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EFFECT OF POP-UP CYCLE PATHS IN BRISTOL, UK

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Este documento foi escrito no idioma Inglês Britânico.

To my family.

"An endless number of green buildings don't make a sustainable city."

Jan Gehl

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ABSTRACT

Within the broader concept of tactical urbanism, the pop-up initiative has been created to test spaces that value the individual and active modes within the urban environment. In this context, pop-up cycle paths are low-cost and quick urban experiments to implement cycle lanes to encourage bicycle usage by the population. During the first year of the Covid-19 crisis, the pop-up initiative was used by several countries to prevent the increase of car use and create new incentives for active mobility modes through a modal shift.

This dissertation explores a specific pop-up cycle lane initiative implemented in Bristol, UK, focusing on the effectiveness of these cycle lanes to new cyclists. For this purpose, the research was based on case study research and previous manuals on pop-up schemes.

The methodology developed aims to assess the behaviour and opinion of cyclists about the new infrastructure. Thus, the development of data collection was performed by monitoring the implemented pop-up bicycle lanes, applying a survey to bicycle users in the city and concluded by conducting interviews to the focus group of the study, cyclists who changed their behaviour after the implementation of the temporary cycle lanes.

The results about implementing the pop-up cycling network in Bristol suggest that the city deserved a better definition of the objectives for each section, along with better project design regarding the location and execution of the pop-up infrastructure to ensure better connectivity between the cycle lanes. In addition, it was perceived a great interest from the population to expand the cycling network beyond the urban centre and participate in the Bristol city council's decisions to build a more sustainable urban mobility network.

KEYWORDS: Pop-up cycle path, Tactical Urbanism, Modal Shift, Active Mobility Modes, Bicycle.

RESUMO

Dentro do conceito mais amplo do urbanismo tático, a iniciativa pop-up foi criada para testar espaços que valorizam o indivíduo e os modos ativos dentro do ambiente urbano. Neste contexto, as ciclovias pop-up são experimentos urbanos de baixo custo e com rápida implementação, a fim de incentivar o uso de bicicletas pela população. Durante o primeiro ano da crise do Covid-19, a iniciativa pop-up foi utilizada por vários países para evitar o aumento do uso do carro e criar incentivos para os modos de mobilidade ativa através de uma mudança modal.

Esta dissertação tem como objetivo explorar a iniciativa de ciclovias pop-up implementadas em Bristol, Reino Unido, concentrando-se na eficácia das ciclovias temporárias para trazer novos utilizadores da bicicleta. Para este fim, a pesquisa foi baseada em estudos de caso e manuais anteriores sobre esquemas pop-up.

A metodologia desenvolvida visou avaliar o comportamento e a opinião dos ciclistas sobre a nova infraestrutura. Assim, o desenvolvimento da coleta de dados foi realizado através do monitoramento das ciclovias pop-up implementadas, seguido da aplicação de um inquérito aos usuários de bicicletas na cidade e concluído com a realização de entrevistas ao grupo de ciclistas que mudaram seu comportamento após a implementação das ciclovias temporárias.

Os resultados sobre a implementação da rede de ciclismo pop-up em Bristol sugerem que a cidade merecia uma melhor definição dos objetivos para cada secção, juntamente com um melhor projeto para escolha da localização e execução da infraestrutura pop-up, de modo a garantir uma melhor conectividade entre as ciclovias. Além disso, foi percebido um grande interesse da população em expandir a rede de ciclovias para além do centro urbano e participar das decisões do conselho municipal de Bristol na construção da rede de mobilidade urbana mais sustentável.

PALAVRAS CHAVES: Ciclovia Pop-up, Urbanismo Tático, Mudança Modal, Modos de Mobilidade Ativa, Bicicleta.

INDEX

INDEX OF FIGURES

Index of Tables

1

INTRODUCTION

The proposal to rapidly implement temporary cycle routes exists since the 1970s, as a way to give priority to active modes of mobility over cars in the urban environment. The concept of pop-up bicycle paths is derived from portable architecture, which uses easily accessible and low-cost materials to build cycling infrastructure. This new network of temporary bicycle paths is justified as a form of urban experience related to Tactical Urbanism. In this way, the municipality can test in practice the bicycle paths and analyse the efficiency of the route; then, depending on the proven efficiency, the bicycle paths can be made permanent or removed from the streets.

1.1. THEORIC BACKGROUND

On December 31st, 2019, a new strain of Coronavirus (Covid-19)[1] was discovered in Wuhan, China. The WHO declared the Coronavirus outbreak a Public Health Emergency of International Concern on January 30, 2020. As a result, on March 11th, 2020, the COVID-19 outbreak was declared a pandemic, with more than 200 countries worldwide reporting cases. By the end of 2020, Europe would be confronted with the virus's second wave.

Compared with previous pandemic crises, the Covid-19 outbreak has affected countries much faster. An explanation is a quick transmission aided by different sorts of transportation facilities. According to Lai et al. (2020), scientists have demonstrated that the virus can survive on metal and plastic surfaces for several days without proper sanitation measures. In this sense, modes of transportation have enabled two faster ways of spreading the coronavirus: first, among transport-sharing users and then spreading to other locations; second, transportation itself may be a contagious environment.

Because of the high contagion rates and rapid increase in the number of deaths, many countries decided to change citizens' behaviour by implementing national lockdowns and reducing public transportation users. As a result, the Covid-19 pandemic has significantly impacted urban transportation; meanwhile,

[1] W.H.O (2020). Retrieved from: *https://www.who.int/docs/default-source/coronaviruse/situation-reports/20200130-sitrep-10-ncov.pdf?sfvrsn=d0b2e480_2/.*

residents' mobility has been limited by travel restrictions, stay-at-home orders, and the temporary closure of all unnecessary establishments.

However, Lai et al. (2020), explains that public transport cannot be closed down completely, mainly because all the essential workers that count on public transport to get to their workplaces are less likely to work from home. The pandemic situation affected the maintenance of public transport once the functionality of this mode is to allow as many people as possible to move around together, working at total capacity, a concept that cannot be applied during social distancing measures. Thus, a lack of safe modes of transportation at the start of the pandemic outbreak could cause the population to shift from public transportation to private cars, causing a setback in the development of sustainable mobility.

According to Ammelband (2020), during the first lockdown, Santander, Spain, saw a decrease in public transportation and a 78 % decrease in motorised private transport use. The same author also notes that the perception of hygiene in using private cars instead of public transportation does not account for the disadvantages: car accidents, money, and time spent on parking. To that end, city managers, transportation planners, and urban planners should strive to provide better and safer alternatives to the widespread use of automobiles, which is undesirable due to the visible side effects (UNECE, 2020, as cited in Lai et al., 2020).

Furthermore, Warren & Skillman (2020), as cited in Ammelband (2020), analyse the average daily distance travelled during the Covid-19 pandemic using cellular data and conclude that travel distance per person has decreased significantly in many cities. Singapore, for example, reduced its daily travel distance from 3.6 km before the outbreak (24.01.2020) to 1.5 km after the first restriction measures (27.01.2020), a 58 % reduction. Following the survey, Hong Kong experienced a similar outbreak timing as Singapore; the distance decreased from 3 km per person daily to 0.18 km per person, resulting in a 92% reduction in travel time. Another example, New York City, declined from 5.2 km (02.03.2020) to daily 0.031 km per day (23.03.2020); it means a fall of 99% from the average daily distance travelled.

According to the Secretary-General of the United Nations, as cited in Ammelband (2020) and previous research findings, despite all of the harmful effects of the Covid-19 pandemic, it could also be a window of opportunity to rethink and shape people's mobility patterns. According to Teixeira and Lopes (2020), active mobility modes could be a way to manage options to the overcrowding risk of infection as well as a lifeline to meet the mobility needs of urban residents. As a result, governments needed to develop safer public transportation to recognise the importance of providing transportation to essential workers.

With this desire, many countries worldwide began to reshape the city's cycling infrastructure. As shows in Figure 1, the aims of some of the areas studied in this dissertation literature review, which had developed relevant length of pop-up cycle paths during the first year of the Covid-19 pandemic. The empty streets within cities enabled a change in street design by constructing new temporary cycle lanes, also known as pop-up cycle lanes, which are seen as a sustainable and low-cost way to recover the city following the pandemic event. According to Ammelband (2020), these changes were only possible during the Covid-19 pandemic, allowing for rapid improvements in cycling facilities, for example, in Berlin. Over the pandemic, other cities, including London (Lovelace et al., 2020) and Paris (Dunning & Nurse, 2020), made significant progress in building pop-up lanes and expanding permanent cycling infrastructure.

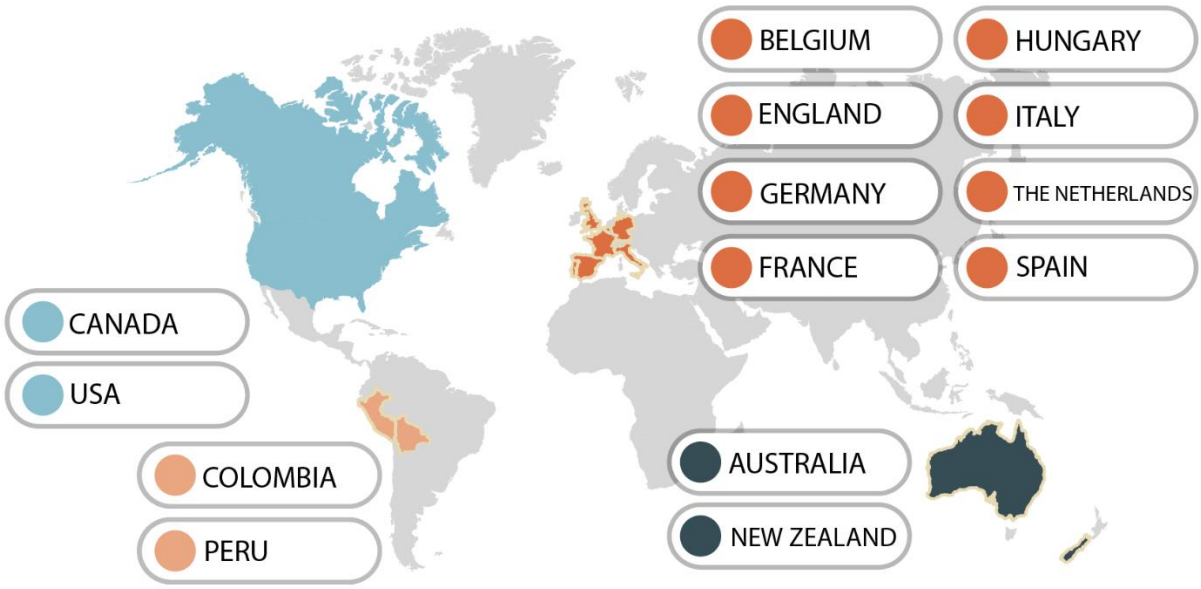

Figure 1 – Countries that had relevant development of pop-up cycle paths during the first year of pandemic. Source: Elaborated by the author from the data provided by Ammelband, S. (2020), Bauer et al. (2020), Dunning & Nurse (2020), Kraus & Koch (2020), and Lovelace et al. (2020).

In this context, Bauer et al. (2020) report that in Germany, car traffic has nearly returned to pre-pandemic levels by the end of summer 2020, while public transportation (bus and tram) has 20% fewer passengers per kilometre than before the pandemic. On the other hand, since the government began incentivizing active mobility and developing new pop-up facilities, bike traffic in the city has increased by approximately 90%. Such evidence suggests that active mobility modes could be a viable option for inhabitant mobility rather than public transportation or private automobiles.

Using Google's "COVID-19 Community Mobility Reports" data, the study case of this research, Bristol, UK, experienced a significant decrease in the percentage of public transportation users and journeys to workplaces compared to the baseline. Even with the relaxation of lockdown measures, the average number of people using public transportation fell by -73% in December 2020 compared to the previous year, and this number is still -45% lower in May 2021. Some of the data suggest that, as a result of the pandemic, a sizable proportion of the community is still working from home. To encourage people to use active mobility safely, the government has also planned to install pop-up cycle infrastructure in Bristol in late summer 2020, which could be used for outdoor exercise and shopping for necessities.

1.2. RESEARCH QUESTION AND OBJECTIVES

The dissertation aims to study the impact of pop-up cycle lanes on cycling levels in the city based on theoretical background. Whether from establishing this new cycling infrastructure, more people would increase their confidence when cycling in busy urban areas. In this perspective, the main objective is to analyse the effectiveness of pop-up cycle lanes as a relevant factor to motivate new bicycle users. This study focused on temporary bike lane implementation projects in Bristol, South West England, between August 2020 and April 2021.

In order to achieve the general objective of the research, the following specific objectives were established:

- Explore the implementation process of the temporary cycle lanes;
- Perform a critical analysis from the perspective of the author and cyclists of the city regarding the quality of the implemented infrastructure;
- Identify whether there have been modal shifts to cycle modes after the period when the temporary cycle lanes were installed.

The rationale for studying temporary cycle paths comes from the possibility of reaching more bicycle users in the city context. Furthermore, new cycle facilities could be a quick method to test new routes for prioritising active modes without much government investment. The results obtained in this study may answer fundamental questions about implementing new cycling structures in the urban environment.

1.3. DISSERTATION STRUCTURE

The project began with the current theoretical background of the pandemic, in which several countries decided to implement temporary cycle paths to provide more space for urban mobility during the crisis. As a result, the work provides evidence of changes in mobility levels worldwide during the pandemic period. In addition, it discusses an analysis of pop-up cycle lanes in Bristol as part of an emergency application aimed at increasing levels of active mobility in the city centre. The study will examine the effects of this infrastructure's implementation on population modal behaviour, looking into possible changes in commuting and modal shift as well as attempting to understand popular satisfaction with the new active mobility infrastructure. Following the study concept, Chapter 2 of this dissertation project (1) began to investigate pop-up cycle lanes as an alternative to improving the transportation system within cities in other outbreak situations, (2) followed by an explanation of the temporary cycle paths as part of the Tactical Urbanism, demonstrating the purpose of these facilities and examples of this movement before the pandemic, (3) Finally, projects related to the expansion of the urban cycle network via pop-up routes developed during the pandemic outbreak, as a method to support active mobility modes, with comparisons to the case study. Chapter 3 explains the development of the research methodology, (1) beginning with the local demonstration of the case study, national and municipal urban projects, and a focus on the execution process of the city's pop-up cycle lanes; (2) following that, the chapter will detail the methods used for the development of the research. Chapter 4 will analyse the data collected from (1) the perspective of the temporary bicycle path implementation process, (2) the evaluation of the quality of the new infrastructure from the perspective of the researcher, the population, and the interviewees, and (3) from the answers collected, verify if the objectives set for the temporary bicycle paths were met from the perspective of the researcher, the population, and the interviewees. Lastly, Chapter 5 will bring the research to a close-by, determining whether infrastructure has been evaluated to affect the urban context of Bristol positively. Figure 2.

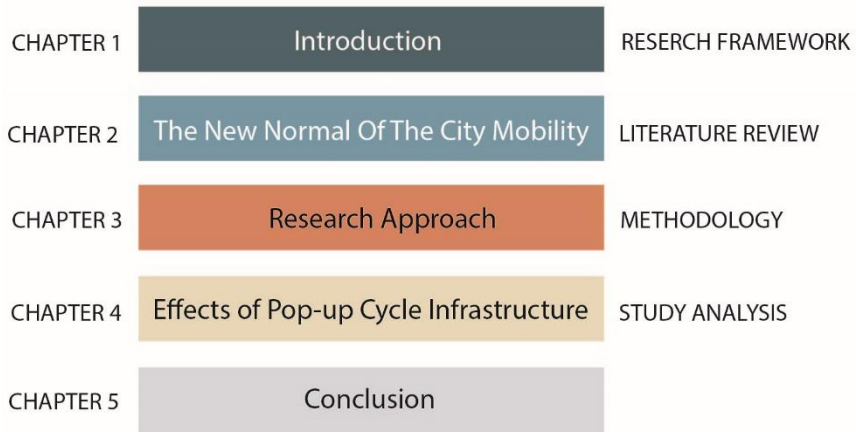

Figure 2 – Research framework scheme.

2
THE NEW NORMAL OF THE CITY MOBILITY

This chapter aims to present the course that urban mobility has taken since the beginning of the Covid-19 pandemic, establishing planning strategies to support the active mobility in city centres. Thus, based on the global events of the outbreak and the state of lockdown established in 2020. This chapter will present the consequences of the impact of the pandemic on urban mobility, emphasising the importance of the active modes within urban centres as a measure to encourage sustainable mobility. Consequently, indicating the strategies created by countries before and after the pandemic can serve as mobility solutions during urban crises and explain the need for change in urban planning strategies that must occur for a better post-pandemic urban transport scenario. The following timeline illustrates the evolution of the Covid-19 pandemic until the peak of the change in population mobility behaviour, which occurred with the beginning of the lockdown measures. Figure 3.

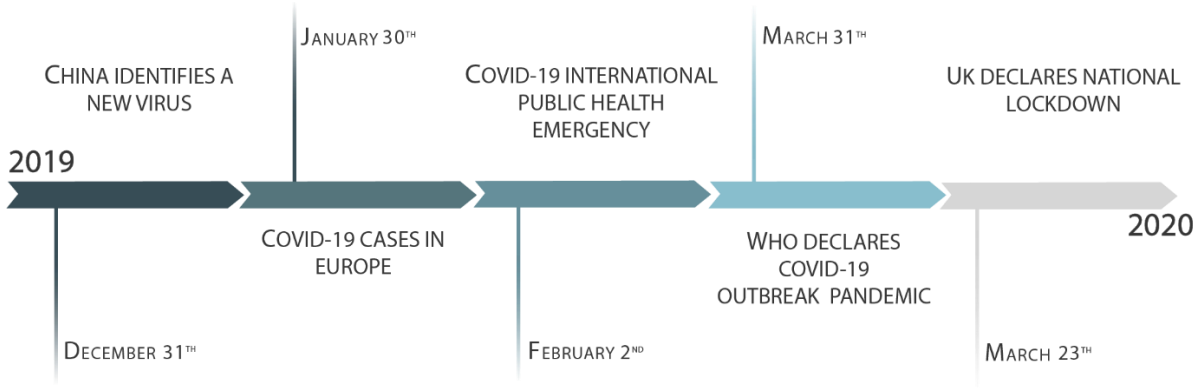

Figure 3 – Timeline of events related to the Covid-19 outbreak. Source: Elaborated by the author from the data Go.uk (n.d.).

2.1. ACTIVE MOBILITY INFRASTRUCTURE AS A TOOL TO ENHANCE THE TRANSPORT NETWORK

Besides the increase of private cars used over the years, the pandemic outbreak has clarified the necessity for different commuting modes in the environment of the city. Teixeira & Lopes (2020), evidenced that one of the main reasons people shifted to e-bikes in China during the 2002–2004 SARS outbreak was to avoid the overcrowded public transport services. This example helps recognise that a significant number of people tend to avoid using the public transport system to protect themselves during public health crises. In this perspective, governments worldwide have invested in sustainable temporary infrastructure to increase levels of active mobility modes. Cycling has been an alternative to urban

mobility during the Covid-19 outbreak, mainly because active mobility allows citizens to maintain social distance measures during their essential journeys. In addition, improving sustainable infrastructure in cities could be an opportunity to minimise modal shift to motor vehicles and enhance issues of public transport overcrowding.

> At a time when governments are committing large finances to rail upgrades to take larger and faster trains, and roads are being widened to enable more rapid car transit, it turns out that existing transport infrastructure can be repurposed rapidly and at low cost to support safe transit and reduce the burden of a global pandemic. Whilst the opportunity is present, to make a lasting change will require a significant amount of planning. (Dunning & Nurse, 2020).

Deponte et al. (2020), states that during the Covid-19 pandemic, the percentage of individual vehicles will increase in the environment of cities. In contrast, Lock (2020), identified the increased cycling potential of the population during the same period in Sydney, showing different behavior between cities concerning the decision to use active mobility modes. Both authors agree that, during the pandemic outbreak, the levels of public transport users will decrease. On that purpose, the governments should incentive the shift from the private vehicle to the soft mobility modes, focusing on creating new infrastructures, such as the pop-up lanes infrastructure. Therefore, this topic aims to bring evidence that active mobility modes can be a strategy to develop a wider network of sustainable urban mobility.

