sustainable systems to face future socioeconomic and environmental challenges. Mobility is one of the main components of urban infrastructure and city systems that have been developed to reduce global carbon dioxide emissions. Cities in recent years have endeavoured to adopt new smart sustainable transportation system that has been implemented differently according to the city's infrastructure and community needs. The smart mobility concept aims to eliminate the negative consequences of current transportation systems by more efficient mobility options for future cities. Mobility is not only related to urban infrastructure but is also an important aspect of the city's built environment and public life. The public space that is available for everyone to enjoy freely is shaped by the movements of the urban environment, including bicycles and pedestrians. In this paper, design principles for public space are covered by using smart mobility dimensions. Oxford Road, which is an iconic street in Manchester frequented by many people daily, is chosen as a case study area. The case study area urban context and mobility systems situation will be assessed by using mixed research methods such as observations, photos, serial visions, counting and mapping. The outcome of this research will produce a smart mobility framework that supports the city's future urban developments.

Keywords: t Smart Mobility, Urban Mobility, Urban Design, Public Space, Urban Infrastructure

INTRODUCTION

Urban mobility has been on the rise globally as transportation methods advance. However, this surge in movement is causing issues both in cities and for the environment. Urban dwellers are grappling with high expenses, time wastage, and uncomfortable transportation experiences. Additionally, the problem of carbon emissions linked to mobility poses a significant threat to the planet's future. Smart mobility, is one of the cornerstones of the smart city concept, presents a new approach to address urban mobility challenges. Future cities can benefit from more sustainable and efficient mobility solutions that mitigate the adverse impacts of existing transportation systems. Besides being a matter of urban infrastructure; mobility is a vital aspect of public life. This study aims to assess the existing situation of Oxford Road through observations, photographs, walking, serial visions, and mapping. Ultimately, the findings and recommendations from this study will lay the groundwork for enhancing the smart mobility system on Oxford Road.

METHODOLOGY

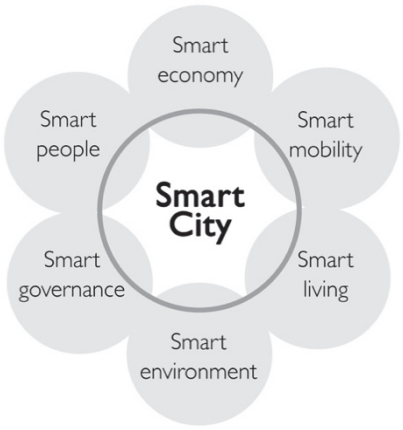
The research paper will employ a combination of research methods to assess the current state of Oxford Road in Manchester. By utilizing both qualitative and quantitative approaches, this study aims to uncover the complex relationship between mobility patterns and the built environment.
Quantitative research will be used to collect measurable data for statistical analysis, while qualitative research will investigate the meaning attributed to various occurrences by individuals (Groat and Wang, 2013). This mixed-method approach will involve serial vision, mapping, tracing, photography, and test walks to comprehensively analyze public life and urban dynamics within the chosen case study area.

Additionally, this study takes into consideration previous reports, initiatives, and surveys conducted by various authorities. Serial vision, a visual analysis technique involving traversing the entire area and capturing sequential images, was applied to examine the open spaces along Oxford Road (Cullen, no date; MUD, 2020). Photography was used to gain insights into the urban context and public life of the case study area. Maps were generated to visually represent and explore activities, urban elements, transportation networks, and the process of urban regeneration along Oxford Road. To assess people's movements and experiences and identify potentials and challenges, tracing and test walks methods were employed at key public nodes along the road (Gehl and Svarre, 2013).

SMART CITY CONCEPT

Over the past twenty years, the notion of the smart city has gained popularity in global policies and academic discourse. Within the smart city literature, its definition and scope have been explored within the realms of business, academia, and government. Due to its diverse approaches, the smart city concept, characterized by fuzzy edges, lacks a precise and universally agreed-upon definition and scope. Numerous studies in computer science and software fields concentrate on smart city technologies from a pragmatic standpoint, devoid of ideological aspects. Similarly, some research state the economic implications of smart city technologies implementations within the business. Governments, on the other hand, have embraced the smart city concept as a toolkit of solutions for socio-economic development, aiming for enhanced safety, democracy, and sustainability. The multifaceted approaches to defining the smart city create a dilemma (Albino, Berardi and Dangelico, 2015; Kitchin, 2015). A city can be considered "smart" by investing in both social and human capital, embracing both traditional transportation systems and modern information and communication technologies (ICTs), thereby fostering economic growth and a high quality of life. This transformation involves intelligent management of natural resources and the implementation of participatory governance(Caragliu, del Bo and Nijkamp, 2011). The smart city concept operates as a networked system that continuously gathers data on the movement of people and materials, influencing both the physical and social aspects of urban life. However, a city truly becomes "smart" when it can synthesize and integrate the collected data to enhance efficiency, sustainability, quality of life, and equity (Batty *et al.*, 2012; Silva, Khan and Han, 2018).

The smart city concept is based on six fundamental dimensions: smart economy, smart mobility, smart people, smart governance, smart environment, and smart living (as illustrated in Figure 1) (Giffinger et al., 2007).



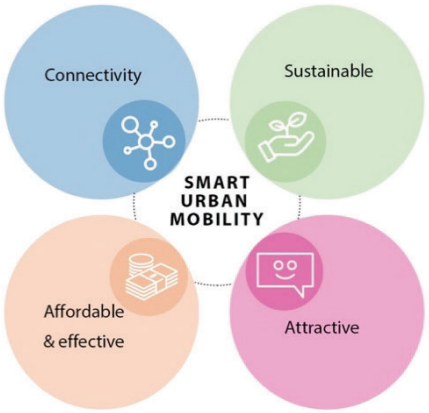


Figure 1.(left) *The dimensions of Smart City Source:(Giffinger et al., 2007)*
Figure 2. (right) *Smart urban mobility features (illustrated from (Lyons, 2018) by author)*

Smart Urban Mobility

Smart urban mobility aims to create inclusive, efficient, and sustainable transportation solutions that enrich the lives of diverse city dwellers while contributing to a more resilient and enjoyable urban environment. Smart urban mobility is based on four essential pillars. First, connectivity is defined making physical movement of people and goods more efficient. The notion of affordability and effectiveness in smart urban mobility is considering the varying skills and requirements of city residents, such as physical, financial, and cognitive capabilities and needs. Third, attractiveness plays a significant role in ensuring that mobility systems are appealing to all city residents, enhancing the overall urban experience for users and business owners alike. Lastly, sustainability is a core focus, emphasizing the need for urban mobility systems to endure economically, socially, and environmentally, even in an unpredictable future where transportation preferences may shift (Lyons, 2018).

On the other hand, Jeekel (2017) points out that smart mobility has four key implementation areas: vehicle technology, Intelligent Transport Systems (ITS), data utilization, and innovative mobility services. Vehicle technology involves advancements such as electric vehicles, improved car safety,

***Figure 3**. PRTs in Masdar City Dubai, Autonomous boats in Amsterdam, car sharing in London, bike sharing in Manchester (Google images, no date.)*

autonomous driving, and optimized powertrains. ITS focuses on the intelligent management of traffic and transportation infrastructure to enhance efficiency and safety. Data plays a key role in smart mobility, utilizing real-time passenger data, logistics planning, and big data solutions to enhance urban transportation and transform cities. Lastly, innovative mobility services encompass smartphone-driven mobility demand and ticketing, the promotion of ridesharing, integration of various transportation modes, the introduction of modern biking systems, and even the exploration of individual cars as a form of public transport (Figure 3) (Jeekel, 2017).

The studies mentioned above point out both integrating brand-new technologies into cities and smart mobility is more than applying technological investments to the city. As Green (2019) highlights, the "smartness" of a city is closely linked to the creation of a sustainable, livable, and equitable urban environment, with technology serving as a valuable tool rather than the ultimate objective (Green, 2019). In other words, smart mobility should ultimately contribute to making cities more sustainable, attractive, and inclusive through the judicious use of technology.

OXFORD ROAD IN MANCHESTER: THE CASE STUDY ANALYSIS

The significance of mobility concerns has been growing in tandem with the increasing population of Manchester, one of the most densely populated cities in the UK. Within Manchester's transportation network, Oxford Road plays a vital role in accommodating various modes of transportation, including public transit, railways, cycling, and pedestrian traffic. Situated to the south of Manchester City Centre, this area ranks as England's second-most important hub for business, entertainment, and retail, trailing only behind London. Oxford Road spans a distance of 1.6 miles, extending from St. Peter's Square to Whitworth Park (as depicted in Figure 4 and Figure 5).