2.1.1. ACTIVE MOBILITY INFRASTRUCTURE AS AN ALTERNATIVE TO THE OVERCROWDED PUBLIC TRANSPORT SYSTEM

Although Teixeira & Lopes (2020), explain that high levels of transport are the principle for any sustainable public transport system. However, overcrowded public transport has been a government concern along with increasing Covid-19 transmission rates. Therefore, after the pandemic events, governments recognised that active mode investment could be a model for sustainable mobility and a good alternative for the efficient functioning of public transport.

Teixeira & Lopes (2020), affirm that cycling has been viewed as a pandemic mobility resolution because of the high versatility and the easy placement in a small percentage of the existing roads networks, which is usually exclusively occupied by vehicles. The idea of a temporary form of bicycle infrastructure was spread worldwide once it was confirmed that it could be built as quickly as possible to provide efficient urban mobility in an emergency context. The pop-up cycle lanes focus on increasing safety and urban mobility opportunities with a zero-emissions modal. Besides that, the area designed for the bicycles - *cycle lanes* - do not require much investment and urban planning work, such as motorised vehicles infrastructure. Moreover, cycle lanes can also be a space for other active modes, like e-bikes and electric scooters.

Mattsson & Jenelius (2015), illustrate that disruption in urban areas often leads to traffic congestion, affecting all transportation sources. Therefore, events such as natural disasters, public transport, or urban logistics strikes normally directly affect the urban mobility. The author argues that by establishing an efficient cycling network, the resilience in the urban transport system can be enhanced, as this is vital to maintain the functions of transporting people and goods within urban centres.

Ammelband (2020), also debate that the bike lanes network can help change urban mobility perception. This argument is associated with the increase in the number of bicycles following the redistribution of

traffic in planned neighbourhoods, generally resulting in more livable and safer areas. As an outcome, cycling can provide an essential network, allowing a flexible transport solution, mainly for short and medium distance travels, a characteristic that applies to travel distances within European cities.

As an example of a mobility disruption, Saberi et al. (2018), studies the impact of the use of the Bike Sharing System (BSS) as of active mobility mode over the strike on the London Tube on July 9th, 2015. The authors create a comparative analysis of BSS mobility patterns before, during, and after a disruption in the system, discovering that London's total number of bicycle-sharing travels increased by 85% from the average trips per day. The distance of the trips also increased by 88%, from an average of 23 minutes to 43 minutes. The author confirms that bicycle mobility mode could potentially relieve the load in the public transport and increase the resilience of the transportation network system during disruptive events.

The significant increase in bicycle travels over the tube strike in London indicates that active mobility, in some cases, can be less affected than motorised transport over the city's disruption. Martin & Shaheen (2014), indicate that the increase in active mobility usage could substitute shorter trips that could be completed by rail or bus in a few stops, decreasing the number of trips made only by public transport. The author assumes that active mode could also generate new travel opportunities for the population across the city when connected with public transport.

Although there is not enough research to prove a high level of infection in public transport, measures to reduce the number of passengers per trip on public transport have emerged as a way to reduce the levels of coronavirus infection of the population. In this regard, governments have also decided to invest in infrastructure for active mobility modes and allocate public transport to those who cannot make the modal shift to active modes. Teixeira & Lopes (2020), exemplifies the decline in public transport use, showing that at the end of March 2020, the New York City underground system had an average of 500,000 daily trips, compared to the standard of almost 5.5 million. This translated into a reduction in the number of trips of around 90%.

Kraus & Koch (2020), mentions that in 2019, over 3 million electric bicycles were sold in the European Union. The author states that more than 50% of overall trips in Europe are shorter than 5 kilometres, being a perfect opportunity to encourage more people to cycle. Moreover, the increase in people cycling could expand bicycle-friendly areas in cities; since the larger the presence of bicycles on the streets, then the more likely it is that drivers will be on alert, consequently, there will be fewer accidents involving cyclists.

The decision to encourage an active mobility mode such as the bicycle brings in itself a significant point of encouraging the use of public and private transport only to reach long distances. While the development of infrastructure that supports active modes of mobility, such as pop-up bike lanes, can bring more confidence to the population to move safely around the city to their usual short-distance destinations.

2.1.2. ACTIVE MOBILITY INFRASTRUCTURE AS AN ALTERNATIVE TO TRAFFIC CONGESTION

Cervero et al. (2017), reveals that inspired by Latin American cities (Curitiba and Bogota), the Mayor Myung-Bak Lee (2002-2006) had a vision for Seoul in South Korea, to prioritising people over cars as a perspective for his urban management. Even before the pandemic outbreak, the South American cities were already carrying out projects to change the urban scenario, encouraging the transformation of the roads where the priority is now given to the cars and change for spaces that represent people.

To prove that cities lose a sizeable urban area by prioritising cars over active modes, Lehmkühler et al., 2020, compared the area occupied by car parks in large urban areas to justify the implementation of pedestrian streets project in Berlin. The authors' research found that the parking area in London occupies the equivalent area of 10 times the Hyde Park area, also in New York City, the car parking area occupies over 13 times the area of Central Park. This kind of information puts into perspective the targets of achieving 80% of all journeys made by walking, cycling, or public transport by 2041 in London. Jäppinen et al. (2013) also demonstrate that despite the quality of public transport, Helsinki, Finland, evidences a rise in private car numbers, consequently increasing traffic congestion and parking issues. These examples show that even cities with successful public transport systems experience dilemmas with car traffic.

In a research on the lack of bike infrastructure, Dunning & Nurse (2020), analyse the investments made by the English government in transport infrastructure between 2018 and 2019. In these, approximately £480 was spent on transit infrastructure per person, compared to £6 on cycling infrastructure[2]. According to the English national survey, the contradiction of these investments exists because around 40% of all urban journeys made in 2017-2018 were less than 2 miles distance[3]. Furthermore, Palominos & Smith (2020), state that active and sustainable modes (walking, cycling, and public transportation) account for 63 % of journeys in London streets in 2018. Ignoring the fact that active mobility represents for about half of all British commutes, public financing has focused on increasing automotive infrastructure rather than soft and sustainable facility modes in past decades. From the perspective of the urban mobility network, higher investment in traffic facilities demonstrates how ineffective the tax distribution system is at supporting sustainable modes.

As a response, temporary cycling infrastructure is being deployed as a cost-effective option for urban areas to reduce the consequences of urban traffic by boosting modal shift initiatives in cycling-friendly environments. In a study conducted in New York, Faghih-Imani et al. (2017) compared the bike system to taxi rides and regular automobiles. In comparison to taxi travels, the research reveals that bicycles can be a competitive mode of transportation, notably during weekday mobility, a faster mode of displacement at peak hours, short travel time, and distances up to 3 km. Following that, Hamilton & Wichman (2018) provide an example of a low-cost alternative in Washington, DC, where the Bike Share System (BSS) helped reduce traffic congestion by 4% while also boosting the efficiency of transportation choices improving accessibility within the metropolitan area.

Martin & Shaheen (2014), studies also suggest that cycling could be an attempt at modal shift initiatives. Cycling, in general, was found to be a faster mobility mode during short-distance trips during traffic congestion compared to taxi rides, driving private vehicles, and public transportation displacement. This perspective demonstrates that implementing infrastructure to encourage active mobility modes, particularly cycling, could be an opportunity for reducing traffic congestion in urban areas because it requires less investment and road space while providing better traffic flow.

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[2] HM Treasury Public Expenditure Statistical Analyses (PESA), 18 July 2019. Retrieved from: https://www.gov.uk/government/collections/public-expenditure-statistical-analyses- pesa (HM Treasury, 2019, *as cited in* Dunning & Nurse, (2020));

[3] Department of Transport, Statutory guidance, Traffic Management act 2004: network management in response to COVID-19, 13, may 2021. Retrieved from: https://www.gov.uk/government/publications/reallocating-road-space-in-response-to-covid-19-statutory-guidance-for-local-authorities/traffic-management-act-2004-network-management-in-response-to-covid-19 (Updated 25, February 2021);

2.2. STRATEGIES TO BOOST THE LEVELS OF ACTIVE MOBILITY MODES

As previously stated, the countries' primary concern about urban mobility is that normal operating levels of public transportation may contribute to the spread of the Covid-19 virus throughout cities. Many countries have begun to invest in quick actions to promote active mobility since the start of the pandemic outbreak (e.g. walking and cycling). It is regarded as a secure solution for maintaining mobility logistics during the Covid-19 pandemic. As a result, cycling and walking may be a viable alternative to accessing essential services such as the pharmacy, groceries, and household necessities for those without access to a private vehicle and for whom public transportation is dangerous. In this context, the following topic will address urban infrastructure and technological experiences that can help reduce mobility barriers and increase levels of active mobility.

> Many European cities are taking steps to make active mobility (e.g. walking and cycling) a safe and more attractive mobility option during the Covid-19 outbreak. Urban areas could consider temporary enlargements of pavements and increased space on the road for active mobility options to facilitate the needs of the population to move in a safe and efficient way, while reducing speed limits of vehicles in increased active mobility areas". (European Commission, 2020, p.15, as cited in Deponte, Fossa, & Gorrini, 2020)

Will Norman, the London Cycling and Walking Commissioner, stated in a speech cited by Dunning & Nurse (2020), that investment in new modes of active mobility is necessary for cities. The UK government's decisions reflect a new approach that most countries are taking to address the pandemic's mobility issue. The country is focusing on implementing active modals strategies to address healthy, low-cost urban mobility in traffic. The general solutions are to widen the pedestrian pavement and create vehicle-free zones to create temporary lanes designated for active mobility modes.

Lehmkühler et al. (2020), describes today's cities as built around private car traffic when pedestrians and cyclists are highly marginalised. The perceived space occupied by motorised traffic compared to pavements or public areas demonstrates that cities do not have enough space to adhere to the new distance to health and safety rules during the pandemic. As a result, urban planners and decision-makers have faced the challenge of reducing the space allocated to motorised transport while creating appealing spaces for people to use sustainable transportation modes.

According to Lai et al. (2020), walking and cycling increased during the pandemic. Walking is, in fact, the most democratic mode of transportation. This mode of transportation, by definition, connects all other types of mobility modes at the start or end of any journey. To encourage walking, a comprehensive, safe, and well-connected network of pedestrian-friendly paths are required. Deponte et al. (2020), refer to three fundamental elements that evaluate the level of the walkability of urban environments:"*(i) presence of services within a walkable distance; (ii) level of comfort and safety experienced by pedestrians; (iii) attractiveness of the urban areas in terms of architectural design and social context"*.

Throughout the lockdown, countries such as the United Kingdom developed active modes of exercise that could replace gyms and indoor exercise facilities if they remained closed. Furthermore, an increase in outside physical activity in a safe cycling environment may contribute to the development of a liveable neighbourhood; however, high-speed vehicle obstruction on roads in family areas may limit the ability to interact socially with friends and neighbours. According to Jacobs' theory of eyes on the street, creating the prospect of a safer environment aids in the creation of a warm sense of community, which

is necessary during the lockdown period and can permeate and qualify urban liveability. Such community planning strategies will be critical for cities severely impacted by the coronavirus.

Furthermore, when combined with arguments about air pollution, it is clear that encouraging cycling and walking has both individual and population-level benefits. Active modes of transportation, along with public transportation, are critical components of sustainable urban mobility. According to Cervero et al. (2017), cities will improve sustainable forms of connectivity by enforcing road contractions on transportation infrastructure, creating new pedestrian zones, and fine-grained networks for bike paths and sidewalks.

Finally, the NACTO manual (2020) acknowledged the need to rethink street infrastructure to incentivize cycling and walking as a sustainable mobility network. These strategies could function as tools to respond to the demand for social distance while encouraging active mobility modes, thus creating alternatives to the shared transport system without encouraging increased vehicle use. In parallel, these low-cost strategies will help improve the urban traffic environment after the pandemic event or just the perception that such a change is necessary.

2.2.1. STRATEGIC PLANS FOR PRIORITISING ACTIVE MOBILITY MODES

The experience of transforming cities into more bike-friendly environments did not occur after pandemic crises. Worldwide tools and urban projects are attempting to alleviate the city's traffic problems before Covid19. Traffic calming, for example, has been proposed in some European cities to slow traffic speeds and reduce reliance on private cars. According to Cervero et al. (2017), this concept was first implemented in Dutch cities, where planners and engineers installed speed bumps, realigned roads, shortened intersections, and planted trees and flower pots in the middle of streets slow traffic. Consequently, developing the streets to become an extension of a neighbourhood's livable space.

According to Cervero et al. (2017), some European communities have used the cellular neighbourhood design concept to reduce traffic congestion. Outside the cells, vehicles use roads with roundabout intersections; the intern connections, on the other hand, are reserved for cyclists and pedestrians. Central Gothenburg, Sweden, was one of the first cities to implement cellular urban design and block traffic. A recent master-planned community with a butterfly-like physical layout is located in Houten, The Netherlands, south of Utrecht. Because active mobility modes account for more than half of all trips, car use is reduced. Since the community does not require cars, it has up to 25% lower car use than similarly sized Dutch cities, resulting in one-third of the average traffic accidents. The Houten example also resembled the Car-Free district strategy, which is common in many older European cities where the narrow and winding inner-city streets were never designed for motorised traffic. Figure 4.

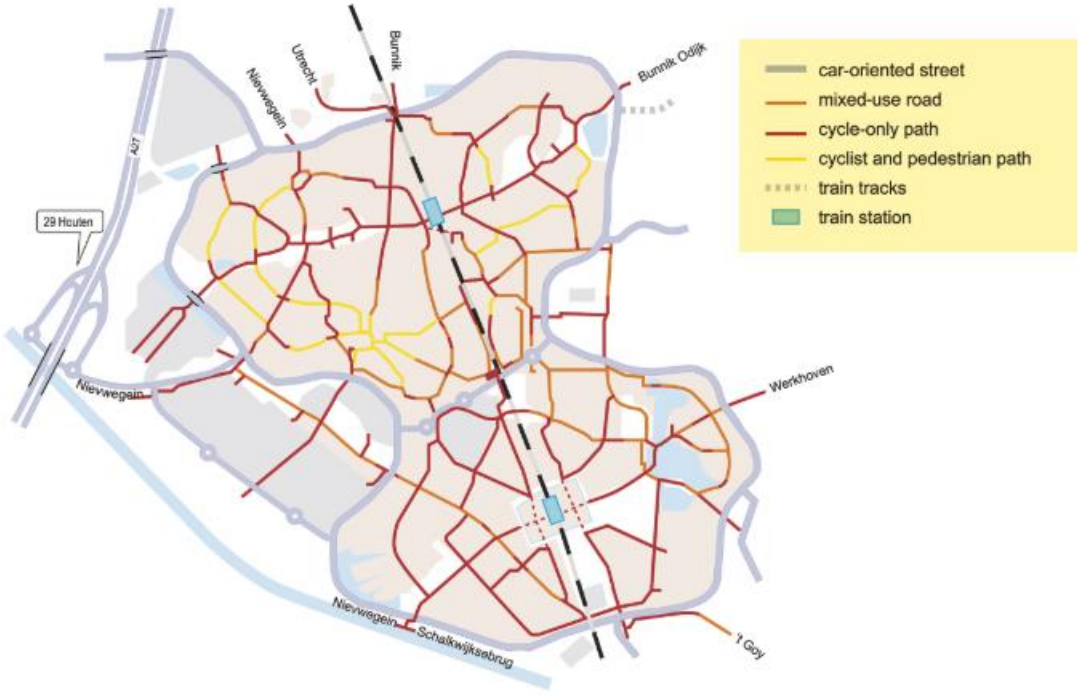


Figure 4 – Street layout and cellular design of Houten, the Netherlands by Municipality of Houten. Source: Cervero et al. (2017).

Cervero et al. (2017) use Barcelona as an example of a different Car-Free district strategy. Pedestrians and cyclists have priority inside this Spanish city's superblock areas. Residents' car access is limited to delivery drivers and emergency vehicles, which are monitored by access points and retractable bollards. The same strategy was used in Cambridge, England. Instead of using bollards, cameras were installed to control entry to the city's historic core.

According to Lehmkühler et al. (2020), after a significant urban project in Berlin, the reduction of oversized roads and parking spaces frees up land for much-needed urban green spaces and public areas throughout the cities. This statement stems from the agreement that these areas play an important role in social life by providing desirable living quarters and vibrant public spaces where people can meet. Furthermore, Palominos & Smith (2020),) show that pedestrians aggregate 65% more capital than drivers on average per month, demonstrating an excellent value on London's pedestrian-oriented streets based on suggested research.

In particular, Dunning & Nurse (2020), cites that after two years of project planning in 2017, the city of Ghent, Belgium, implemented an entire cycling infrastructure in just one weekend, a similar proposal as the temporary bike lanes that have been implemented in the early days of the Covid-19 crises. According to the same author, the goal of this urban project was to designate cycling routes by directing traffic through distinct city zones. Ghent's planning goal was to reorganise the streets, clarify cycling-priority areas through repainted streets, and add concrete bollards used as a barrier to prevent vehicles from accessing the bike lanes and protecting cyclists. The link between the Ghent planning project and the Covid-19 mobility crisis is the need for a rapid implementation action based on an in-depth study of the urban space. Cities that already have cycling path implementation projects could reorganise studies to focus on faster construction because it is much easier to implement small changes to adjust for public demand once the infrastructure is in place. Figure 5.

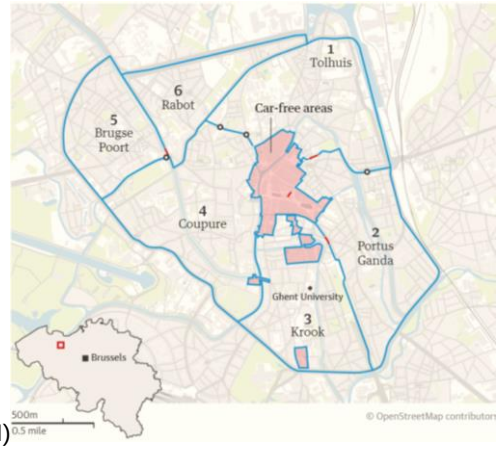
(I)  (II) 

Figure 5 - (I) Implementation of the Gent's Circulation Plan, (II) The circulation plan. Guardian graphic. Source: Zając (2019).

According to the author Lai et al. (2020), policymakers and governments should always encourage people to walk and use bicycles as alternatives to private cars for short and medium-range movements. However, the author also stated that many cities, including most of those in Southern Italy, are unprepared to implement and manage cycling networks. However, the author also stated that many cities, including most of those in Southern Italy, are unprepared to implement and manage cycling networks. This affirmative follows the missing connections between the cycling paths caused by a poorly designed infrastructure consisting of small sections on the route, typically representing an unsafe rote that people are afraid to ride. As a result, replacing motorised vehicles and designing more conducive cities to active mobility modes is a complex project with numerous variants, even with potential benefits to the urban environment. This type of project must focus on a thorough study of social behaviour and necessities and plan an infrastructure that will not take too long to complete and can be easily modified if the population does not adhere.

2.2.2. TACTICAL URBANISM AND POP-UP STRATEGIES TO ENHANCE URBAN MOBILITY

Tactical Urbanism strategies will be conceptualised in the context of urban planning and the development of new city infrastructures in this subtopic. For example, Lydon & Garcia (2015) define Tactical Urbanism as a tool used by residents to draw attention to perceived flaws in policy and physical design, intending to reclaim urban space from motorised vehicles. Municipalities, organisations, and project developers can use the tool to broaden the scope of public engagement, test aspects of a plan early and frequently, and accelerate implementation - making it easier to create great places. Before the pandemic event, tactical urbanism was commonly used to replace car parking spaces with more social interaction areas. Following the Covid-19 pandemic, this type of measure was implemented for commercial establishments and districts to enforce the required distance between people, tending to expand the pavement area beyond the sidewalk.

According to Silva (2016), Tactical urbanism is a type of urban spatial planning that focuses on the short-term and agile implementation of a provisional infrastructure that includes citizen participation. Tactical urbanism, in other words, aims to solve specific urban problems by involving the public in

decision-making and infrastructure implementation. The author refers to citizens' participation in this process as a response to their own adaptation to the solution of urban needs and thus as a tool to address government entities' lack of response to citizens' needs.

Tactical urban planning, as opposed to formal strategic urban mobility plans, frequently changes areas that may present particular difficulties within the urban context. According to the author Silva's (2016) research, these modifications can occur at various urban scales, but in general, they aim to claim for themselves the use of urban territory in situations such as non-use of a specific territory and traffic design transformation. These actions may be more common in specific urban areas, such as blocks, street sections, sidewalks, and road intersections.