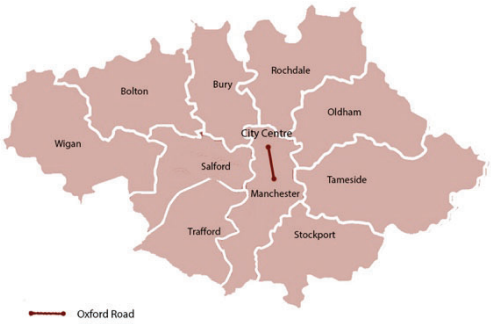


***Figure 4 (left).** Location of Oxford Road(Source: Author)*
***Figure 5 (right)**. Oxford Road is a vibrant axis for the city (Source:Author*

Throughout its history, Oxford Street has consistently served as an important transportation artery for Manchester and has evolved alongside advancements in transportation technologies. Notably, electric trams and motor-buses became fixtures along Oxford Road as Manchester's public transportation system developed (Figure 6). In the early 1800s, the vicinity surrounding Oxford Road was sparsely populated. However, with the rise of industrialization, the area quickly became densely populated as Manchester's population surged. The Royal Infirmary remained a prominent landmark along the road during this transformation (Figure 7).

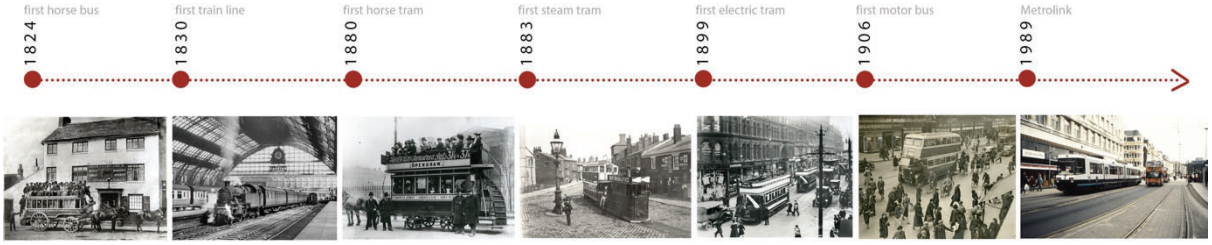


Figure 6. *Urban development around Oxford Road (Source: Author)*

During this period of development, numerous historical structures emerged, including the establishment of Victoria University in 1850, which later became the cornerstone of the University of Manchester. Over the years, the addition of public buildings like the Town Hall, Central Library in St. Peter's Square, and cultural institutions such as the Whitworth Art Gallery contributed to creating public spaces and vibrant environments along the road. All Saints Park, Whitworth Park, St. Peter's Square, Brunswick Park, and University Green appeared as open spaces along the road. Beyond serving as a transportation corridor, Oxford Road also functions as a public venue for hosting protests and meetings. Today, Oxford Road boasts a diverse range of buildings with various functions and activities.

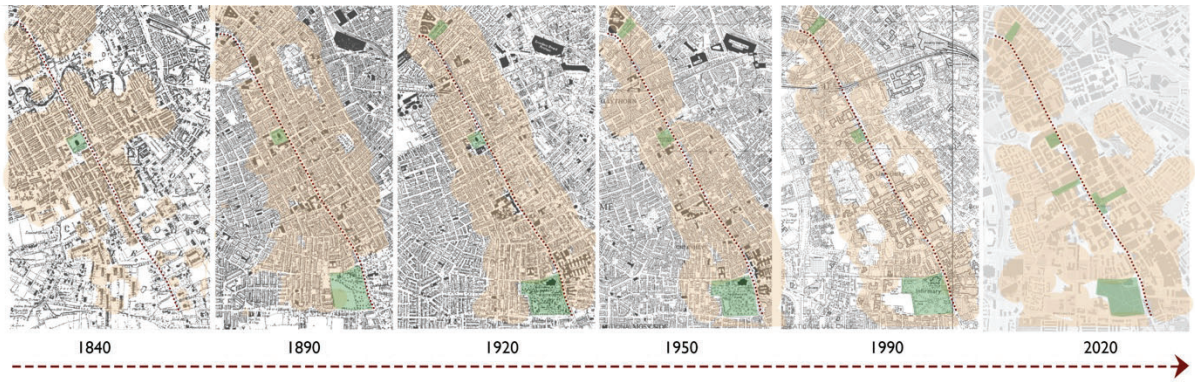


Figure 7. *Urban development around Oxford Road (Source: Author)*

Oxford Road has a diverse range of buildings with various functions. The route and its surrounding area are home to numerous cultural institutions, including the Whitworth Art Gallery, Manchester School of Art, the Manchester Museum, the Palace Theatre, and Manchester Central Library (Manchester Urban Institute, no date). Additionally, the road features public buildings, office buildings, shops, hotels, car parks, residences, universities, churches, sports facilities, hospitals, and a train station, making it a daily route for a significant number of people. Simultaneously, Oxford Road

serves as the backbone of Manchester's innovation hub, known as the Oxford Road Corridor. This initiative involves collaboration between public and private sector partners to promote investments in academic excellence, research, and the commercialization of opportunities. This area has been established as a special hub for new research, incubation, science park facilities, important civic structures, public spaces, and cultural amenities, thanks to the presence of major institutions, including Manchester Metropolitan University (Manchester Met), University of Manchester (UoM), Manchester University NHS Foundation Trust (MFT), the Royal Northern College of Music (RNCM), and Manchester Science Partnerships (MSP)(Deloitte, 2018) (Figure 8).

***Figure 8**. Buildings functions on Oxford Road (Source: Author)*

Thousands of students, commuters, residents, and visitors utilize Oxford Road daily to access institutions and attractions. Approximately 42,000 residents live around the road, and it serves as the educational hub for 74,000 students studying at the campuses along Oxford Road. Manchester is home to Europe's largest student community, with two major universities, the University of Manchester and Manchester Metropolitan University, driving significant pedestrian and vehicular traffic throughout the academic year. Even during the summer term when the student population decreases, other major institutions such as the Central Manchester University Hospitals NHS Foundation Trust and the Oxford Road Corridor maintain the road's bustling nature. The Corridor alone employs 79,000 people, and over 2 million individuals visit the road annually to explore its diverse cultural attractions (Deloitte, 2019).

Urban heritage plays a crucial role in reflecting the characteristics of societies throughout history (ICOMOS, 1987). Furthermore, urban heritage contributes to place identity, provides psychological and aesthetic value, fosters cultural memory, and serves as an economic resource (Everard and Pickard, 1997). Historic buildings lend authenticity to a city's image, and a historical environment offers a unique urban experience. Oxford Road boasts several historical landmarks featuring different architectural styles, including Gothic, Baroque, Edwardian, Art Deco, Jacobean, and Renaissance

(Figure 9)(Historic England, no date). This diversity of urban heritage provides unique experiences for pedestrians in particular.