According to Lydon et al. (2015), the goal of this movement is to create a temporary structure with specific goals for the community that are not meant to last long. The goal of these infrastructures, according to the author, is to allow people to use urban space in a variety of ways and to allow the same environment to carry out a variety of activities depending on the need of the moment. As a result, Tactical Urbanism has emerged as a new and practical feature that focuses on transforming existing spaces rather than creating new urban environments. Therefore, the author (Lydon & Garcia, 2015), argues that according to the concept of Tactical Urbanism, the results of transformations in the territory should be immediate, but not necessarily permanent, for this reason, this urban movement focuses on developing small areas with the support of the user community.

In general, the process of modifying urban space has a significant impact on the attitude of the community. According to Silva (2016), this relationship occurs because the community is involved in the process of modifying the living space, both in the decision-making and space execution stages. As a result, people have a sense of ownership over the new urban space, directly affecting the project's efficiency.

Silva (2016) demonstrates that Tactical Urbanism can be a low-cost and straightforward way of testing urban solutions that would otherwise require significant investment. This is possible because this urban transformation model repurposes existing objects rather than acquiring or creating new ones. According to the author Silva (2016), Tactical urbanism can be an opportunity for people to transform space while using it, rather than waiting for the urban environment to degrade before building a new space. The use of urban space allows people to have new perspectives that argue for its modification, as opposed to municipal projects, in which infrastructure is implemented and, if adaptation is required, the municipal commission must be consulted.

The implementation of pop-up cycle paths in this study's case study - Bristol, UK - is strikingly similar to the concept of temporary installations identified from Tactical Urbanism. Similar aspects of the installation process include quickly installed infrastructure, readily available and easily acquired materials, temporary aspects, clearly defined objectives, and the ability to obtain quick results from facility use. On the other hand, the temporary bike lane installations that took place in the case study in August 2020 have as a precursor the municipality using state funding, besides that, does not directly involve the user community in decision making, a set of factors contrary to the characteristics of Tactical Urbanism.

According to Silva (2016), the similarity between pop-up facility initiatives and the characteristics of Tactical Urbanism in this context can bring real opportunities for the improvement of urban space. Furthermore, whereas Tactical Urbanism focuses on repurposing unused space, municipal urban planning focuses on repairing broken points. In this sense, Tactical Urbanism methodology aims to

transform unconsolidated spaces into consolidated ones in terms of population use, whereas urban planning aims to change what is considered harmful urban behaviours.

Municipal urban planning supported by Tactical Urbanism initiatives can also achieve good results regarding the efficiency of urban space transformation. As previously described by Silva (2016), Tactical Urbanism promotes temporary structures that work as testable solutions to the malfunctioning of the urban environment. These temporary solutions, after the test phase, if proven with positive effect, should be made permanent by the city council to be formalised within the urban organisation context.

Lydon et al. (2015), bring examples of temporary cycle paths within one of the concepts related to Tactical Urbanism, such as the *Open Streets* and *Play Streets*. In this theory, the community takes initiatives to close local streets to cars and allocate only for people and active modes. This initiative usually takes place for a few hours or a day during the weekend for community interaction and leisure. Lydon et al. (2015), cites the project named "Ciclovía" (meaning cycle path), a tactic used in Bogota, which since 1974 performs the actions of the Open Street, where the community can interact socially in an equitable way in addition to performing physical exercise. As an example of the Play Streets movements, the author cites the case study of this research, Bristol, UK, which has had the initiative to close some of the community streets so that children can play safely since 2011. The Play Street strategy, which started with a few parents and communities, eventually gained the support of the city government, which was able to organise and expand the project to other neighbourhoods. As a result, the project had established over forty leisure streets throughout the city by 2013. Figure 6.

(I) 

(II) 

Figure 6 – (I) Bogotá, Colombia, has launched the called Ciclovía ("bike path") in 1974, closing certain streets off to auto traffic temporarily, the Ciclovía project is still being practised in Bogotá today; (II) Play Street project. Source: Lydon & Garcia (2015).

According to Lydon et al. (2015), the pop-up initiative arose from the 1970s concept of portable architecture, which described the insertion of seasonal and mobile installations as a way to reclaim public space for people. Portable architecture is a forerunner initiative of pop-up parks (Parklet), which aim to replace car parking with small mobile parks, thereby expanding the interaction space of the pavement. Lydon et al. (2015) describe the Pop-Up Rockwell project in Cleveland, USA, which featured the collaboration of urban design students in 2012. This urban intervention was carried out along four blocks where complete green streets were designated, with the quick and low-cost execution of a bicycle path using adhesive tapes to demarcate the bicycle path and traffic areas. Figure 7.

Figure 7 – Students apply traffic tape as part of the Pop-Up Rockwell project in Cleveland, USA. Source: Lydon & Garcia (2015).

As mentioned in this sub-topic, the characteristics that describe the concept of tactical urbanism are very much related to the pop-up cycle lane initiatives developed since 2020. Among the similarities, the following can be pointed out: the quick execution of the project; the well-defined objectives regarding the modifications and the expected behaviour for the population; the punctual interventions in the urban centre; the use of easily accessible and low-cost materials; the structure's temporary nature; and, finally, the initiative to recover the urban space for the utmost good. The characteristics that distinguish pop-up initiatives from this movement, on the other hand, can be summarised as the population's limited participation in selecting the sites for intervention and the project's execution and elaboration by city hall. As a result, this study's correlation of these two urban intervention models seeks to understand which aspects of temporary interventions play an expressive role in implementing sustainable mobility in a concept of urban space improvement.

2.2.3. MAPPING METHODOLOGIES FOR DEVELOPING MORE CYCLING INFRASTRUCTURE

Other strategies demonstrate applicable methodologies for balancing urban space distribution between motorised vehicles and active mobility modes during a pandemic outbreak. According to Palominos & Smith (2020), there is enough space on the city's roads for vehicles and pedestrians to coexist. The author also claims that narrowing roadways is beneficial to pedestrians rather than detrimental to vehicles. This subtopic will present some research on mapping public space to comprehend the division of urban corridors to increase the space in the streets dedicated to active mobility modes.

Palominos & Smith (2020), conducted an analysis using Transport for London's (TFL) cycling infrastructure documentation tool to determine the shortest paths between all railway and underground stations in inner London. By mapping the distribution of the lanes and comparing the roadway to the cycling network, it is possible to identify the critical pathways based on this research. By conducting a cross-section evaluation of narrowing roads, the author proposes interventions in critical locations, strategies for developing new cycling and walking infrastructure, and dedicating more space in the streets to active mobility. As cited before, London's streets carry most of the trips made by active and sustainable modes. All these studies are part of the UK Government's Industrial Strategy area, dedicated to Future Mobility, to reformulate urban planning emphasis in developing streets that could optimise sustainable and low environmental impact travel systems. Thereby, to reach the target of 80% trips made

by sustainable modes in 2041 in London, the number of 67% trips in 2018 needs to increase by 0.7% per year[4].

Palominos & Smith (2020), presented a method for analysing central London's street network and proposing alternative scenarios to confirm a micro-mobility network that prioritises active travel and public transportation by comparing maps. According to the authors, the map analysis determines the shortest routes focusing on the city's essential nodes, such as hospitals and schools, as well as other urban equipment that can be used during times of crisis or emergency events. This infrastructure improvement aims to identify sections of city roads that require wider pedestrian pavement, the establishment of car-free zones, and the installation of bike lanes. Figure 8.

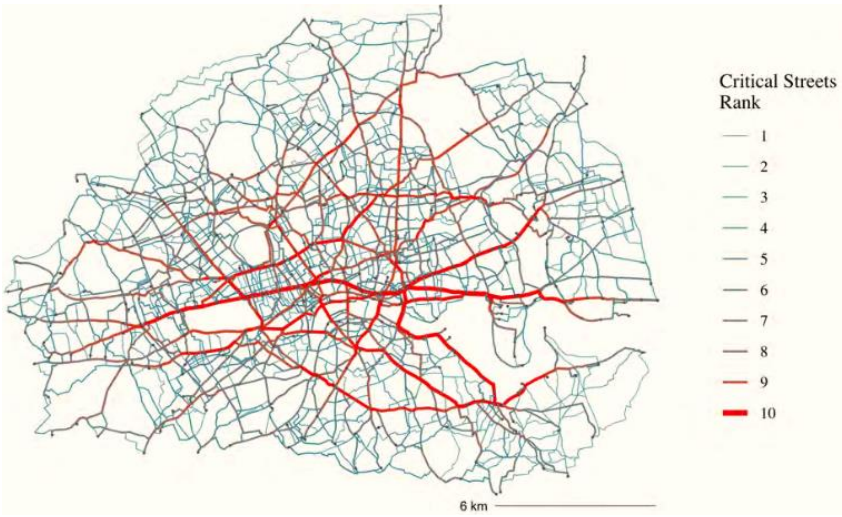


Figure 8 – Critical streets ranked according to shortest paths through route. Source: Palominos & Smith (2020).

Another example in the United Kingdom, described by Lovelace et al. (2020), is a method to condense the complexity of cities networks down to the most important roads. They were moreover prioritising the cycle lanes over cars in a reallocation scheme. This concept has supported investment in temporary cycling infrastructure in cities worldwide and in all English cities. The study focuses on two main points; "Estimates of cycling potential at the street segment level from the UK Department for Transport funded Propensity to Cycle Tool (PCT) project (Goodman *et al.*, 2019; Lovelace *et al.*, 2017)" and "Data derived from Open Street Map, with several new variables added to support cycling infrastructure planning (see www.cyipt.bike for an overview)" (Lovelace et al., 2020). Figure 9.

The first aspect is that the English government intends to double the cycling potential of cities – the number of one-way journeys to work and school – beginning with the administrative city centre, and the strategy should include hospitals due to the pandemic event. This mapping can categorise streets based on their speed limit, which has been linked to the levels of incidents involving cyclists based on knowledge of the structure of the main roads. The second aspect, the team developed a simple algorithm using the Open Street Map to identify road sections with a spare lane (from the CyIPT tool). The Rapid Cycleway prioritisation Tool, developed at the University of Leeds, aimed to identify the best routes for

[4] Retrieved from: Greater London Authority, 2018, *as cited in* Palominos & Smith, 2020;

temporary cycleways to be implemented with the help of the Emergency Active Fund. This tool focused mainly on those cities in England that had not developed Local Cycling and Walking Investment Plans (LCWIP).

The Propensity to Cycle Tool (PCT), a platform that uses the British National Census 2011 as a data source and ranks the routes based on cycling potential, is used in this study cited by Lovelace et al. (2020) - The Rapid Cycleway Prioritisation Tool - to estimate the choice of the top-ranked cycle path. This is represented by estimating the number of people who bike to work and school. As a result, the best routes for new cycle paths are determined based on the available space for the cycle path without causing too many drastic changes to existing roads, which would take more time to implement. The best routes were chosen by following the preceding steps or by having existing cycle lanes on more than 80% of the road. However, the high percentage of existing cycle ways chosen through the Open Street Map does not imply that these lanes are of high quality for cycling modes. The map below shows how the developed tool was used in the city of Bristol.

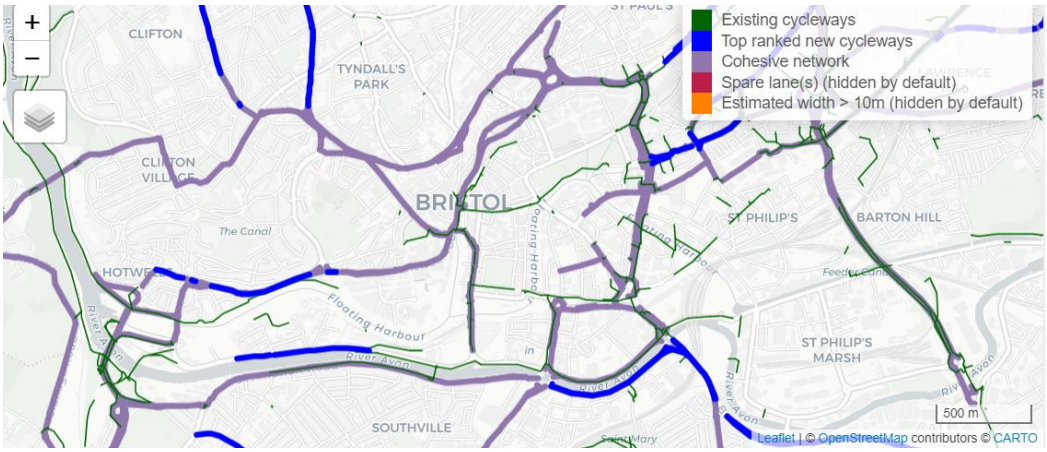


Figure 9 – Maps shows existing disjointed cycleway networks (green), potential cycleway routes according to the Rapid Cycleway Prioritisation Tool (blue) and cohesive networks (purple) in Bristol, UK. Source: Rapid Cycleway Prioritisation Tool (n.d.).

However, another tool within the Cycling Infrastructure Prioritisation Tool (CyIPT) platform aims to quickly contact the population's needs and opinions about urban infrastructure. As a result, Widen My Path is a tool to democratise the municipality's interaction with cyclists. In this regard, the map below was used at the start of the plan to create new temporary bike lanes in Bristol, the case study city for this research. The population could use this platform to mark locations for improvement in cycling and walking infrastructure, interact with one another, communicate the presence of barriers on the routes, and share common opinions about difficulties on city bike routes. An interactive map eventually superseded this system on the city council platform[5]. Figure 10.

[5] News Bristol city council. Bristol residents have say on transport plans with interactive mapping tool (09, June 2020). Retrieved from: https://news.bristol.gov.uk/news/bristol-residents-can-have-say-on-transport-plans-with-interactive-mapping-tool

In brief, the study was applied first in Leeds; the United Kingdom has generated likely results for prioritising the temporary cycle infrastructure, selecting just the roads with a high cycling potential. In these methods, Lovelace et al. (2020), proved the ability to give efficient support to policymakers in choosing the new cycling lanes, especially when target decisions to execute faster cycling infrastructure.

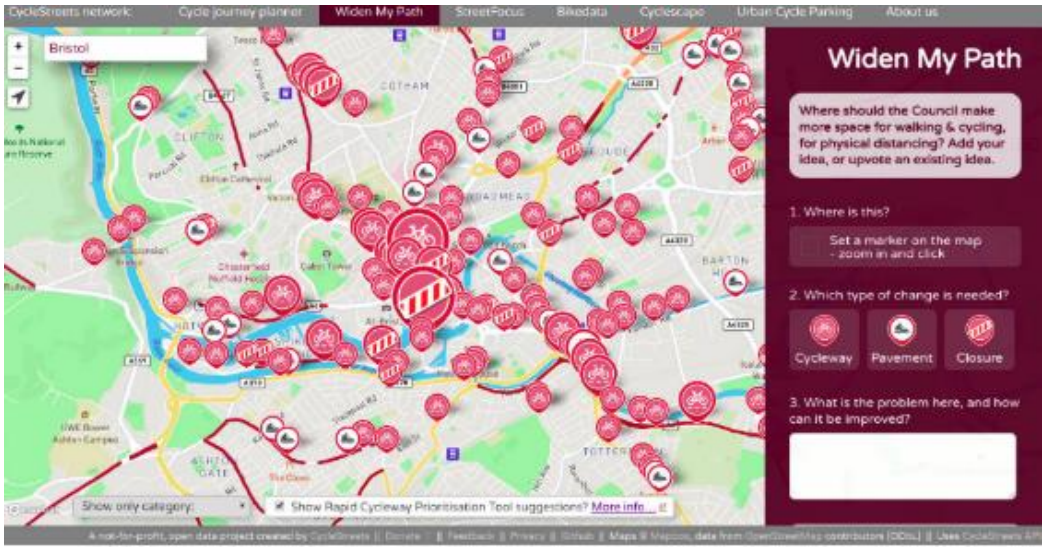


Figure 10 - A screenshot from the websites widenmypath.com (top), including top cycle route recommendations generated using the methods developed on this paper. Source: CycleStreets Ltd (n.d.)

Deponte et al. (2020) cite the project Milan 2020 in Italy as a framework to promote better pedestrian mobility during the early stages of a pandemic event. The author describes tools that could aid in identifying critical areas where maintaining social distance rules is impossible. The "GIS-based Interactive Sidewalks Map of the City of Milan Geographic Information Systems (GIS)" enables the analysis of samples of geo-referenced structured datasets, in this case, the walkability level in the city's neighbourhoods. The study collects points of interest as well as census data on the socio-demographic characteristics of the residents. The work employs GIS-based technology to create interactive cartography that analyses the city's infrastructure, qualifying the structure per dimensions of possible one-meter recommendation distance for contagion containment; and evaluating the pavements based on their width from measuring each sidewalk in Milan. Using this database, it was discovered that more than 40% of Milan's sidewalk area is insufficient to maintain the social distance measures. As a result, Milan must begin interventions based on increased pedestrian comfort and safety, with the produced cartography defining priority areas.

As demonstrated in this subtopic, several types of tools must be developed in order to identify the best routes for bike lanes in the city. As previously stated, these tools can range from identifying routes based on available road space to implementing cycle paths to identifying the most common routes taken by cyclists, which is primarily determined by trip destinations. However, in this work, the efficiency of temporary infrastructures applied based on the needs of cyclists transiting in the region was only examined, with no consideration given to the selection of pop-up routes based on origin and destination criteria.

2.3. POP-UP INITIATIVES TO SUPPORT ACTIVE MOBILITY FACILITIES

Before the Covid-19 crisis, the process of making cities more appealing for active mobility modes was based on extensive planning before implementing any infrastructure. Tactical urbanism was more focused on improving communities rather than involving the city on a larger scale. Since the beginning of the pandemic, when shared mobility modes were thought to be a transmission environment for the virus, governments have accelerated urban improvements to follow the new social distancing measures. The fast investment in active mobility facilities, such as pop-up cycle lanes, happens as an option for people who still had to work during the lockdown instead of using the public transport.

According to Lehmkühler et al. (2020), cities quickly set up pop-up paths on major roads to make more space for the growing number of cyclists and pedestrians. These temporary lanes were constructed using available building materials, and the painting of road signs distinguishes this infrastructure. These are either located on the side of the road, widening the pavement to accommodate a new cycle lane, or they occupy the entire road, obstructing motorised traffic. The use of construction materials is intended to alert traffic to the new road division, build a physical barrier, and protect cyclists and pedestrians from motorised traffic. Figure 11.

Figure 11 – Pop-up cycle path in Berlin. Source: Ammelband, S. (2020).

The UK department for transport, DfT (2020), names temporary cycle lanes projects 'Trials' and describes them as an essential means of engaging the process of supporting cycle modes. Accordingly, within the UK Cycle Infrastructure Design, the temporary cycle paths to understand the potential and demonstrate to the population the scheme of space relocation to implement cycle paths. The trial involves the deployment of temporary neighbourhoods for just a few weeks, provided that these are communicated in advance to the local community and comply with the Signs Regulations and General Directions. As part of the project development and delivery of the final scheme, the cycling standards document clarifies the need to monitor temporary cycle ways before and during the implementation period.

As a result, the temporary cycle facilities set up in many countries during the early stages of the Covid-19 outbreak confirmed the lack of existing cycle infrastructure in most cities worldwide. Although the pop-up lanes were designed as temporary infrastructure, they were installed in high-traffic areas. It demonstrates that countries that already had planning studies on cycling infrastructure could implement

the pop-up infrastructure more quickly using the existing implementation basis. Furthermore, one of the benefits of this temporary arrangement is the ability to change the infrastructure quickly. On that purpose, Lovelace et al. (2020), cities that on May 09th 2020, the UK government announced a £250 million package pop-up active transport infrastructure. Therewith, all the advantages and the urgency for developing new strategies to promote safe mobility.

According to Dunning & Nurse (2020), pop-up paths are a low-cost investment due to the low cost of repainting road symbols, despite the higher cost of providing new signs such as 'wands' and protected cycle lanes. The implementation and repair cost of the active modes facilities is much less than normal roads infrastructure. A crucial aspect since governments has spent a great deal of money on pandemic hospital expenses. Simultaneously, Kraus & Koch (2020), calculate that creating provisional bike infrastructure could generate $2.3 billion in health benefits per year if the population keeps the cycling habits.

The key locations to implement the new cycle infrastructure were also the main destinations during the lockdown, such as hospitals, grocery stores or anywhere that could have essential workers. This decision was made to provide safe displacement over the cities without encouraging increased car use. At the same time, the implementation of temporary infrastructures is not intended to create a new attraction during the pandemic lockdown. In this sense, families are being influenced to change their modal behaviour, but the population will only continue to use active mobility after the pandemic if the infrastructure is executed efficiently.