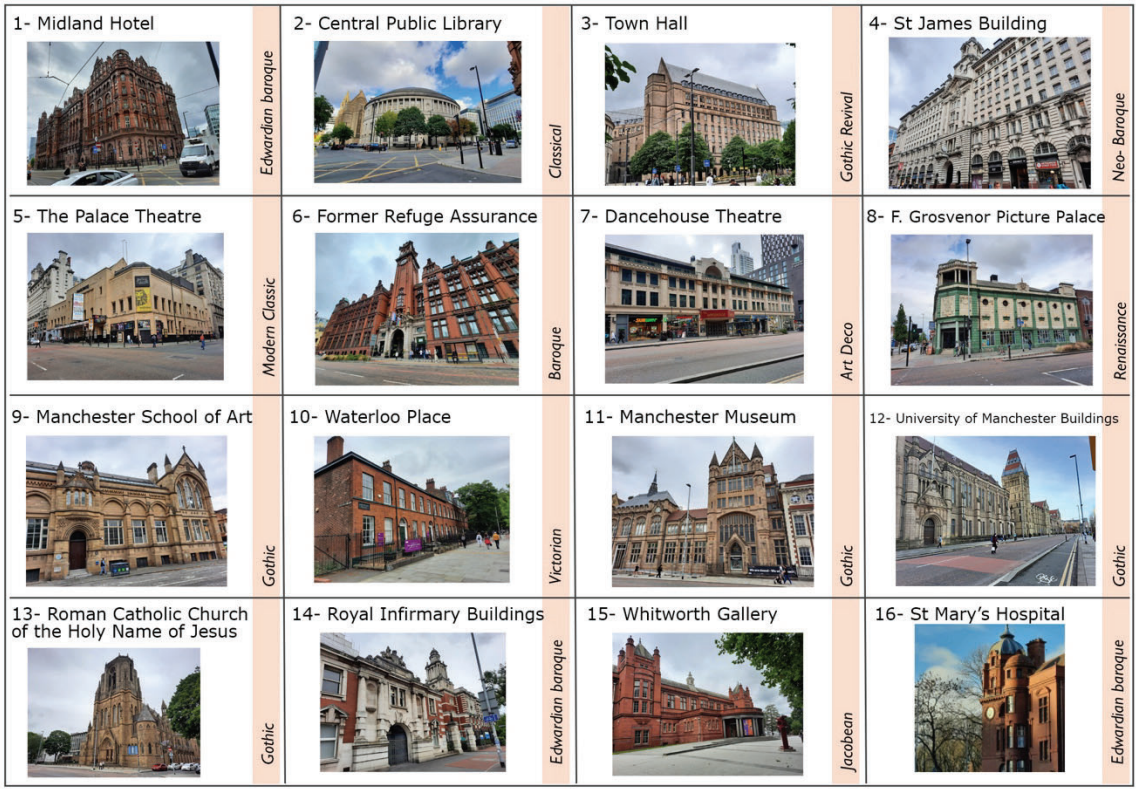


***Figure 9**. The table shows historical landmarks on the road and their architectural styles. (Source: Author)*

Regarding transportation modes on Oxford Road, the Metrolink line, Manchester's main light rapid transit system, intersects with Oxford Road at St. Peter's Square. Metrolink creates a vital connection between the road and the entire city. Additionally, Oxford station, located next to the road, is part of the national railway network, making access to the road easy for those traveling from outside the city (Figure 10).

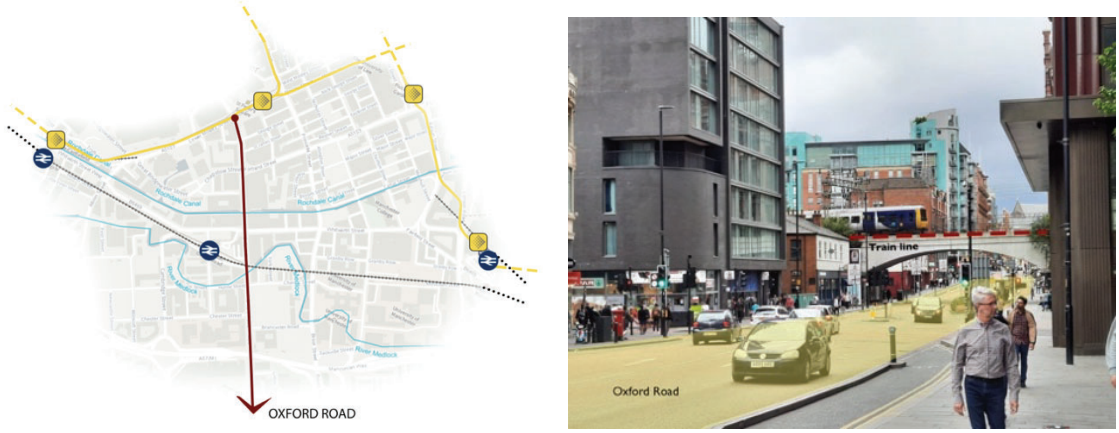


***Figure 10.** Metrolink and railway links on Oxford Road. (Source: Author)*

In 2017, Oxford Road underwent a significant transformation to address its heavy traffic congestion. During this time, it was reimagined as a pedestrian-friendly boulevard with restricted automobile access during specific hours. The stretch of road between Hathersage Road and Portland Street became exclusive to buses, black cabs, and cycles from 6 a.m. to 9 p.m. To create a more pleasant and environmentally friendly atmosphere, the road received wider pedestrian walkways and 'Dutch-style' cycle lanes, designed to enhance cyclist safety (Figure 11). Since the introduction of these separated bike lanes on Oxford Road in 2017, there have been over 500,000 cycling rides annually (*Oxford Road Corridor*, no date). The new 'bus gate' initiative encourages people to use buses, bicycles, and walking, resulting in a significant 95% reduction in general traffic on Oxford Road. By 2025, Greater Manchester aims to have up to 10% of all journeys conducted by bicycle (Transport for Greater Manchester, no date). Dutch-style cycle paths provide comprehensive and safe bicycle infrastructure, with design principles that prioritize cyclists' safety.

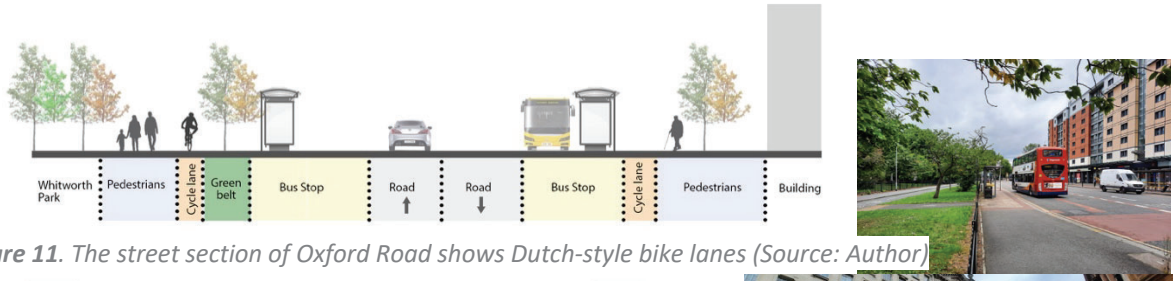


***Figure 11**. The street section of Oxford Road shows Dutch-style bike lanes (Source: Author)*

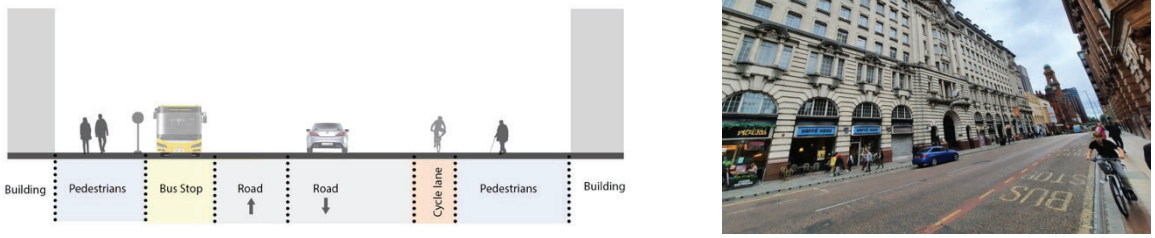


***Figure 12.** The street section of Oxford Road shows traditional bike lanes (Source: Author)*

Road is a two-lane road with a dedicated cycle lane. However, this lane isn't always clearly separated from the adjacent traffic by physical buffers. Both traditional bike lanes and one-way protected cycle tracks can be observed on the road (Figure 12) Despite the existence of separated bike lines, when looking at the data on bicycle accidents on the road between 2005 and 2020, it's evident that accidents are concentrated at intersections (Cycling Accidents in Manchester Map, no date). While cycle lanes and bike boxes at junctions are essential safety measures, they may not provide adequate protection for cyclists, who are among the most vulnerable road users due to their lack of physical protection compared to vehicle drivers.

Open public spaces are integral urban elements where people move about, gather, and engage in various activities. On Oxford Road, five open spaces will be examined in the scope of this case study: St. Peter's Square, All Saints Park, University Green, Brunswick Park, and Whitworth Park. These public spaces, serving as primary gathering points along this busy road, significantly influence pedestrian flows and are integral components of Oxford Road's mobility patterns (Figure 13).

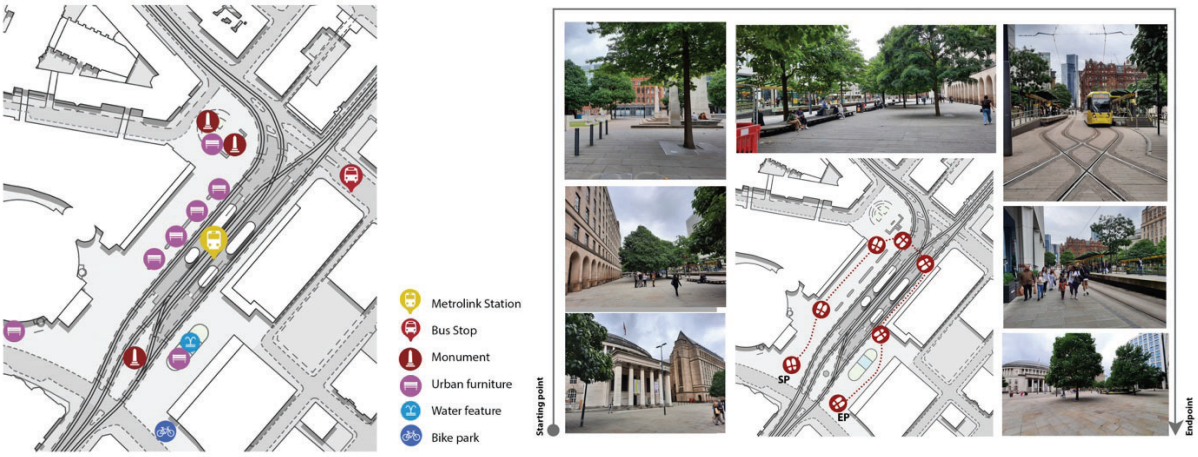


Figure 13 *St.Peter's Square, one of the open public space on the road, analyse by mapping and serial visions (Source: Author)*