Lovelace et al. (2020), describes three actions that can be taken to encourage more people to use active mobility: (I) point closures or contraflow cycle lanes; (II) exclusive use for the active modes, either permanent or at certain times of day; (III) build of pop-up cycleway or bike paths. These strategies aim to give road's priority to the active mobility modes while reducing the space on wide roads for private vehicles. Furthermore, the standard speed limit of 30km/h and traffic calming measures with shared spaces turn cycling and walking into a safer mode of travel while supporting new cyclists to gain more confidence. These measures are necessary as only the implementation of infrastructure, temporary or permanent, will not result in residents automatically switching to cycling modes.

Although it is clear the necessity of more bike paths on the roads, Lovelace et al. (2020) attest to the lack of cycling data in the United Kingdom regarding pop-ups paths' potential construction areas. In practice, the lack of previous planning study could lead to random placement of the new cycling infrastructure, mainly driven by the availability of street space and easy redistribution of the car traffic. Aside from the numerous benefits demonstrated by implementing pop-up cycling infrastructure, encouraging active transportation modes may cause public transportation to operate at less than full capacity; it is unclear whether this decision will result in a public transportation viability crisis.

Indeed, some of the authors of this literature review (Ammelband, 2020; Kraus & Koch, 2020) state that by the end of 2020, many governments will have implemented more incentives for active modes than in previous years. Thus, as a form of lockdown strategy, many urban centres, including those with good cycling infrastructures, such as the Netherlands and Denmark, will see significant changes in street design. In this perspective, Bauer et al. (2020), suggests that after the temporary routes are completed, and their functionality for cycling quality is proven, these routes should be converted into a permanent solution for urban mobility.

2.3.1. POP-UP CYCLE PATHS STUDY CASES

The practice of implementing temporary bike lanes by organised communities arises from the need to reclaim a better division of road space, ensuring safe access for users of active modes. Since the beginning of the pandemic, countries and municipalities have implemented this practice in a similar way to the Tactical Urbanism methodology, taking the necessary care to contain the disease, i.e. without involving the population in the implementation process. However, it is substantial to understand that it is too soon to comprehend the actual effects of the new cycle structure on city mobility. Moreover, in one year of the Covid-19 pandemic, many factors could interfere with the reliability of the data studies, such as different lockdown measures, new Covid-19 variants, different countries responses and other relevant factors.

At the time of this data collection, there is insufficient research to conclude that current levels of active mode use have increased to a similar average pre-pandemic level, taking into account the specific sections of new road infrastructure deployment. For the time being, research on pop-up paths focuses on the significance of this type of initiative in improving urban mobility space and ensuring cyclist safety. As a result, no precise data on modal shift levels after the temporary bike paths were discovered, but what could be identified were negative levels of public transportation compared to pre-pandemic years. As a result, some countries worked hard to demonstrate and explain their mobility actions during the pandemic year. As a result, this sub-topic is dedicated to exposing and analysing the temporary bicycle path projects completed in 2020 to maintain urban mobility safety quickly.

Angiello (2020) provides an overview of early Covid-19 pandemic mitigation strategies in Italian cities. At the start of the pandemic, Italy was heavily affected, particularly in the Lombardy region. As a result, the government pledged to reduce the virus's impact, articulating the response at three levels of governance: national, regional, and local. As a result, municipalities have implemented the national intervention agenda on a small scale.

Angiello (2020) provides an overview of early Covid-19 pandemic mitigation strategies in Italian cities. At the start of the pandemic, Italy was heavily affected, particularly in the Lombardy region. As a result, the government pledged to reduce the virus's impact, articulating the response at three levels of governance: national, regional, and local. As a result, municipalities have implemented the national intervention agenda on a small scale. This pandemic strategy would aid in the reorganisation of the city and provide a short-term operational response. Long-term resilience of the city. Based on these principles, the Milan intervention makes more space on public roads for active mobility and develops areas with appropriate physical distancing. The strategy promoted 35 km of new bike lanes and widened the city's pedestrian paths, expanding the city's Limited Traffic Zones (LTZ) and ensuring access to essential public services within a 15-minute walk. According to Angiello (2020), Naples was in charge of virus transmission in a different scenario than the north of Italy. In addition, cities approved electric shared mobility services, such as developing electric vehicle charging stations and financial assistance to purchase electronic bikes. Turin, on the other hand, did not develop any active mobility strategy.

Although Italy became an epicentre of the pandemic, the measures to guarantee the urban logistic within the cities were essential to help the country recover from the widespread pandemic damage. To mitigate the effects of the mobility crises, Italy used a significant portion of the recovery budget to expand cycle lanes and public paths. These strategies can help to alleviate congestion while also boosting the economy by allowing businesses to reopen. Simultaneously, the author Angiello (2020) suggests that most prominent cities in Europe could reshape the streets because, without people or traffic, the public authorities can improve cities by implementing large-scale urban projects, promoting cycling and reducing the car-oriented urban development areas.

Dunning & Nurse (2020) investigated the availability of cycling and walking infrastructure during the Covid-19 crisis. The discussion begins by presenting the rise in car rides at the start of the pandemic. Evidence showed that the number of private cars in China increased after the outbreak, rising from 34% to 66%. According to the author, the population's concern about shared vehicles and lockdown measures caused the levels of occupation in cities public transportation to drop dramatically, by approximately 50% when compared to previous travels. Simultaneously, with the social distancing measures, public transportation had to limit occupancy.

Despite the fact that the first pandemic scenario described by Dunning & Nurse (2020) conflicted with environmental goals of developing more sustainable cities, an international agreement recognised the role active modes should play in enabling mobility during the Covid-19 crises. This agreement prompted governments to lead investments to incentivize active modes of transportation, thereby increasing global sustainable mobility. According to the authors Dunning & Nurse (2020) cities such as Vancouver and Melbourne have removed car parking spaces, widened sidewalks, and installed temporary bike paths, demonstrating government attitudes toward implementing active mobility infrastructure. In this sense, the article brings other examples such as Budapest, where they created 17 km of pop-up bike lanes, although the most significant initiative example is in Paris, where were intend to build 650 km of temporary and permanent cycle lanes as part of the strategy to make the French capital a cycle-friendly city.

Dunning & Nurse (2020) summarize the article stating the danger of creating a cycling infrastructure where cycling is not typical behaviour. According to the author, implementing cycle paths without the approval of the population could result in flawed transportation experimentation, resulting in harmful behaviour against cycling, the opposite effect of countries that already have active mobility as part of their culture and are also taking advantage of the opportunity to expand their sustainable mobility infrastructure. For example, countries such as Belgium and The Netherlands are temporarily closing some roads, where the occupancy levels are above-perceived capacity, redirecting the car traffic through other roads, and planning to expand their bike facilities building new lanes and spaces for bike storage.

Kraus & Koch (2020) case study discusses the effect of pop-up bike lanes on cycling in European cities following the pandemic outbreak. This extensive working data evaluated 106 European cities based on over a decade of previous daily research and included recently announced data about the pop-up cycle path during the pandemic. During the early stages of the crisis, the author discusses how Bogota's announcement to build 76 kilometres of temporary bike lanes inspired the plan to build temporary cycling infrastructure in Europe. During the first lockdown, these plans were developed to allow essential workers to travel safely.

Kraus and Koch's (2020) research is thus carried out to estimate a Poisson regression model, with the number of daily cyclists as a variable outcome of the number of pop-up bike lanes in service in kilometres per city. As a result, the study compared cycling changes in the weeks following the installation of the new pop-up lanes, revealing that, on average, the new cycle paths increased cycling viability by 7% while demonstrating a low cost of infrastructure and high health benefits. Meanwhile, this study has insufficient data to determine whether the increase in cycling levels is due to new cyclists or cyclists who have decided to cycle more frequently or farther. Therefore, an in-depth study about the impact of the new infrastructure in changing cyclists' route choices and a possible modal shift is needed with georeferencing to trace individuals' journeys. In that respect, Kraus & Koch (2020), criticise the cycling interventions operated by the availability of street space and lack of roads' research about traffic distribution.

That said, Kraus & Koch (2020) states that on the positive side, the study concludes that governments have been aiming to build 11.5 km of temporary pop-up bike lanes per city per year. According to data from the European Cyclists' Federation, each km of bike lane built increases the city's cycling viability by 0.6%. The author also cites the case of Seville, where over 120 kilometres of bike lanes were installed to increase cycling and reduce congestion.

In Germany, Bauer et al. (2020), concluded that mobility had changed abruptly during the Covid-19 pandemic, such as air quality, roads occupation, and other elements. Throughout the outbreak, people enjoyed and preferred walking and cycling much more as a form of transport; it was visible how space was unevenly distributed between people and vehicles. One of the main strategies to provide more cycling infrastructure over the Covid-19 pandemic was implementing the TEER system, which means *Temporary installation and expansion of bicycle traffic facilities,* the official name for the pop-up cycle paths. The Berlin Senate Department for the Environment, Transport and Climate Protection started the system by the end of March 2020, calculating 25% of more cyclists in June of the same year. In a few weeks of implementation, 25 km of bike infrastructure was built in the German capital. Moreover, a prominent part of these pop-up facilities will gradually become permanent cycle paths after adjustments and road evaluations. Figure 12.

Figure 12 – Experiment in Berlin Middle: Part of the Friedrichstrasse turns five closed to cars for months and offers more space to linger, stroll and cycle. Source: Bauer et al. (2020).

Some cities planned new cycle infrastructure for years but did not build it until the crisis hit. The Berlin Mobility Act, in particular, was passed in the German capital in 2018. It increased active mobility and legitimised bike lanes. According to Bauer et al. (2020), the advantage of temporary cycle paths is that they are easy to improve; thus, this temporary infrastructure could work as an experimental phase of an urban planning project, saving costs and accelerating future construction projects.

Another approach to improve the security of the new cyclists is to reduce speeds for individual motorised traffic. In Berlin, this strategy has proved a possible way to achieve these aims is to share the street space. For instance, the Berlin district of Friedrichshain - Kreuzberg created 18 temporary play streets in May 2020 as part of the social distance measures. Bauer et al. (2020), conclude that Berlin's experience with temporary measures can be transferred to other municipalities inside the country and worldwide.

In contrast to the European examples, Ammelband (2020) provides an example of bicycle policy in Lima, Peru. Cycling is a long-term strategy in the South American country with a flat topography. Before the Covid-19 pandemic, three-quarters of residents used public transportation; after the pandemic, local public transportation in Lima was limited to 50% of passengers; at the same time, demand for safe modes of mobility rapidly increased. As a result, to create a safe and accessible environment for cycling in Lima, the local government intends to implement a long-term plan of 301 km of new and permanent bicycle lanes. The short-term solution is to create in 45 days 142 km of new pop-up cycle paths. The author compares Lima and Berlin in perspective; even with completely different economic positions, both cities brought a real possibility to implement quicker cycling infrastructure during the outbreaks. Figure 13.

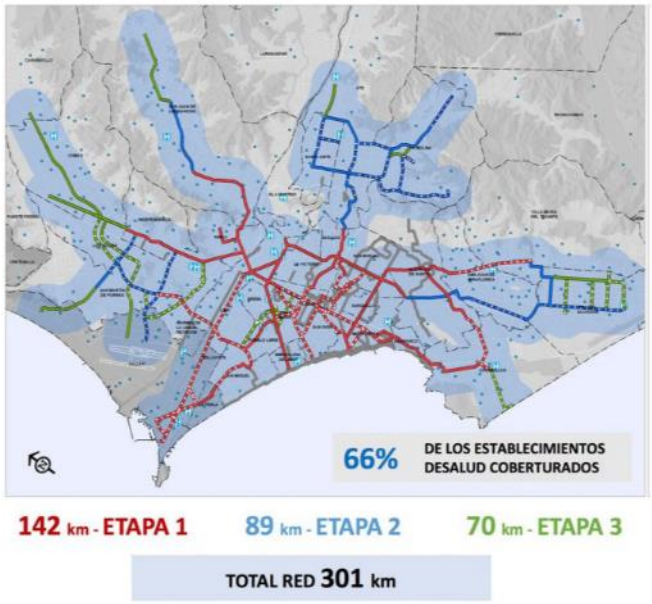


Figure 13 – Expansion of the bicycle network in Lima by Peru 21 (2020). Source: Ammelband (2020).

2.3.2. GOOD PRACTICES FOR DEVELOPING POP-UP CYCLE PATH

Some cities created manuals to guide the construction of bike lanes facilities and inspire other cities worldwide to develop a more active mobility-friendly infrastructure as a mobility strategy for essential workers throughout the Covid-19 pandemic. These manuals aim to plan new urban infrastructure using available resources and include adaptive methodologies such as materials and implementation plans. This sub-topic compares the manuals created for Berlin, Making Safe Space for Cycling in 10 Days, and NACTO, Streets for Pandemic Response & Recovery, to replicate these documents as examples of good cycling practises. Furthermore, these will be used to assess the infrastructure implemented in this research's case study.

According to the Berlin' manual, other cities are applying the temporary infrastructure measures as front mobility during the Covid-19 pandemic. For example, Bogotá, Colombia, was the first to allocate 35 km of new bike lanes; at the same time, Paris, France, announced the implementation of 650 km of cycle lanes starting as a temporary measure. Most recently, New York City declared the closure of 100 miles of street spaces for cars. In this context, the German capital had to adapt to the new social distancing measures and respond to the mobility pressure. However, above all the pandemic problems, the lack of cycle paths occurred during normal circumstances. Therefore, in the early times of the pandemic

lockdown, the reduced car traffic was the perfect opportunity to reinvent the public space and create more walking and cycling areas by implementing new pop-up paths. Berlin's planning project also highlights that additional space for cyclists can allow more people to use public transport safely by reducing overcrowding. Besides that, it is the chance for the community to comprehend the cycling network and discover how the system will work within the city. Figure 14.

Figure 14 – Pop-Up Bike Lane in Berlin – Friedrichshain- Kreuzberg. Source: Mobycon (2020).

The manual first implemented in the Friedrichshain-Kreuzberg district divides the pop-up planning methodology into eleven steps to be completed in ten days. Each phase describes a series of topics explaining what is to be achieved at the project stage. Moreover, some phases have a time limit to be finished, such as the 3rd step, about the *Enable Quick Implementation*, not allowing delays with the local authorities. The challenge of building the temporary measures in ten days comes from the method of testing the solutions shortly after implementation. The 10th step, *Adjust and Modify*, focuses on reviewing the project in place, which means that the department will have time to analyse the new facility after the implementation and make improvements if necessary. Thus, using the construction material available helps with the immediate implantation and the possible changes.

The difficulty in this kind of temporary project is predicting the right places for implementations and anticipating possible accidents. In a pandemic scenario, another problem could be to create a new attraction in the city. For that purpose, Berlin's manual focuses on implementing a pop-up network connecting people to essential journeys, such as supermarkets and hospitals, not to attract unnecessary journeys.

According to the manual, four principles must be followed when implementing temporary measures: separation, forgiveness, predictability, and network approach. The document also includes some examples of cross-section solutions for various road widths, demonstrating what needs to be changed to make a street more bike-friendly. These cross-section examples can be used in other cities as part of the manual goal to help other countries improve their mobility facilities during the Covid-19 pandemic. To conclude, the temporary measures like the pop-up cycle paths should pass for regular working evaluations. Subsequently, once this kind of pop-up planning project has proved effective in the city's environment and the cycling levels have been ensured, these solutions should become a permanent urban infrastructure solution.

The NACTO (2020), Streets for Pandemic, Response & Recovery, has the same intention as the German document, but with a different approach. According to the manual, once the Coronavirus transmission rate increases indoors, it is vital to prioritise the roads and pavement for the public and active mobility modes. Therefore, the manual created in New York focuses on urban mobility for cycling and gives examples of areas where people could organize the space safely than people could have access to essential shops and social services. These including safe walkable areas to exercise outside and spaces for queuing out of markets or essential shops. Furthermore, the NACTO planning study includes urban design proposals for reorganising outdoor spaces where people can meet again and reopen their businesses in the manual.

The NACTO (2020) divides a public health response strategy into three stages: stay-at-home/orders in place, Pre-vaccination, re-opening, and Vaccine/post-Covid-19. According to the document, these phases are critical in the Covid-19 scenario because the government will have to take a different approach during the pandemic phases, such as organising vaccination locations. Each phase has a detailed approach for different scales within the city: Neighbourhood Streets, Neighbourhood Main/High Streets, Major Urban Streets, and Edge Streets & Boulevards. In this manual, the proposal on turning up first in Neighbourhood Main/High Streets level in pop-up bike lanes would grow in scale and connection with the following city's areas.

Unlike the Berlin manual, the NACTO (2020) then divides the process into three Emerging Practices: *Planning and Engagement*, *Material and design*, and last *Network Strategies*. Although the manual has a more general explanation and steps to follow, it does not contain a deadline to finish each phase. The first phase focuses on identifying the city's available space, planning & evaluating the projects' goals and minor projects, and focusing on engaging with the community and stakeholders. The second phase is responsible for the in-place action, such as choosing materials and signs to identify the new intervention in the streets. The final phase must connect the existing network to the critical priority during the Covid-19 pandemic. Figure 15.

The NACTO (2020) text explains that this could be a historic moment for the ordinary course of cities to change, where for the first time, due to the limitations of urban mobility, countries have taken seriously the development of active mobility develop everyday practices. So, while the manual aims to develop a design plan for emergency solutions, it should also plan how longer-term problems, such as economic recovery, will be solved.

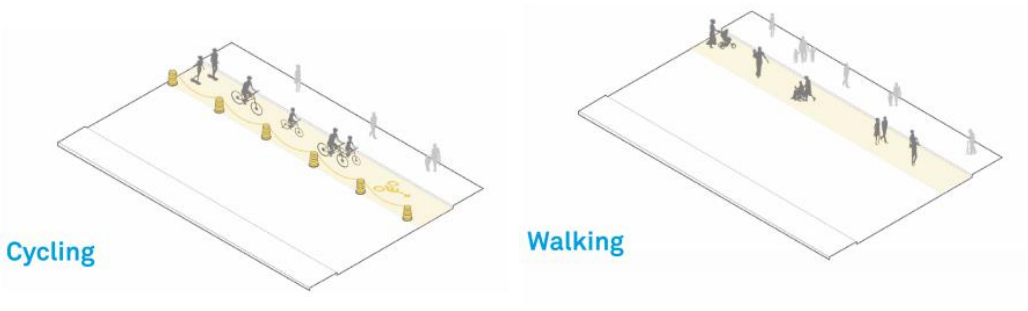


Figure 15 – Examples of space design dedicated to active modes developed in the NACTO manual include pop-up cycle lanes and pavement space expansion. Source: NACTO (2020).

The table below compares aspects of the two manuals discussed in this literature review, highlighting the main descriptive topics and understanding the temporary bike lanes projects described in each manual. Table 1.

Table 1 – Comparison between the pop-up manuals, Making Safe Space for Cycling in 10 Days (2020) and The NACTO manual Streets for Pandemic Response (2020)

Comparative Topics / Emerging Plans	Making Safe Space for Cycling in 10 Days (BERLIN)	The NACTO manual Streets for Pandemic Response
Temporary Cycle Infrastructure	YES	YES
Other Temporary Infrastructure	Walking	Walking; Shared Streets; Markets; Transit; School Streets; Dining; Loading; Queuing; Sanitation; Play Streets; Communication;
Descriptive manual for the implementation	High level of detail on the implementation of pop-up cycle paths;	Medium level of detail on the implementation of pop-up cycle paths;
Decision location for the pop-ups	Provide links to the essential services; enlarge spaces for active modes of neighbourhood streets;	General urban context; Neighbourhood Streets; Neighbourhood Main/High Streets; Major Urban Streets; Edge Streets & Boulevards;
Connection to the existing cycle network	It mentions the need for a cycling network but does not focus on connecting cycle paths.	It mentions the expansion of the cycle network but focuses on connecting this network with public transport.
Implementation	"a process in eleven steps, to be completed within 10 days"	Finding Space; Planning & Evaluation; Engagement
Verification of the plan's efficiency	Evaluate with 72h; quick-scan assessment reviewing: reduced risk of infection, traffic safety, traffic flow.	"Monitor projects every day or twice daily at first, then weekly, to ensure that barriers remain in place and signs are understood"

3
RESEARCH APPROACH

3.1. STUDY CASE

3.1.1. BRISTOL CITY

This dissertation's case study is in Bristol, United Kingdom. According to the council's website, Bristol has an estimated population of 463,400 in the urban area, with a projected increase to 500,000 by 2021, making it the largest city in the South West of England. According to Banister and Marshall (2000), the increase in car travel has become a significant traffic problem in the city over the last ten years. Now, twenty-one years later, the urban reality is not much different from the past. This has happened because Bristol has a substantial connection between the new neighbourhoods and motorways, making travel to the city centre dependent on cars, as bus routes and cycling infrastructure do not keep pace with the growth in urban construction. Figure 16.