OXFORD ROAD: SMART MOBILITY FRAMEWORK

Urban mobility is a critical concern for cities worldwide, and in response to changing global dynamics, cities are striving to create sustainable and livable environments. The rapidly expanding city of Manchester is no exception and must adopt a new approach to land use and transportation methods.

Figure 14 *Before and after street views according to our future visions (Source: Author)*

Oxford Road, a central transportation artery in the city, is integral to Manchester's transportation network, but its high congestion presents challenges. To address these issues, a paradigm shift in mobility is essential. In recent years, there has been a growing emphasis on walkability and bikeability in cities globally, driven by increased awareness of the environmental, social, and economic advantages of active mobility (Centre for Liveable Cities, 2016). This study proposes a smart mobility strategy that prioritizes active mobility in alignment with Manchester's transportation strategy. A radical change, such as pedestrianizing Oxford Road, is proposed.

- Private car and public transportation traffic on Oxford Road could be redirected to nearby main roads like Upper Brook Street and Higher Cambridge Street. Additionally, major intersections could be converted into underpasses to ensure uninterrupted pedestrian and cyclist flow along Oxford Road. Intersections are known to increase accident risks and reduce pedestrian comfort (Figure 14).

Figure 15 *Autonomous boats on Rochdale Canal (Source: Author)*

- Most of the buildings along Oxford Road serve public functions, including universities, hospitals, art galleries, shops, and restaurants. Given that the majority of users are students and employees, pedestrianizing Oxford Road would prevent the fragmentation of the Oxford corridor and create a more comfortable and safer urban environment for daily users.
- Several historical landmarks of Manchester are situated on Oxford Road, and traffic flows can have adverse effects on historical buildings. Vibrations caused by passing vehicles can damage structures due to foundation movement. Therefore, coordinating modern mobility systems with the protection of historical heritage is necessary (Bata, 1971). Air pollution also poses a significant threat to historical structures, leading to material deterioration, structural damage, and soiling. Pedestrianization is crucial for conserving urban heritage on Oxford Road.
- Designing suitable cycling infrastructure on the road encourages active mobility. Strengthening links between Oxford Road and public transportation will encourage cycling, even for those coming from the city's outskirts. Cyclist needs, such as charging stations and smart-controlled bike shelters, should be provided along the road.
- The river and canal can serve as alternative access routes to Oxford Road. Electric autonomous boats can reduce motor vehicle congestion in the city, offering a smart and environmentally friendly transportation mode (Figure 15).
- Personal Rapid Transit (PRT) vehicle lines could be introduced on Oxford Road. These small podcars would not disrupt the comfort of pedestrians and cyclists, especially for those with disabilities or the elderly.
- Oxford Road is home to numerous cafes, restaurants, and cultural activities. Pedestrianization would enhance the road's appeal and contribute to the local economic development.
- Open spaces along Oxford Road could be integrated into the proposed pedestrian promenade. Eliminating motor vehicles would slow down traffic, improving the safety and comfort of public spaces. According to Jane Jacobs, streets are the most vital public spaces in a city, and their safe use is an indicator of a successful city. Social interaction, an essential part of public life, would flourish in these gathering areas.

CONCLUSIONS

To conclude, Oxford Road possesses the potential to evolve into an iconic public space. The catalyst for this transformation lies in the concept of pedestrianization. Embracing an environmentally friendly and people-centric design approach, while considering the benefits of technological advancements, will serve as a cornerstone for our future vision in terms of smart mobility.

It's important to clarify that the perspective on smart mobility presented in this study departs from a purely technophilic approach. Instead, our notion of smartness for the city revolves around sound decision-making and the development of urban policies that prioritize human well-being, all enabled and enhanced by technology. In this context, technology for the city, encompassing elements such as Information and Communication Technology (ICT), the Internet of Things (IoT), real-time data analysis, and smartphone applications, functions as a valuable tool. Its purpose is not to be an end in itself, but rather a means to create a more livable and sustainable urban environment.

In essence, the aim is to use technology as a facilitator, empowering cities and their inhabitants to make informed choices, optimize resources, enhance mobility options, and ultimately foster a harmonious and vibrant urban ecosystem. By embracing this holistic perspective on smart mobility, we can envision Oxford Road not just as a transportation node but as a dynamic and improving public space that enhances the quality of life for all city dwellers.

REFERENCES

Albino, V., Berardi, U. and Dangelico, R. M. (2015) 'Smart cities: Definitions, dimensions, performance, and initiatives', *Journal of Urban Technology*, 22(1), pp. 3–21. doi: 10.1080/10630732.2014.942092.

Bata, M. (1971) 'Effects on buildings of vibrations caused by traffic', *Building Science*, 6(4), pp. 221–246. doi: https://doi.org/10.1016/0007-3628(71)90014-4.

Batty, M. *et al.* (2012) 'Smart cities of the future', *European Physical Journal: Special Topics*, 214(1), pp. 481–518. doi: 10.1140/epjst/e2012-01703-3.

Caragliu, A., del Bo, C. and Nijkamp, P. (2011) 'Smart cities in Europe', *Journal of Urban Technology*, 18(2), pp. 65–82. doi: 10.1080/10630732.2011.601117.

Centre for Liveable Cities (2016) *Walkable and Bikeable Cities: Lessons from Seoul and Singapore*. Centre for Liveable Cities, Singapore and The Seoul Institute.

Cullen, G. (no date) *Townscape*. New York: Reinhold Pub. Corp.

Deloitte (2018) *Oxford Road Corridor Strategic Spatial Framework*. London.

Deloitte (2019) *Oxford Road Corridor Strategic Regeneration Framework Guidance*. London.

Everard, Jackie and Pickard, Rob (1997) Can urban conservation be left to the market? The value of partnership-led conservation regeneration strategies. *International Series on Advances in Architecture*, 26. pp. 619-632. ISSN 1743 3509

Gehl, J. and Svarre, B. (2013) *Jan Gehl & Birgitte Svarre*, *How to Study Public Life*. Available at: https://tudelft.on.worldcat.org/oclc/865475474.

Giffinger, R. *et al.* (2007) *Smart cities: ranking of European mid-sized cities*, *Digital Agenda for Europe*. Available at: https://ec.europa.eu/digital-agenda/en/smart-cities.

Green, B. (2019) *The Smart Enough City: Putting Technology in Its Place to Reclaim Our Urban*. Massachusetts: MIT Press.

Groat, L. N. and Wang, D. (2013) *Architectural Research Methods*. New York: Wiley- Blackwell.

Historic England. (n.d.). [Website]. Retrieved from https://historicengland.org.uk/..

ICOMOS. (1987). Charter for the Conservation of Historic Towns and Urban Areas (Washington Charter 1987).

Jeekel, H. (2017) 'Social Sustainability and Smart Mobility: Exploring the relationship', *Transportation Research Procedia*. Elsevier B.V., 25(July 2016), pp. 4296–4310. doi: 10.1016/j.trpro.2017.05.254.

JMW Solicitors. (n.d.). Cycling Accidents in Manchester Map. [Website]. Retrieved from https://www.jmw.co.uk/services-for-you/personal-injury/cycling-accidents/page/cycling-accidents-manchester-map

Kitchin, R. (2015) 'Making sense of smart cities: Addressing present shortcomings', *Cambridge Journal of Regions, Economy and Society*, 8(1), pp. 131–136. doi: 10.1093/cjres/rsu027.

Lyons, G. (2018) 'Getting smart about urban mobility – Aligning the paradigms of smart and sustainable', *Transportation Research Part A: Policy and Practice*. Elsevier Ltd, 115, pp. 4–14. doi: 10.1016/j.tra.2016.12.001.

Manchester Urban Institute (no date) *Stories from the Road*. Available at: https://www.mui.manchester.ac.uk/connect/stories-from-the-road/.

MUD (2020) *MUD-Lab Toolkit: Serial Vision*.

Oxford Road Corridor (no date). Available at: https://oxfordroadcorridor.com/ (Accessed: 23 August 2021).

Silva, B. N., Khan, M. and Han, K. (2018) 'Towards sustainable smart cities: A review of trends, architectures, components, and open challenges in smart cities', *Sustainable Cities and Society*, 38(January), pp. 697–713. doi: 10.1016/j.scs.2018.01.053.

Transport for Greater Manchester (no date) *Active Travel*. Available at: https://activetravel.tfgm.com/ (Accessed: 25 August 2021).