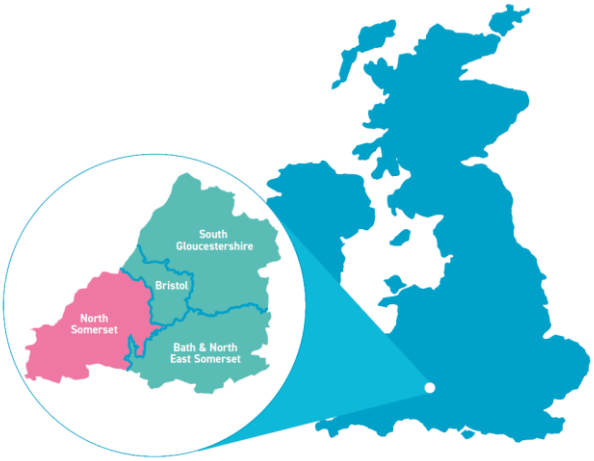


Figure 16 – Map of the WECA - The West of England Combined Authority. Source: West of England Local Cycling and Walking Infrastructure Plan 2020-2036, 2021.

Banister & Marshall (2000), demonstrates that like countries with high levels of bicycle use, Bristol in the past also had projects to encourage modal shift to sustainable modes of urban mobility. However, the author shows an example comparing the Brislington Park project build in Bristol, 1993 to other modal shift projects in The Netherlands. He clarifies that the project in Bristol was considered unsuccessful once it focused just on building a big car park for the people coming from the outside city,

not focusing on building an efficient cycling or bus network from the parking point to the main destinations.

The current strategy to reduce car traffic in English cities is part of a wider policy to reduce air pollutants' emissions within the urban centre by 2050. According to the Bristol Transport Strategy, which was adopted in 2019, the city accounts for approximately 25% of the country's total pollutant emissions, making it a representative part of the plan to reduce pollutants in British territory. Consequently, Bristol's transport strategy has the vision to reduce car-commuting levels from 53% to 43% by 2036, developing the plan to improve the transport network with more sustainable and resilient goals[6]. In addition, the strategy intends to make cycling more inclusive and accessible by encouraging people to use cycling as their primary mode of transportation for one-mile journeys. In addition, the transportation scheme will provide new facilities for cyclists, such as parking and clearly marked routes, allowing safe connections to the city's cycle network.

Bristol City Council also intends to implement the Clean Air Zone by 2023, reinforcing the reduction of the city's most polluting vehicle traffic, primarily diesel vehicles. It also aims to slow down traffic on the roads and prioritise safe traffic and active mobility modes. The map below depicts Bristol city centre, highlighting the area where only certain types of vehicles will be allowed to travel free of charge. Figure 17.

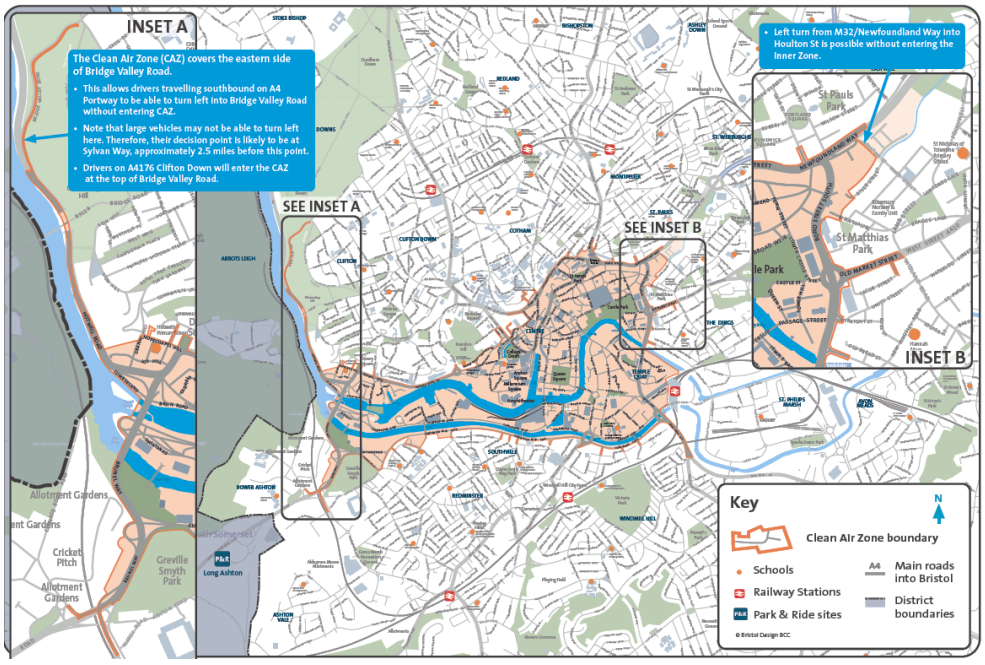


Figure 17 – Map of Bristol's Clean Air Zone D. Source: Council (2018).

The British government has promised new investments in expanding cycling infrastructure to meet the national pollution reduction target. Bristol is a member of the WECA – The West of England Combined Authority – a group that includes the councils of Bath & North East Somerset, North Somerset, and South Gloucestershire to allocate government investments for sustainable growth policies. Following

[6] West of England Councils (2017) West of England Joint Transpot Study. Retrieved from: Bristol Transport Strategy (2019), page: 39;

the government agenda, the LCWIP – The West of England Cycling and Walking Local Infrastructure Plan – (2020-2036) is the first step towards building up strategies that focuses on producing local sustainable mobility infrastructure to boost the levels of walking and cycling in the region. With these considerations, Bristol plays an important role in implementing this plan, as fourteen of the fifty-seven routes mapped for cycling and walking development are located in the city.

Understanding the details of government plans for sustainable mobility is crucial to this research; as with investments earmarked for cycle path improvements, it was possible to fund temporary emergency infrastructure at the start of the Covid-19 crisis. In addition, understanding local transport strategies are essential, as these influence where urban infrastructure improvements have been implemented so that there is coherence between the objectives of each plan and more coordinated use of investments.

As a result, within the walking and cycling improvement plan, the LCWIP, climate change, air quality targets, and the Covid-19 pandemic crisis are exemplified as challenges and opportunities for better urban development. The diagram below is from Bristol's transport strategy document and shows how plans to improve the sustainability of urban mobility fit into regional and national scale projects. Figure 18.

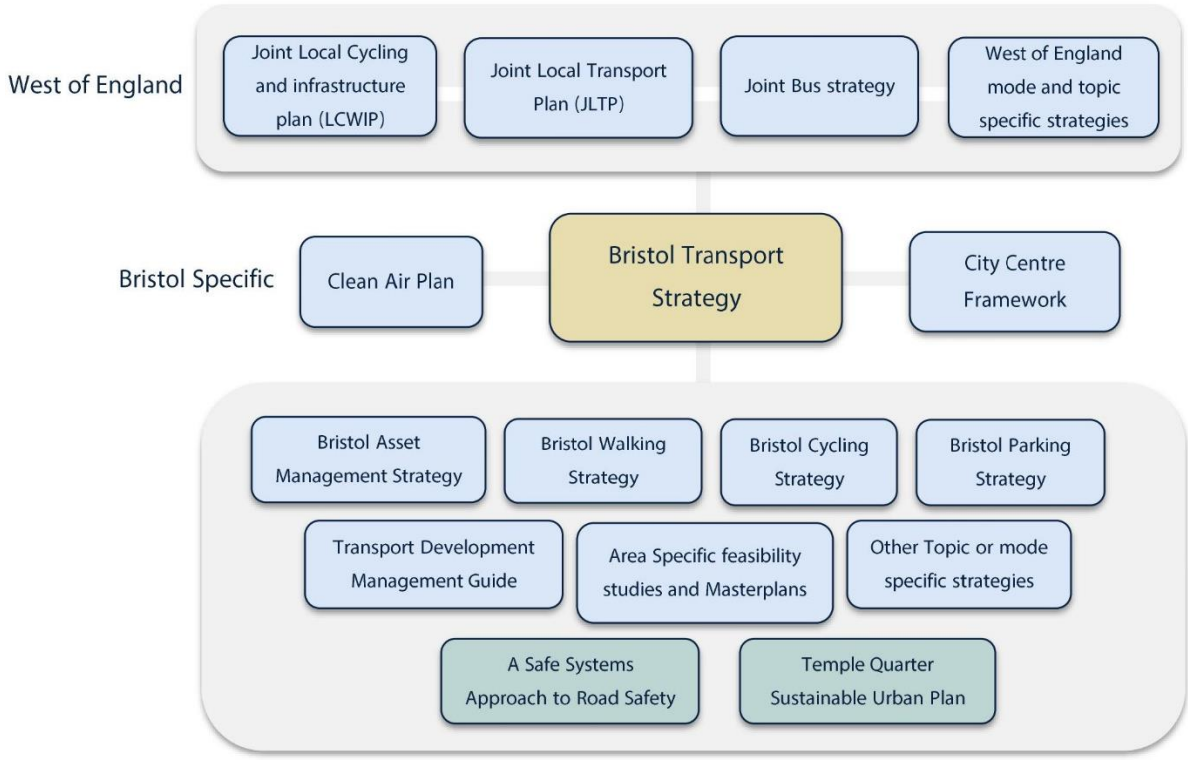


Figure 18 – Diagram demonstrating the connection between the West of England region's key mobility strategies and Bristol's transport strategy. Source: Elaborated by the author from the data provided by Transport Strategy, 2019.

3.1.2. POP-UP CYCLE PATH IMPLEMENTATION PROCESS IN BRISTOL

This topic explains the process of implementing and executing pop-up cycle paths in Bristol, bringing the council's perspective on events gathered through research into official data contained on the city council website and interviews with one of the project responders. This topic also included input from cyclist activists involved in the implementation of bicycle paths, as they have been following all events since the beginning and have a greater understanding of urban cycling infrastructure. As a result, the description of the pop-up implementation process is based on data gathered from available research tools and reconnaissance of the research's territory.

In summary, pop-up cycle paths are the rapid execution of cycle routes to urban infrastructure. The population can implement this model as part of a tactical urbanism strategy to improve the mobility of a street or community, which occurs with the involvement of the local population. Another example addressed in this paper is the municipality's implementation of a pop-up cycle lane; in this case, urban resources are used to test previously planned routes, implementing the bike lane quickly, with available materials, and with the intention of making the route permanent. This denomination applies to the pop-up works that took place in Bristol and were studied in this master dissertation.

In July 2020, the Department for Transport – DFT – released a new document regulating cycling infrastructure and design for the UK territory. In the cycling infrastructure design content, the “trials” are the actions to implement temporary bicycle lanes, as they could be an alternative to test new bicycle routes in the city. As a result, these cycle paths required the installation of vertical posts/barriers (of various materials) that can be easily deployed to delimit the cycling space on the road, as long as these routes are designed in accordance with transportation regulations to maximise their chances of functioning.

The development of the new cycling transport measures aimed to allocate more road space in urban centres to sustainable transport modes, thus supporting the population's behavioural shift towards active mobility modes. Another reason for investing in bicycle infrastructure was to prevent the limitations set on public transport from causing an increase in the number of cars in the urban environment during the pandemic scenario. Besides that, the pop-up measure enables establishments to use outside areas in the streets, helping them not shut down the business.

Before the pop-up lanes were implemented, the City Council launched an interactive mapping tool that intends to understand the population needs for changes in the city traffic infrastructure to enhance walking and cycling. Figure 19. The public could highlight the locations where some changes could be made in the infrastructure according to their perception of the online platform. In addition, the walking and cycling improvement map had a topic where the citizens could submit a new suggestion in the map or agree with the issue already posted.

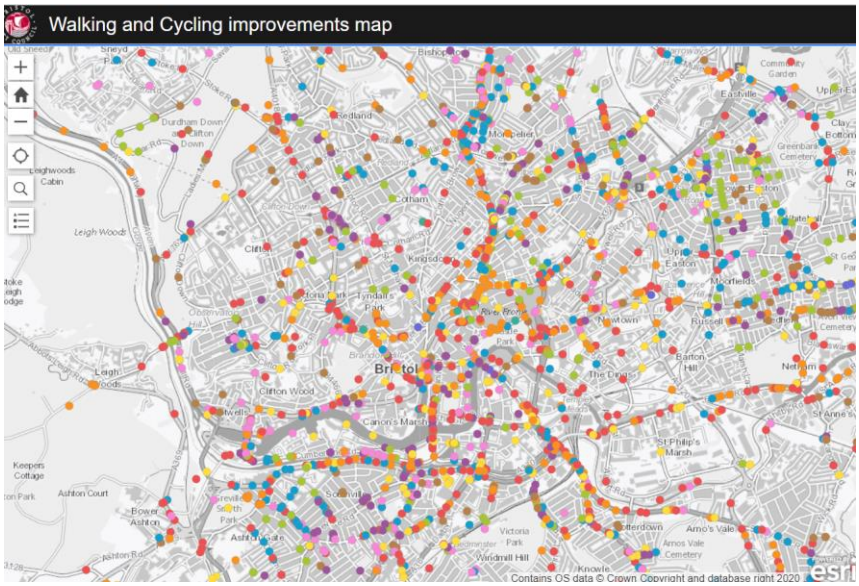


Figure 19 – Walking and Cycling improvements map. Source: Bristol City Council (2020).

The temporary cycle facilities in the Bristol scenario were installed in August 2020[7]. To ensure social distance in busy areas of Bristol city centre, the package included the construction of a safe walking infrastructure, changes to traffic lanes, and the suspension of parking areas. In the first scenario, more pop-up cycle lanes were planned; however, according to the interview with the municipality member, the location of these cycle bike lanes would require construction works and further investments, not amenable to quick implementation. Accordingly, another map was published in September 2020, containing some routes of pop-up cycle lanes that had already been built and other routes that were only planned. Therefore, this research focuses on studying the four main pop-up routes completed in Bristol by April 2021. Figure 20.

[7] Bristol City Council (2020b). Retrieved from: https://news.bristol.gov.uk/news/new-bike-lanes-and-road-changes-in-bristol-city-centre

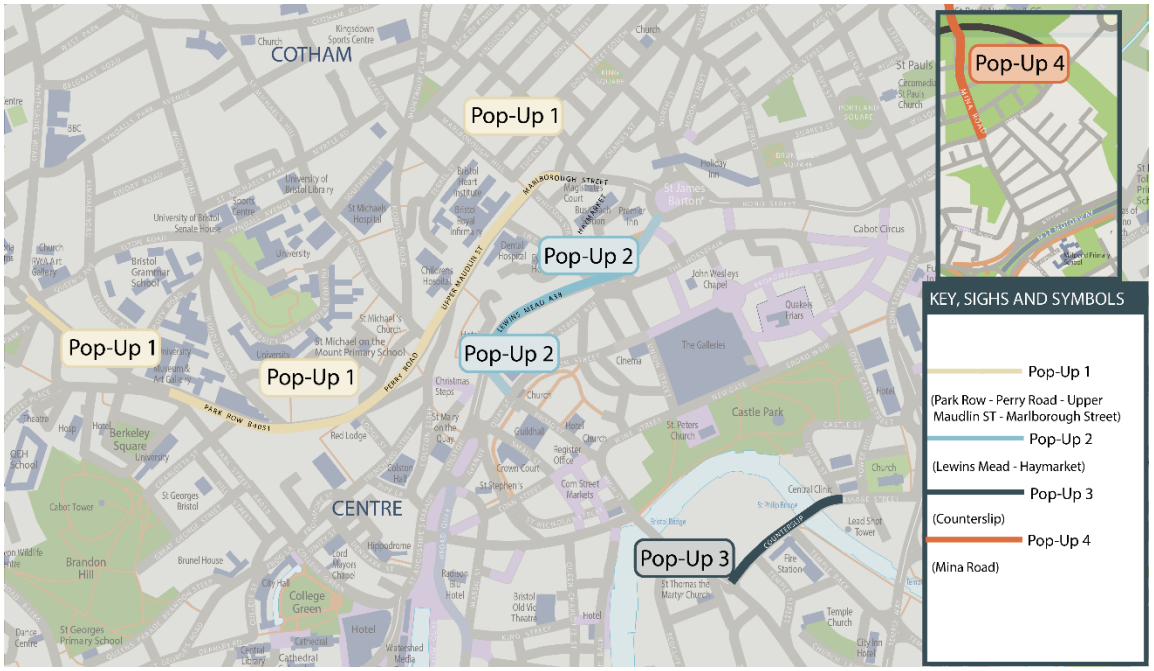


Figure 20 - Pop-up cycle lanes studied in this dissertation. Source: Elaborated by the author from the data provided by Bristol City Council (2020).

Among the main points raised by the Council's correspondent was the fact that, despite all of the difficulties and disasters that have occurred, this pandemic period has proven to be an ideal time to expand the cycling network. Normal urban traffic levels would cause changes to the street space, which would take a long time to implement. Furthermore, based on the interviews, the current projects in Bristol have goals for the next few years. The council member as the chosen model for Bristol street improvements cited the application of the Guide to Healthy Streets Indicators research. The study initially developed for the City of London is based on improving the urban environment for a healthier quality of life for the population. It is based on a series of targets and ten indicators that aim to use better the urban space, including active modes of mobility (walking and cycling). Figure 21.

Figure 21 - The 10 Healthy streets Indicators. Source: Guide to the Healthy Streets Indicators (2017).

According to the council member, the legislation authorising temporary infrastructure would only allow for new cycle path construction until April 2021. So, by this date, Bristol's temporary cycle path project would be completed, and pop-up cycle paths would become permanent. Furthermore, as part of the cycle path implementation process, route counts and monitoring would be performed to analyse the efficiency of the cycling infrastructure implemented[8].

3.2. METHODOLOGY

The methodology analyses first included on-site visits during different seasons and times to understand the object of study within the urban sphere. Thus, this analysis method looked for crucial variants that could influence users' perceptions of pop-up lanes. Moreover, surveys and interviews were also applied as a method of analysis to obtain direct contact with developers and users of cycle paths. From these methodological approaches, essential information could be found, making it possible to analyse and evaluate the new temporary cycling infrastructure and improve the city's cycle network. In effect, the development of the methodology sought to meet the objectives established in this research.

In response to the research objective of analysing the efficiency of the pop-up bike lanes, three specific objects were established; (1) to explore the implementation process of the temporary bike lanes; (2) to conduct a critical analysis of the quality of the infrastructure from the perspective of the author and cyclists; (3) and to identify whether modal shift occurred after the installation of the pop-up bike lanes. The following table summarizes the methodology applied for each object of analysis, described in more detail in the following sections of this chapter.

[8] The results of the counts and monitoring were incomplete for this research, making it insufficient for a concrete analysis.

Table 2 - Explanatory table of the methodology for the investigation of the research objectives.

Object of Analysis/ Methodology	Monitoring of the pop-up infrastructure	Survey	Interviews
Implementation Process	✓		✓
Infrastructure Evaluation	✓	✓	✓
Modal Shift		✓	✓

Subsequently, during the analysis of the data collected (chapter 4), all the methodology applied will be compared collectively. Furthermore, it is essential to explain that each cycle lane was studied individually to compare the results found in the data collection. The decision to study the lanes separate first was made because the pop-up routes are not connected, although they are part of the urban cycling network. Thus, the paths could generate different results for the research according to the urban context inserted.

3.2.1. RECOGNITION OF THE POP-UP CYCLE LANES

Site visits are an essential part of the research process as the first step in any investigation of urban territory. The observation visits were conducted in the investigation areas, focusing on the locations where pop-up bike lanes were already present. The maps of Bristol's pop-up bike lanes, published by the city council between August and September 2020, guided the territory recognition. The pop-up cycle lanes, areas of increased pedestrian space, and changes in road design can all be seen on those maps. Thus, the maps were used to compare the before and after infrastructure documenting data acquired during the research and prove the theories discussed in the literature review (Chapter 2).

During the territory study process, it was decided that the pop-up cycle lanes installed on Park Row, Upper Maudlin Street, and Marlborough Street would be studied together, referred to in the paper as pop-up cycle lane 1. The other sections, Lewins Mead, Counterslip, St Philip's Bridge and Passage St, and Mina Road, would be examined individually in accordance with the city council map's pop-up cycle lanes. Because they are of insignificant length, the other sections of the cycle lane present in the parallel streets described above were not addressed in this research.

Therefore, this stage of the research methodology was crucial for the initial decisions of the territory investigation process and to analyse the implementation process and the quality of the pop-up infrastructure executed in Bristol according to the author's perspective.

3.2.2. SURVEY

This methodology phase consists in apply surveys about the pop-up cycle lanes, trying to reach the significant number possible of Bristol's cyclist population that rides in the temporary cycle paths. The idea of doing the survey comes from the need to get in touch with Bristol's cyclists and the amount of information that can be found once the survey is distributed. The survey made it possible to contact some cyclists willing to be interviewed about their opinion on the new bike lanes.

The survey was carried out using online platforms, allowing the questions to be distributed to groups of local cyclists. The investigations also reached out to cycling activist groups that had previously collaborated with the council on cycle path proposals and were available for consultation on the survey subject. The support of cycling activists was critical in the survey's creation, as they knew what language to use with the public and where to find information about the city's infrastructure and bike paths.

The survey was divided into six sections, the first of which separated responses from cyclists who ride on the pop-up cycle path, permanent cycle paths, and people who never cycle in the city. These three options would lead to specific questions about the lane type and exclude no cyclist commuters from the survey. So, the second part of the survey focuses on understanding cyclists' opinions and behaviours on pop-up lanes, and the third part focuses on cyclists riding on permanent bike lanes in Bristol. The decision to separate the sections between the types of cycle lanes focused on achieving more responses on temporary cycle routes; for that purpose, cyclists using both types of cycle lanes - permanent and temporary - mandatorily responded only about the pop-up bike lanes. However, information on cyclists' perspectives on the two types of lanes could provide a comparative analysis of infrastructure quality during data analysis. Figure 22.

Accordingly, sections two and three present maps showing where the two types of cycle lanes are located in the city of Bristol – temporary and permanent – with those maps, the cyclists were able to mark the specific cycle lanes they use for cycling in their daily lives. In the beginning, the questions are dedicated to understanding cyclists' behaviour during the last few months, between August 2020 and April 2021; these questions could answer the influence of new temporary infrastructure on the decision to use cycling modes. The following questions seek in understanding the frequency of bicycle use before and after the coronavirus outbreak, essential data for this investigation.

Additional questions were asked about the infrastructure quality of the two types of cycle paths. The answers to these questions allowed us to examine the impact of cycling facilities and the sense of safety they create along cycle routes. In this section, an open question was left for the cyclist to answer as they saw fit. At the end of the sections (2 and 3) on the different types of cycling routes, one question asked if the cyclist had engaged in any modal shift activity in the previous year (between August 2020 and April 2021).

Section four, on modal shift, would assist in determining whether people have switched from other non-sustainable modes of transportation to commuting by bicycle and the purpose of travel by sustainable modes. After section four, the survey had a non-mandatory section where the interviewee could provide a personal email address to be contacted for a brief interview about personal views on Bristol's cycle lanes and pop-up routes built in the city in the summer of 2020 (section 5). The survey concludes with personal questions about the respondent, such as age, gender, cycling experience and occupation (section 6). (Appendix III).

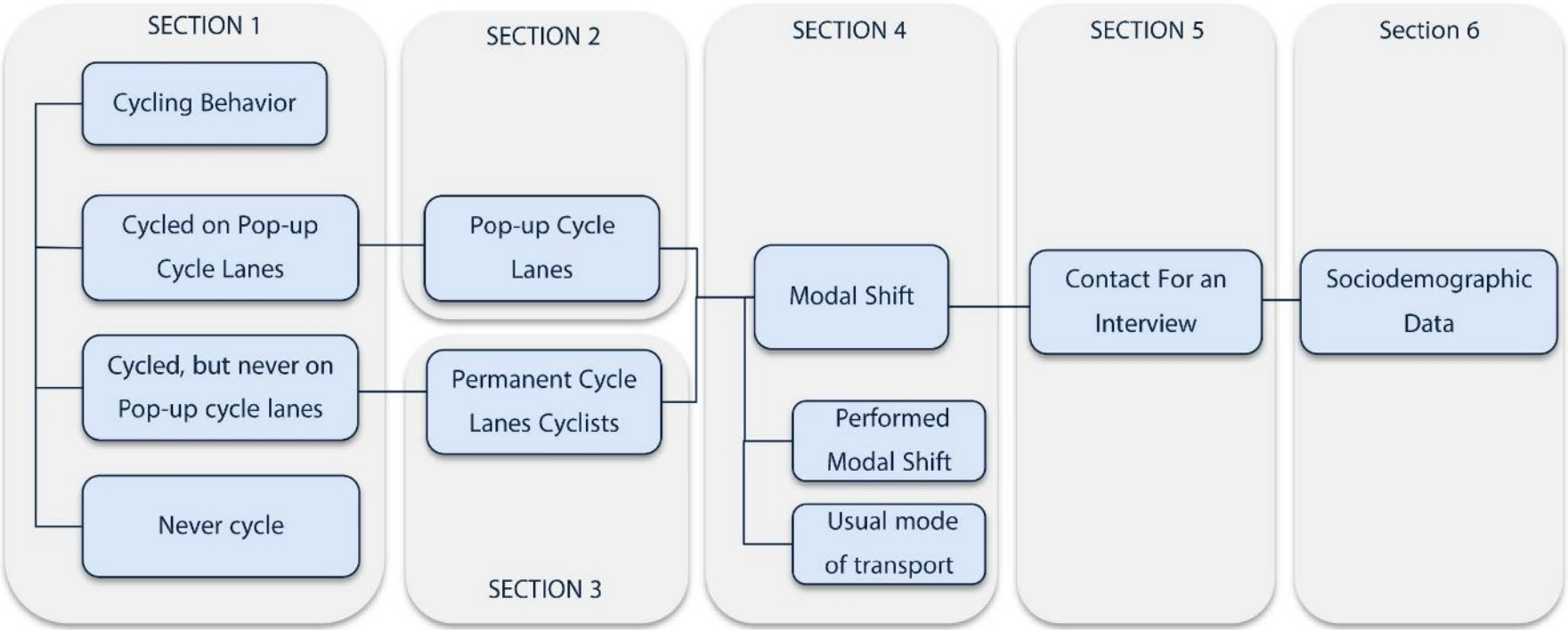


Figure 22 – Diagram describing the sequence of sections and questions asked in the survey according to the purpose of the research. Source: Elaborated by the author.

3.2.3. INTERVIEWS

The interviews focused on four main groups: the city council, cycling activists, general cyclists and cycling shops. Each of these groups would bring to the research different perspectives about the process of the pop-up lanes implementation and effectiveness. These perspectives focus on background infrastructure, planning of temporary cycle paths, the implementation phase, the project's impact on cycling behaviour, finally, whether this project will become permanent.

The first phase of the interviews was characterised by interviews with the Bristol city council, carrying out recognition of the cycle paths by viewing the temporary infrastructure implementation. The meetings then went over the facility's objectives and how they relate to the city's current transportation agenda plans, including an explanation of Bristol's adopted 2019 Transport Strategy. In addition, the Clean City Air for Bristol organisation and the West of England Local Cycling and Walking Infrastructure Plan 2020-2036. These documents guide the new investments in urban mobility infrastructure in the city of Bristol for the next couple of years, so it would be necessary to understand the city's government goals and objectives.

Contact with cycling activists was critical for the research because it allowed us to understand the city's overall cycling landscape. This provides the most up-to-date information on how the construction of pop-up bike lanes in urban areas has evolved since the pandemic's inception. Furthermore, activist organisations are typically very active on social media and can serve as a resource for contacting more cyclists. Activists interviewed demanded that the municipality improve active mobility infrastructure at the start of the pandemic crisis. They set up platforms on which the population could indicate where cycle paths should be implemented and where barriers prevent the flow of bicycles. Accordingly, the activist group had an essential role in elaborating the survey, the choice of questions, and the public's approach.

According to personal opinions on the facility, the interviews for the general cyclist populations focused on answering key research questions about the effect of pop-up infrastructure on everyday cycling. The interviews were conducted with cyclists who, according to the survey, had made a modal shift or had already used the pop-up cycle paths before the infrastructure was installed. Because they are the primary users, the public polled would make critical decisions regarding the classification of the cycle paths. Simultaneously, it was sought to determine whether cyclists believed that pop-up cycle lanes made a difference in the improvement of cycle paths in Bristol.

Table 3 – Table of questions conducted in the interviews with the cyclists

	Questions
I.	Have you been using your bicycle more between August 2020 and April 2021?
II.	Have you noticed more people using a bicycle during this same period?
III.	Have you switched from another mode of transportation to bicycling in this same period? If yes, which one and why?
	Considerations about pop up bike lanes:
IV.	Do you agree with the sections chosen for pop up bike lanes?
V.	Do you feel safer using the bike on these routes?
VI.	Any other considerations about the pop-up bike lanes?
VII.	Do you agree with the sections chosen for pop up bike lanes?

The idea of interviewing bike shops next to the routes of the pop-up lanes occurred because many of the staff in these shops also cycle. Besides that, during the second pandemic lockdown, the UK government allowed cycle shops to remain open to encourage active mobility modes in the city[9]. For this reason, this type of establishment could give an available answer on the general effect of the pop-up infrastructure and the level of cyclists travelling in the area from the number of people frequenting the shop and by observing the surrounding area. A variety of bike shops were found, ranging from modern shops selling electric bikes and scooters to more traditional bike shops that have been in the area for many years. These shops frequently repair bicycles that pass through the area and could be a good source of feedback from cyclists about the new lanes. Overall, five bike shop interviews were conducted, and these were able to answer three main questions from the perspective of the interviewed employees. As a result, it sought to interview existing employees at the establishment prior to implementing the temporary cycle lanes and working during the lockdown period (when the pop-up cycle lanes were implemented). (Appendix IV).

[9] The Health Protection (Coronavirus, Restrictions) (England) Regulations 2020 - Retrieved from: *https://www.legislation.gov.uk/uksi/2020/350/schedule/2/part/3/made?view=plain*

4

EFFECTS OF THE POP-UP CYCLE INFRASTRUCTURE

4.1. ANALYTICAL REVIEW ON THE IMPLEMENTATION PROCESS OF POP-UP CYCLE LANES

The first pop-up cycle map in Bristol (August 2020) was related to the overall urban network map to analyse the city's cycling network. Although the pop-up map showed some of the previously existing cycle paths, it was important for the research to understand the cycle routes in the urban context. Subsequently, in September 2020, the municipality released an updated map with the temporary cycle paths built. However, during the route update, important sections of cycle lanes in the urban centre were removed from the project. Comparing the map below (Figure 23), with the map from September 2020, (Figure 24), some cycle paths have been removed from the project, and others, not with the same proportion, were added. The maps also highlighted common characteristics between the planned temporary routes, such as implementing pop-up cycle paths where there is already a cycling section; and the lack of connection between the pop-up cycle paths and the permanent urban routes. (Appendix I).

As a result, during the interviews, the City Hall was questioned about the map modification, and it was stated that the original map was published to inform the public about changes in urban paths. Some cycling sections were removed due to the need to modify urban infrastructure as part of the implementation of the public works, a project that was incompatible with the goal of pop-up cycling paths. As a result, it was decided to install pop-up bicycle paths where there were already cycling sections because it was anticipated that routes near the urban core would have high mobility demand until the lockdown was lifted. Therefore, instead of serving other city areas by extending the urban cycling scale, it was decided to improve the cycle paths in the Bristol city centre, prioritising active modes in this area. Consequently, there was no concrete response to the lack of connection between cycle paths.

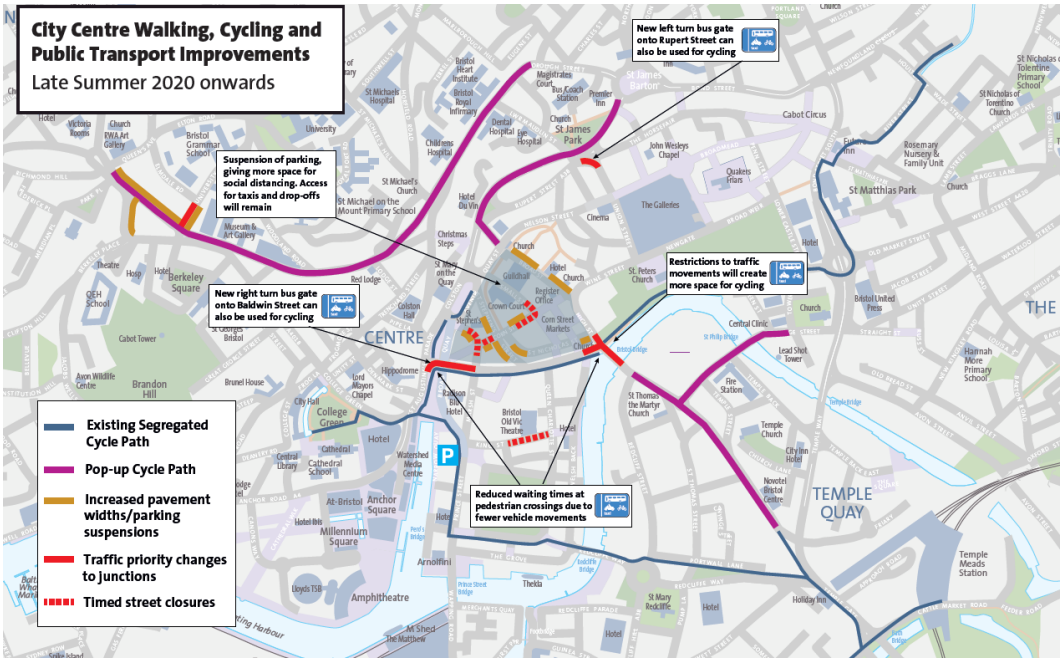


Figure 23 – City Centre Walking, Cycling and Public Transport Improvements (Late Summer 2020 onwards). Source: (Bristol City Council, 2020a)

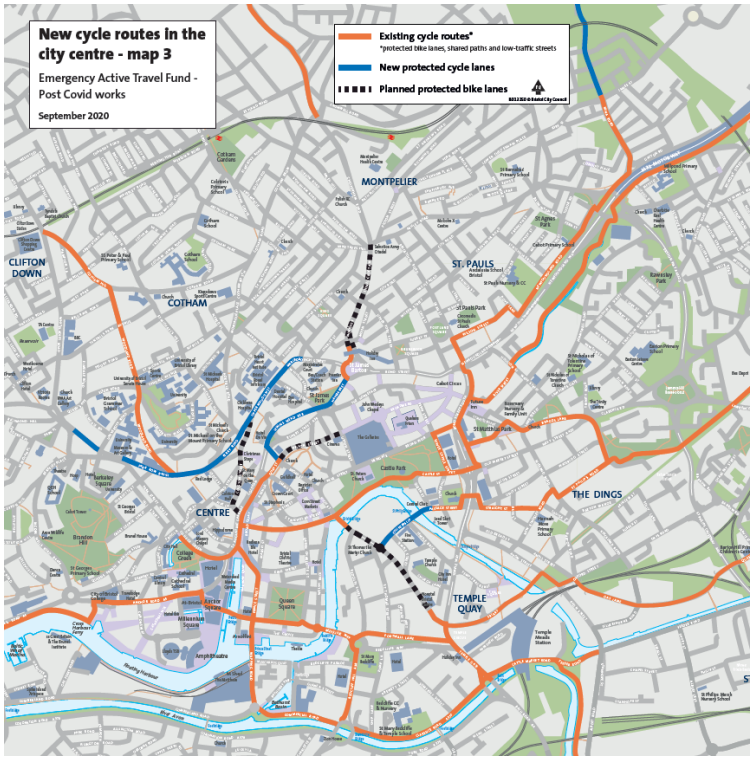


Figure 24 – New Cycle Route In The City Centre – map 3. Source: (Bristol City Council, 2020b)

The interviews with the municipality were critical in understanding the city's ongoing urban mobility projects. Many of these projects are related to the fundamental goals of pop-up or cycle lane locations,

indicating a concentration of investment in Bristol's city centre. This concentration of investment has raised concerns about the impact of public opinion on the location of cycling infrastructure implementation and improvement. Furthermore, such decisions reveal a great deal about the prioritisation of locations for urban improvement.

During the interviews with the bicycle activists, they discovered that they initiated the idea to construct temporary bike lanes. Through the online communication vehicle, cyclists noticed the movement of pop-up bike lanes being developed in cities as an incentive to active mobility modes during the pandemic, requiring concrete action from Bristol City Council during the first half of 2020. In this sense, the platform held online forums to consult the population on possible better cycling infrastructure in the city, encouraging active mobility modes once the avenues were favourable.

According to the council interview, the implementation of the temporary cycle lanes was indeed quick in comparison to the usual patterns of work execution in the city. According to the municipality, similar bike path work would take about six months to complete, whereas the pop-ups were installed in three to five working days, depending on location. However, research into local news regarding the pop-ups revealed that in other parts of the city, outside the administrative centre, sections of pop-up cycle lanes were being carried out without proper signposting or informing the community. Thus, these lanes were quickly removed as they could cause accidents involving cyclists and vehicles, demonstrating that quick implementation does not always mean efficient planning.

The map analysis and site visits revealed that some of the bike lanes proposed in the pop-up project had not yet been implemented (at the time of this dissertation). On the other hand, the municipality stated that the pop-up cycle paths that had been installed would have to become permanent after April 2021, the deadline for which the legislation authorising this type of infrastructure was still in effect. Furthermore, no more pop-up bike lanes could be installed in the city, implying that the project would not be completed.

4.1.1. COMPARISON BETWEEN IMPLEMENTATION PROCESS IN BRISTOL AND POP-UP CYCLE PATHS MANUALS

In this topic, it is essential to understand that, despite the strategies to improve urban mobility in Bristol, no manuals or guides for implementing and replicating pop-up cycle lanes in the city were elaborated. According to meetings developed with the council councillor, the pop-up cycle lanes in Bristol were built following the British Cycle Infrastructure Design Manual, which describes temporary cycle lanes as “Trils”. Despite the fact that all of the features of this infrastructure are related to tactical urbanism, Bristol's cycle lanes were implemented by the city council, which is very similar to the execution of permanent cycle lanes.

The literature review chapter (Chapter 2) was also dedicated to analysing other pop-up cycle plans developed worldwide after the pandemic outbreak. The research understands that guidelines for the construction of temporary cycle paths are as necessary as the goals set for the infrastructure. The manuals analysed in the literature review were the “Making Safe Space for Cycling in 10 Days” and “NACTO manual Streets for Pandemic Response”, so this phase of the analysis is dedicated to describing the characteristics of the planning and implementation process of the pop-up cycle lanes in Bristol, according to the topics studied in the pop-up manuals. The table below compares the manuals for pop-up cycle lanes to the Bristol project. As a result, based on the research findings, such as documents and maps found on the council website and interviews with council representatives and the cyclist population, it was determined which manual is more similar to the Bristol project.

Table 4 – The characteristics of the planning and implementation process of pop-up cycle paths in Bristol, according to the topics related to the manuals Making Safe Space for Cycling in 10 Days (BERLIN) and The NACTO manual Streets for Pandemic Response.

Comparative Topics / Emerging Plans	POP-UP Cycle Lanes Bristol
Temporary Cycle Infrastructure	YES
Other Temporary Infrastructure	Walking
Descriptive manual for the implementation	Low or no level of detail on the implementation of pop-up cycle paths;
Decision location for the pop-ups	Location chosen through popular online research and previous plans to reduce traffic in the urban centre and clean up the city's air;
Connection to the existing cycle network	Project partially connected with existing cycling network;
Implementation	Place selection; rapid implementation of cycles routes (3 to 5 days); monitoring and counting; process to make routes permanent;
Verification of the plan's efficiency	Counting and monitoring cycle paths;

The table below compares the manuals for pop-up cycle lanes to the Bristol project. As a result, based on the research findings, such as documents and maps found on the council website and interviews with council representatives and the cyclist population, it was determined which manual is more similar to the Bristol project.

Table 5 – Table correlation between the characteristics described in the studied manuals and the process of design and implementation of cycle paths in Bristol. The symbology (✓) to identify similarities between plans and (✗) to indicate lack of relation.

Similarity between manuals	POP-UP Cycle Lanes Bristol		
	Making Safe Space for Cycling in 10 Days (BERLIN)	The NACTO manual Streets for Pandemic Response	No resemblance
Temporary Cycle Infrastructure	✓	✓	
Other Temporary Infrastructure	✓		
Descriptive manual for the implementation			✗
Location decision for the pop-ups			✗
Connection to the existing cycle network			✗
Implementation			✗
Verification of the plan's efficiency			✗

OTHER TEMPORARY INFRASTRUCTURE

Aside from the pop-up cycle lanes, the Bristol project also included pedestrian pavement widening. This infrastructure was frequently built near the city's cycle paths, with a focus on pavements with high pedestrian traffic and high traffic flow between shops. This implementation is similar to the German manual, which emphasises the exclusivity of pedestrian pavements and the improvement of high-traffic areas. In this regard, the NACTO manual details other spaces, in addition to the pedestrian space, encouraging active modes and social distancing.

DESCRIPTIVE MANUAL FOR THE IMPLEMENTATION

This study classified the descriptions in the manuals about how to implement the pop-up infrastructure as advanced, medium explanatory, and lacking a concrete pattern. According to the study's findings, the manual or documentation aids in the implementation of mobility infrastructure agencies, as well as being the simplest way to replicate actions in the city that follow the same pattern and have connectivity. The Berlin manual, *Making safe space for cycling in 10 days*, describes how the cycle lanes plan should be executed, from the basic principles to how many hours each step should be completed, the planning process, execution and evaluation of the adopted measures. Due to the high level of detail, the Berlin

manual was classified as an advanced level of detail in this research. The NACTO manual, while detailing the stages, does not have any deadlines for the completion of the project, focusing on the location for the establishment of the execution process. As a result, this manual is classified as Medium explanatory in this dissertation.

Despite other work done around the world, there appears to be no manual or document describing what would be done step by step for the Bristol infrastructure. The pop-ups in Bristol were implemented in three stages: site selection, design and implementation, and infrastructure verification. There was no clear concept or method of implementing temporary infrastructure in the city, which led to the conclusion that this plan would be classified as having a low level of implementation standard, as no replicable standard was developed, resulting in no similarity with the other plans.

DECISION OF THE LOCATION OF THE POP-UPS

When entering the decision aspect of the location chosen for the pop-up cycle paths implementation, both in the NACTO and Berlin manuals, topics were found about the need to deliver safe mobility mainly to the so-called essential workers. On the contrary, in the project executed in Bristol, there was no established concrete objective regarding the choice of implementation locations. The objective of each pop-up route was not highlighted, as there was in the cities that applied the manuals. As previously described in the case study, it was discovered that in Bristol, cycle paths were prioritised over the city administrative centre, a route already incorporated in strategic plans to improve urban transport and air quality in UK cities.

CONNECTION TO THE EXISTING CYCLE NETWORK

There is a poor connection between newly implemented routes and existing national or regional cycle routes in Bristol, as revealed by the urban map and site visits. The change in routes between the first and second maps resulted in a lack of connection between the center's sections in some sections. Furthermore, only rail transport connects the Bristol cycle network to the bus network. Unlike the highlighted manuals, which emphasise the importance of connectivity between routes for cycle flows and other sustainable transportation networks.

IMPLEMENTATION

Within the Berlin manual, some examples of the pop-up projects implemented in the city can be observed. The NACTO manual does not show cycle paths built on the basis of the manual; rather, it shows examples of similar infrastructure in other countries. As the only similarity, it was described in the Berlin plan and Bristol the fast implementation as a relevant topic for the pop-ups, which take place in just a few days of execution. The three manuals' implementation processes are said to use different methodologies, and despite the similar shape of the pop-up cycle paths, it is noticeable that the Berlin cycle paths were more careful with the execution of the infrastructure. Concerning the unfinished cycle paths in Bristol, with no connectivity and gaps in the cycle path.

VERIFICATION OF THE PLAN'S EFFICIENCY

As a form of project verification, the plans chose similar counting and monitoring methods to evaluate the infrastructure, chosen location, and bicycle usage. However, each manual and project applied the counting and monitoring method differently. After all of the cycle routes had been installed, the Bristol pop-up project monitored and counted them. According to the council, the justification for this was that more people would be moving on the street at the end of the lockdown phases. According to the interviews conducted, the counts are part of the standard process of implementing cycle paths in the city to prove the use of the investment for the required purposes. Therefore, the counts were performed by a

specialized company, which set up equipment in specific locations of each pop-up section. Therefore, the counts took place during one week, mostly at peak hours (depending on the location counted).

4.2. EVALUATION OF THE POP-UP INFRASTRUCTURE

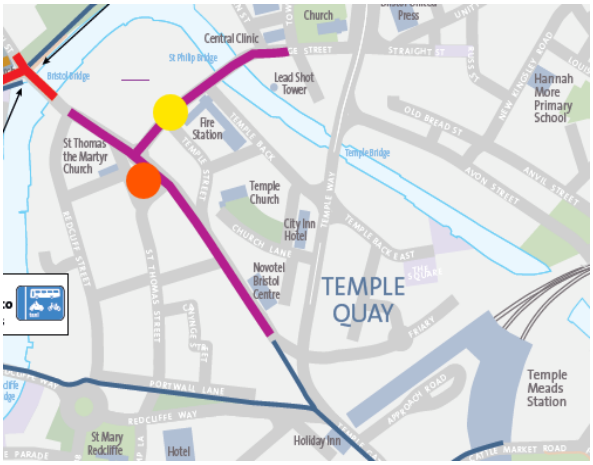
An analysis of the infrastructure in this topic will be based on the group of methods developed in this dissertation; first, a general analysis of the routes created, then an individual analysis of the pop-ups. The evaluation of the implemented infrastructure was based on two moments of the research, the initial phase after the implementation and at the end of the research.

4.2.1. GENERAL ANALYSIS OF THE POP-UP CYCLE NETWORK IN BRISTOL

The maps for the comprehension of the implemented routes identified the lack of connectivity between the chosen pop-up sections and the existing cycle paths in the city. This statement occurs despite the fact that three pop-ups (pop-ups 1, 2, and 3) are in the same region and only one path was implemented in a residential neighbourhood (pop-up 4).

Following an examination of the final map of the temporary bike routes, it was discovered that there were attempts to connect the pop-up sections one and two primarily. However, none of these routes is evident on the path and occupies a concise street segment that does not fully connect the pop-ups. These factors increase when referring to inexperienced cyclists who do not have full knowledge of the route. For example, the parallel and main streets connecting the pop-ups do not have finished cycling infrastructure in the image below. Another aspect of the investigation that was looked into was the lack of continuity in the cycling routes, which put cyclists in dangerous situations among urban traffic. As an example of the lack of continuity of cycle paths, the following photos show that cyclists find significant intersections with several lanes of vehicles at the end of the two pop-up routes (1 and 2), without cycle lane signs showing priority to cyclists. Figure 27.

The pop-up three, which in the initial map of the interventions, appeared to be one of the most promising sections, since it was included in the route that connected Bristol central station - Temple Meads - to the central hub of the city, did not present a clear sense of execution after the removal of Victoria Road from the project. Figure 25. During the monitoring, it was discovered that the pop-up cycle path four (Mina road), which would have been chosen due to its proximity to the national cycle path, did not have a clear route connecting these two points.

(I) 

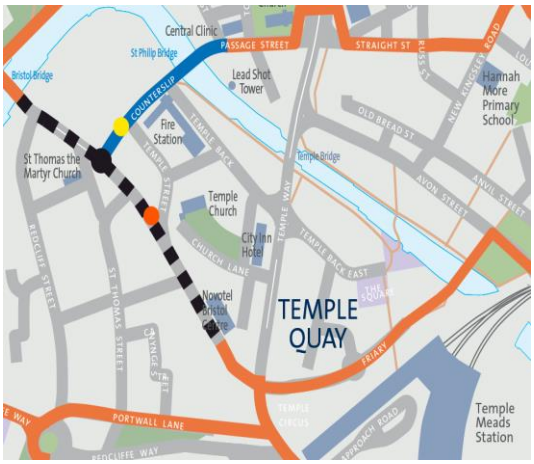
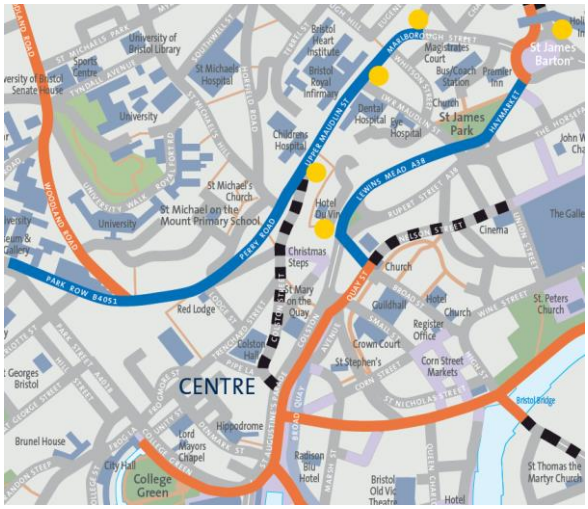
(II) 

Figure 25 - (I) first map demonstrates Victoria street included in the cycling plan in August 2020 (orange dot) followed by pop-up 3 (Couterslip) (yellow dot); (II) second map, September 2020, shows Victoria street as planned cycle path (orange dot), and pop-up 3 (Couterslip) already executed (yellow dot). Source: Elaborated by the author from the data provided by Bristol City Council, 2020a and Bristol City Council, 2020b.

Figure 26 - Image demonstrates the Mina Roda cycling path (yellow dot) in connection with the existing cycling network (orange path); however, this connection does not exist as a form of infrastructure in the actual scenario. Source: Elaborated by the author from the data provided by Bristol City Council, 2020b.

(I) 

(II) 

Figure 27 - I) In this map were highlighted in yellow points the possible connections between pop-up bicycle lanes; (II) Image demonstrates the lack of painting and signalling of cycle lanes in interconnection axes of the city. Source: Elaborated by the author from the data provided by Bristol City Council, 2020a and Bristol City Council, 2020b and Google maps 2021.

The survey conducted got most of the responses from pop-up cycle lane users, meeting one of the research objectives. In the questions about cycling frequency prior to the pandemic, both groups (pop-up and permanent cycle path users) responded that they had previously cycled, indicating that the survey did not reach new cycling users. Because they are already considered regular or experienced cyclists, this public will have an impact on the answers obtained about the infrastructure.

In this regard, the comparison of pop-up and permanent cycle paths on infrastructure quality revealed that none of the topics had a mostly positive effect on infrastructure use choice. There were more positive opinions in the Vertical traffic separation issue, but still lower than the number of answers qualifying the infrastructure as medium and low quality. As a result, based on survey responses, the following graph identifies the cycle path surface and signs at intersections as the two most serious issues, in the opinion of cyclists. Figures 28 and 29 are illustrative.

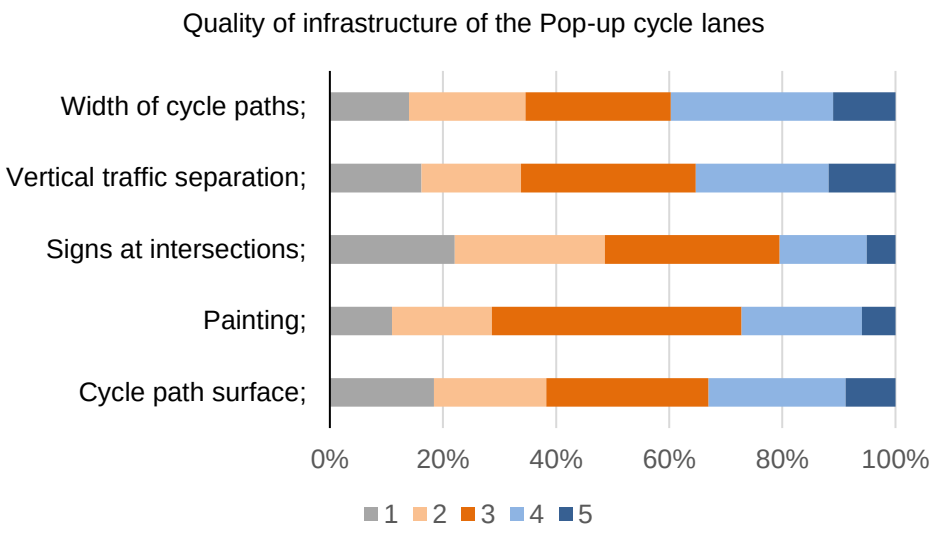


Figure 28 - Graph with the survey answers about the quality of infrastructure of the Pop-up cycle lanes according to the shared experience and opinion. 1 = Very unsatisfied 5 = Very satisfied. Source: Survey developed by the author.

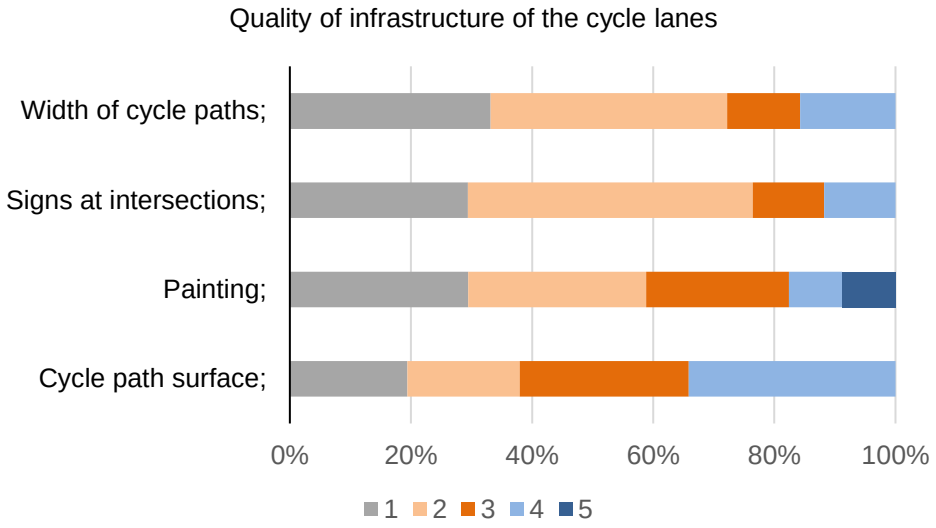


Figure 29 - Graph with the survey answers about the quality of infrastructure of the regular cycle lanes according to the shared experience and opinion. 1 = Very unsatisfied 5 = Very satisfied. Source: Survey developed by the author.

Regarding the feeling of safety, an essential issue within the aspect of pop-up implementation, the point regarding protection against traffic intensity was highlighted as positive. On the other hand, among the negative aspects or those without influence on safety were; Path is illuminated; Quality of the road surface. According to the respondents' opinions, these results are directly related to the perception of new users of bicycles and the problems associated with local overcrowding. Figure 30.

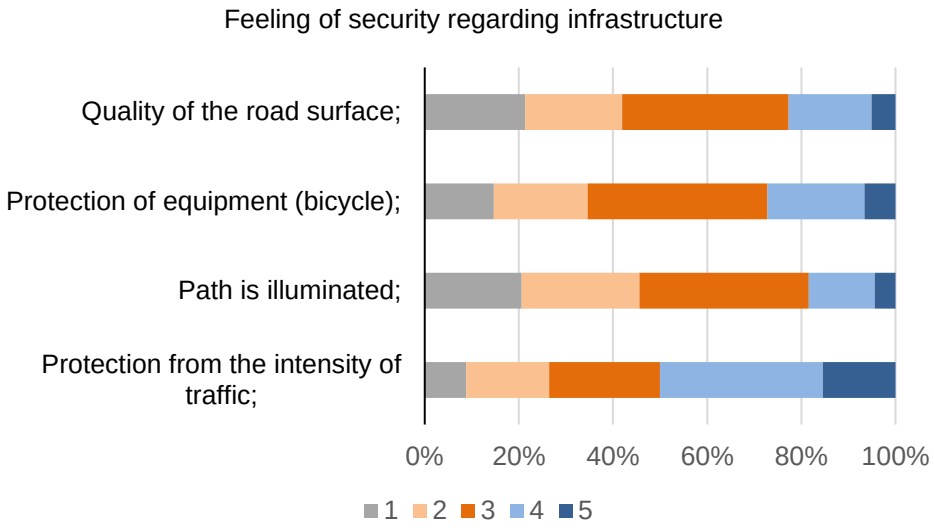


Figure 30 - Graph with the survey answers about the feeling of safety of the Pop-up bike lanes according to the public experience and opinion. 1 = Very unsatisfied 5 = Very satisfied. Source: Survey developed by the author.

Within the survey, in one of the questions, cyclists could describe how they felt about the pop-up bike lanes' safety and quality of infrastructure. In this sense, the following table divides between positive and negative aspects. The main topics reported by cyclists, helping to understand the answers found in the survey graphs.

Table 6 – Answers from the survey on pop-up infrastructure in Bristol.

Positive Aspects	
VIII.	New cyclists feel more comfortable and protected from traffic;
IX.	More attractive to new cycling users because of ease of use;
X.	Block cars from parking in bike lanes;
XI.	They are located on prominent roads from the urban centre;
Negative Aspects	
I.	Lack of connectivity and coherence;
II.	More experienced cyclists feel more comfortable riding outside of the bike lanes due to the poor surface;
III.	Lack of signage and lack of indication of bike lane entrances and exits (start and end);
IV.	Barriers sometimes fall or are removed by local merchants or delivery drivers for parking, which can cause accidents;
V.	Changing routes become more complex with pop-ups;
VI.	In sections that are not well signalized, they cause conflicts with pedestrians;
VII.	Trash accumulated on cycle paths;

It was possible to collect various opinions about pop-ups using the opinions described in the survey. For example, it became clear that new cyclists feel more at ease on pop-ups, whereas more experienced cyclists feel more confident riding on the road due to the quality of the cycling surface. At same time, both report significant problems with vehicles in the region due to the failure to prioritise cycle lanes. Typical comments include separate cycle lanes and inconsistent cycling routes. Local drivers removing pop-up lane protection barriers to park or make deliveries was the most frequently mentioned topic by cyclists in the region.

In the interviews conducted with the cyclists who answered the survey, it was interesting to understand different parameters about the problems observed in the city. Each cyclist interviewed brought their perspective on how the problems of the cycling routes affect them, and an interesting point of the interview as it proves that each person has a particular experience cycling in the city. Table 7.

Table 7 - Most relevant answers to comprehend cyclists' opinion about pop-up cycle lanes.

	Responses from the interviews
I.	Difficulty in using pop-ups because of the type of bicycle, e.g. cargo bikes;
II.	Comparison with cycling experiences in another city (example: Colone, Germany);
III.	Pedestrians crossing cycle lanes, lack of pavement markings or sharing pavement with pedestrians;
IV.	Difficulty in exiting the pop-up routes, either due to the size of the bike or just to change the route;
V.	Lack of confidence to cycle with children;
VI.	No continuity between cycle routes;

4.2.2. INDIVIDUAL ANALYSIS OF POP-UP ROUTES

4.2.2.1. Pop-Up 1 – (Queens Road - Park Row – Perry Road – Upper Maudlin St – Marlorough St)

As explained earlier, pop-up one was analysed in this research as a set of cycle path sections connected by the implemented direction and road flow. However, for Bristol City Council, these routes were designed and implemented separately, each individual section did the municipal analysis of the routes. According to the survey, the pop-up has the highest number of users, with approximately 37 percent of those who responded using this route due to several factors such as an important commercial area, connection to the urban and administrative centre, city parks, and connection to essential city streets. Figure 31.

Figure 31 – Photo of a section of Upper Maudlin St, part of the Pop-up 1 cycle path. Source: Photo taken by the author.

Street characteristics on this route include varying widths across the route, making it challenging to separate cycle lanes from vehicles. As a result, some sections of this route have been modified to prioritise active mobility modes, such as expanding pedestrian walkways and adding new bike lanes. The findings lead to the first diagnosis of infrastructure problems, as cyclists feel compelled to ride in the car lane to overtake due to a lack of continuity in the route and cars parked in the cycle lanes.

The first map made by the municipality and the official map shows the pop-up route 1 continuously to the junction of St James Barton Roundabout. However, what was observed were stretches of discontinuous implementation of the vertical posts, with the floor paint unprotected from the wear and tear of car tyres, causing the paint to wear out quickly. There are numerous infrastructure gaps, parking spaces, and no priority space for bicycles along this route, which connects the city's busiest streets to the urban administrative centre. In addition, there are only a few bicycle parking spots, which are not sufficient to cover a large stretch of road. Figure 32.

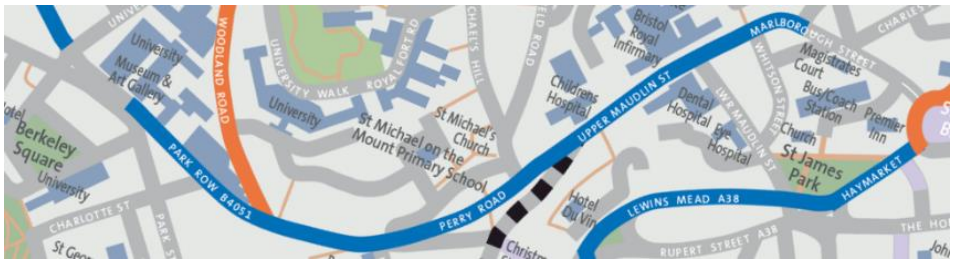


Figure 32 – The map of Bristol's illustrates the pop-up cycle paths (edited) focus for route referred to as Pop-up 1. Source: Bristol City Council, 2020b.

The map below highlights all sections of Route 1 where there are no connections between pop-up cycle lanes. The diagnosis of the cycling flow disruption reveals that, despite the urban modifications made, there were still parking areas between cycle lanes, interfering with the positioning of vertical posts. Another point was bus stops, which sometimes functioned as cycling or cut through the cycle lane and parking lots. It was also understood that vertical posts should not be used between intersection corners due to passing cars; however, the painting of bike lanes sometimes ends without indicating the priority of passage of cyclists. Figure 33.

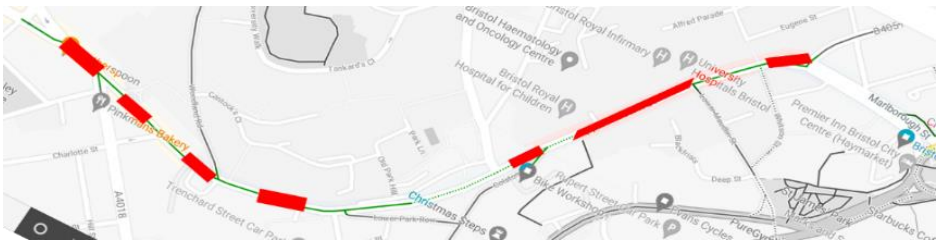


Figure 33 – Diagnostic map of the Pop-up 1 cycle route interruptions. Green line - route of Pop-up 1; Red lines - sections of cycle route interrupted by lack of infrastructure signposting. Source: Edited from google maps by the author.

As noted earlier in this paper, before implementing the pop-up cycle paths, there were already sections of cycle lanes on the pop-up route. The map below highlights the cycling sections of the city of Bristol before the implementation of the pop-ups. However, when comparing the overall cycleway map with the previous diagnostic map (image x), a continuation of the disruptions was seen at various points along the cycle route.

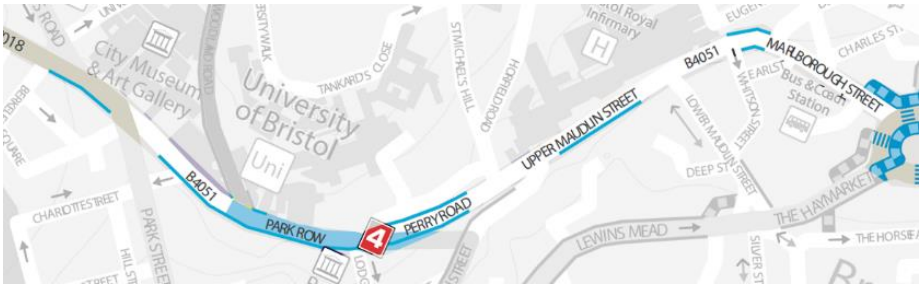


Figure 34 – The map illustrate in blue existing permanent bike paths in Bristol; focus for route referred to as Pop-up 1. Source: Bristol's Cycling Network Map (Bristol City Council, n.d.).

According to the survey responses for this pop-up, local drivers and delivery vans remove vertical posts to park on these cycle paths, leaving them on the ground, which can cause serious accidents. Another problem identified was the amount of rubbish in the cycle lanes, another barrier to cyclists' safety. Furthermore, they reported difficulties changing directions while in the pop-up cycle lanes and pedestrians crossing the cycle lanes at some points, particularly near intersections.

The sections of Queen Rd that received the most attention were those where one of the lanes was removed for pavement widening, and vertical posts for cycle lane protection were installed. Figure 35.

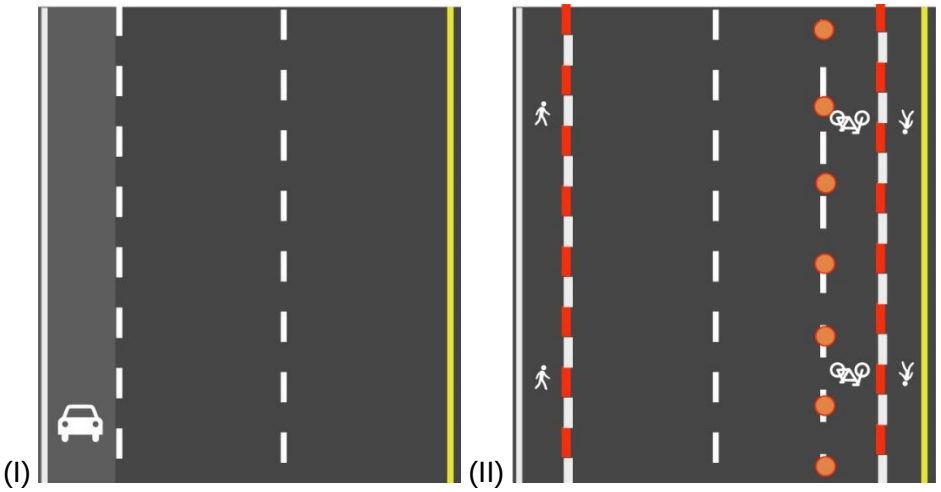


Figure 35 – The map (I) before and (II) after the implementation of the Pop-up Cycle Path 1 infrastructure, section located on Park Row Street towards Perry Road; Removal of parking on one of the traffic lanes, widening of the pavement and implementation of vertical posts to create a pop-up bicycle lane. Source: Elaborated by the author.

The first section of this route begins at the intersection of Whiteladies Rd and Queens Rd; this section had a cycle path demarcation one year before the pop-up was implemented. With this temporary cycle lane initiative, the demarcation is extended, and vertical barriers were installed to the end of this block; additionally, there was pavement widening to support people's social distancing. Next, the section between Queens Rd and Park Row lacks pavement markings and vertical posts, forcing cyclists to share street space with cars. The pop-up bike lanes reappeared a few blocks later, on both sides of Park Row street, extending for a short distance just before the intersection with Woodland road. Figure 36. Then, on Perry Rd, some vertical barriers and cycle lanes are installed, with the characteristic being

discontinued, until Old Park Hill, where the cycle lane is continuous up to the intersection with St Michael Street, featuring the route's longest stretch of the pop-up cycle lane. Figure 37. The infrastructure then disappears for a while until it reappears at Upper Moundlin St, a vital landmark because of the Children's Hospital. Figure 38.

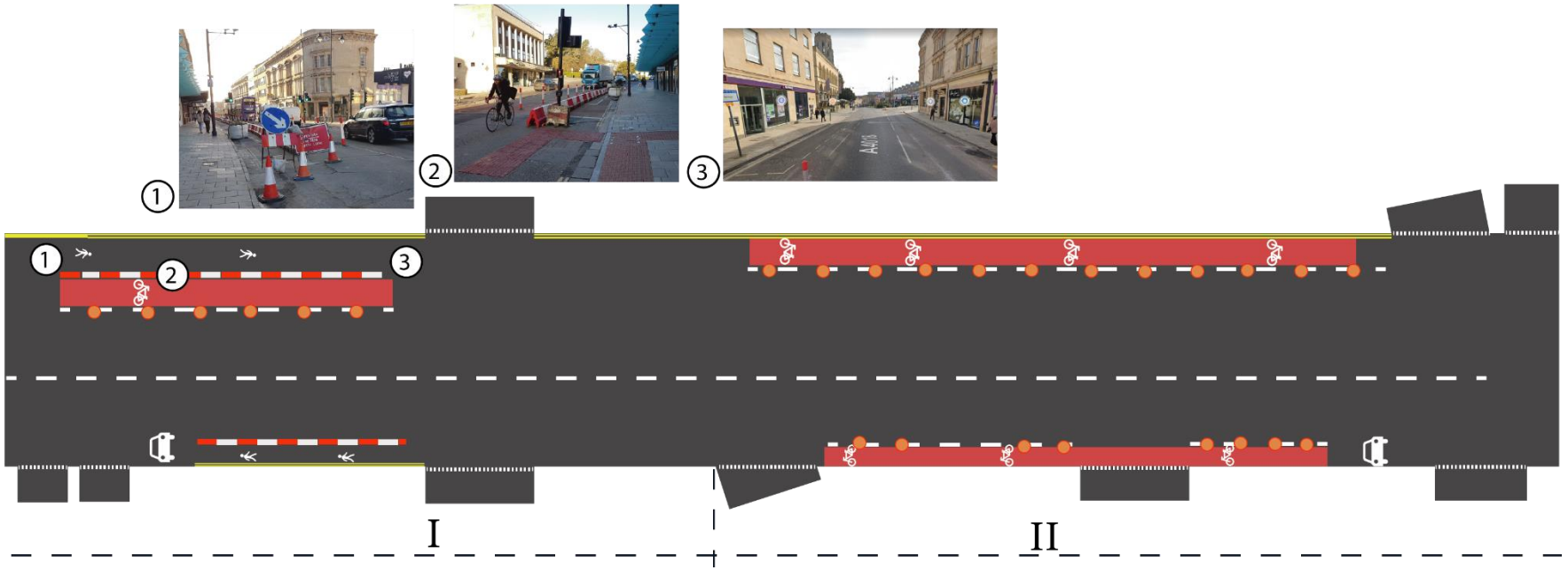


Figure 36 – The map of section 1 of the Pop-up cycle path 1; (I) Queens Road; (II) Park Row. 1- the start of the pop-up cycle path and extension of the pedestrian zone; 2- the intersection between pop-up and pedestrian lane. Source: Elaborated by the author.

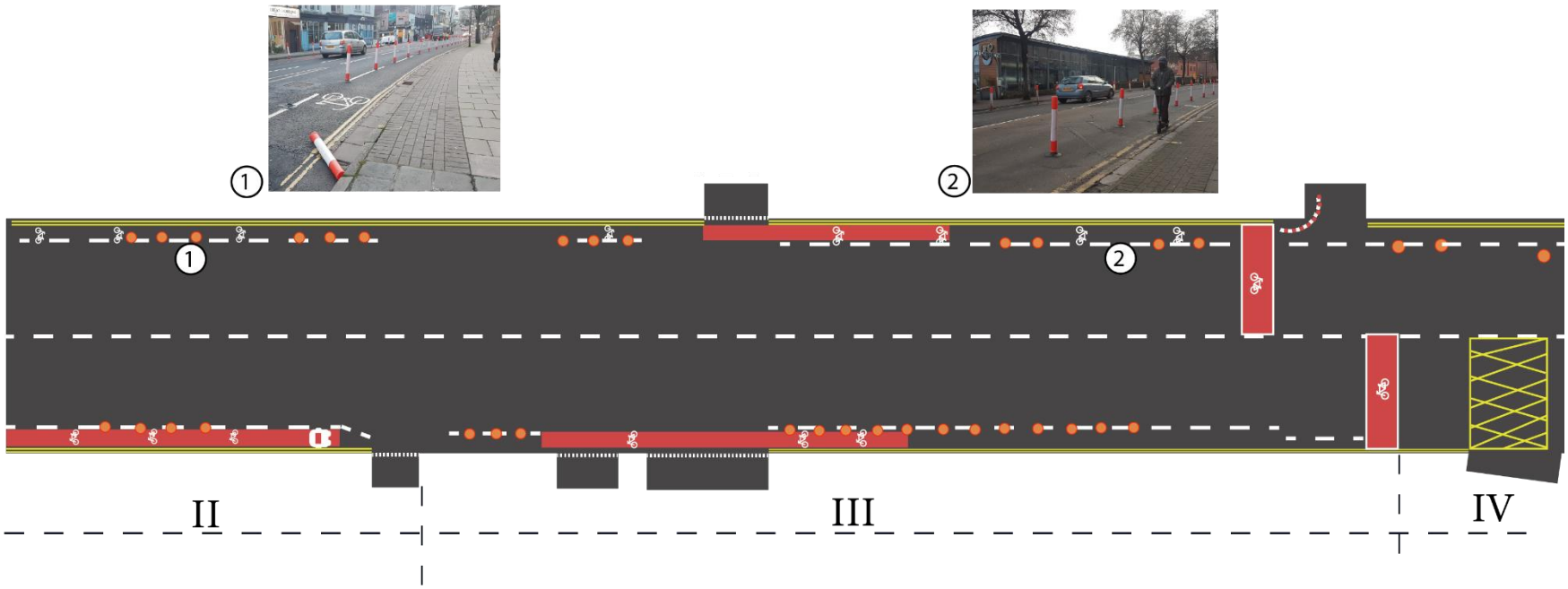


Figure 37 – The map of section 2 of Pop-up cycle path 1; (II) Park Row; (III) Perry Road; (IV) Upper Maudlin St. 1- Vertical posts removed; 2 - pop-up cycle path with a longer extension of the Pop-up 1. Source: Elaborated by the author.

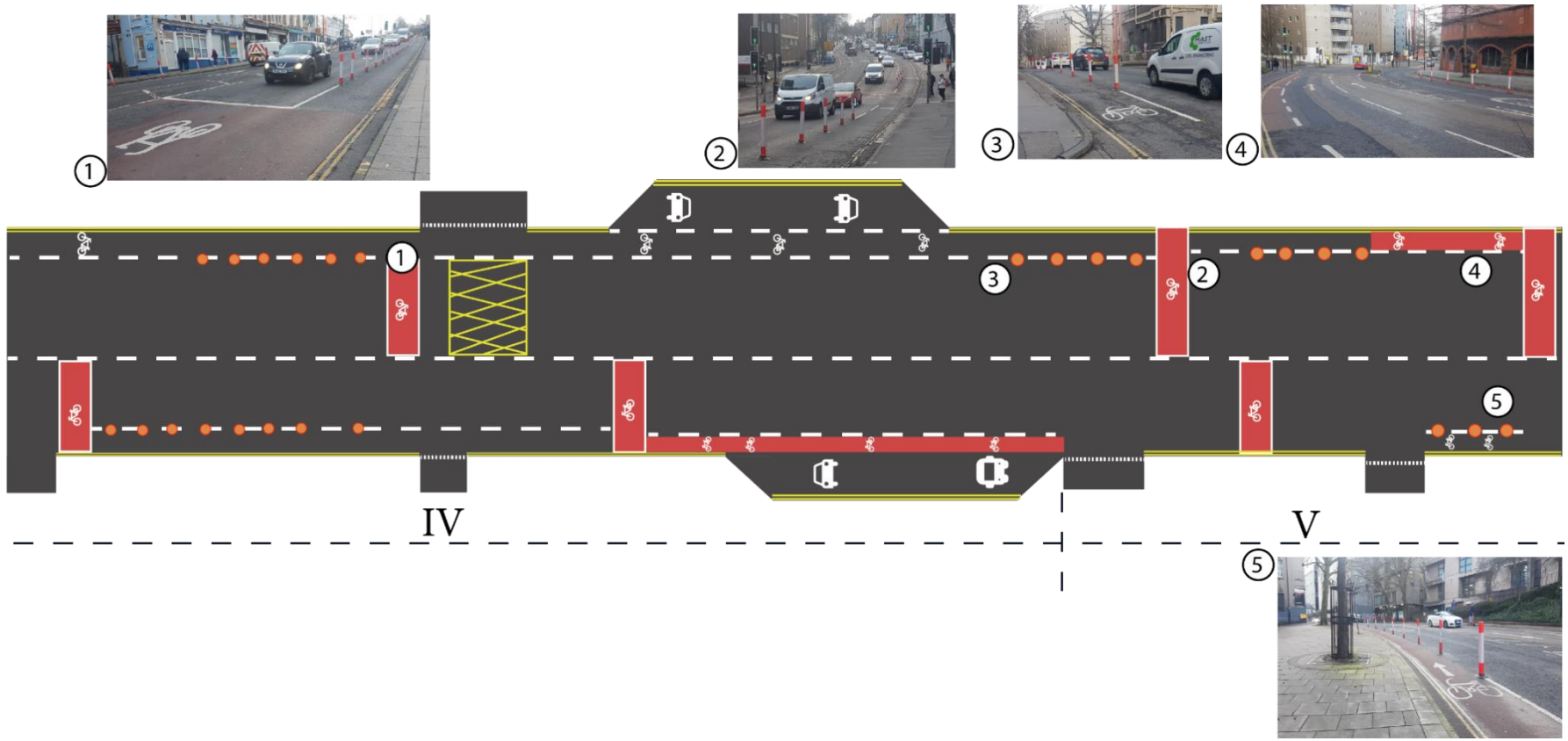


Figure 38 – The map of section 3 of Pop-up cycle path 1; (IV) Upper Maudlin St; (V) Marlorough St. 1- Bike lane in crisscrossing; 2- Interruption stretch of the pop-up; 3- Another perspective of image 2; 4- Section where one direction of the cycle lane has vertical protection and the other does not; 5- Final stretch of the Pop-up 1..

4.2.2.2. Pop-Up 2 – (Lewins Mead)

Pop-up two, like pop-up one, is located in an important part of Bristol's city centre, with links that crisscross the administrative centre and connect to major roads such as Bond Street (A4044) and Gloucester Road (A38). Before the installation of bike lanes, Lewins Mead Street had three lanes, one for buses and taxis and two for vehicles; additionally, before the pop-up, the bike lane shared some sections with the bus lane. Another distinguishing feature of this route is that it has the highest frequency of bus lanes among the routes studied, which is critical in the selection of cycle lane positioning. The cycle path map also shows infrastructure continuing to the end of Haymarket St; however, during field visits, it was discovered that the cycle path ends before the intersection with Upper Maudlin St. Figure 39.

Figure 39 – The map of Bristol's illustrates the pop-up cycle paths (edited) focus for route referred to as Pop-up 2. Source: Bristol City Council, 2020b.

Among the analysis features, it was noted that, similar to the previous pop-up 1, this cycle lane ends without finding a new cycling section, requiring the cyclist to continue in the middle of the avenue without any protection from the surrounding vehicles at the end of this street, at the intersection with the Haymarket street. The lack of connection between the pop-ups is also noted as a flaw in the cycle path design. In this regard, it was determined that the area where the pop-up is implemented is free of interruptions; however, it is not linked to any other infrastructure. Figure 40. Pop-up two was executed in the centre of the road, highlighting the importance of the connection with another cycle path. Once the cyclist finishes the pop-up, they need to head for the bus lane or vehicle lane, a move considered dangerous by cyclists during local interviews.

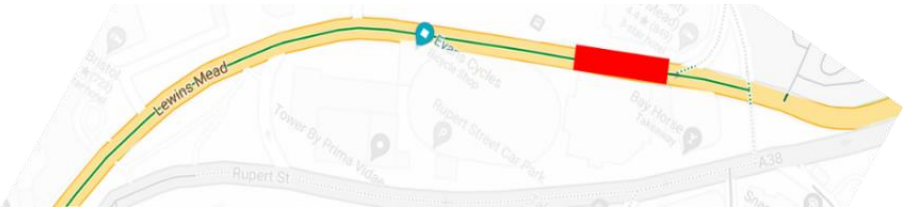


Figure 40 – Diagnostic map of the Pop-up 2 cycle route interruptions. Green line - route of Pop-up 1; Red lines - sections of cycle route interrupted by lack of infrastructure signposting. Source: Edited from google maps by the author.

Unlike the pop-up bike lane 1, the pop-up bike lane 2 had a cycle lane on the full extension. Before, this cycle path was partially shared with the bus lane, which makes sense if the frequency of buses is low. Figure 41. As a result, the decision to relocate the cycle lane to the centre of the road was questioned, but it was interpreted as an attempt to direct cyclists to a single lane. Many responses mentioned the danger of the intersection at the end of this street, which was related to the lack of continuity of this route and connectivity with other urban bicycle paths. One cyclist describes the difficulty of the roundabout crossing further along this route and the danger of entering another traffic lane. According to the bicycle shops in the area, yes, more people have been using this stretch of bicycle lane since the pandemic, and there has been an increase in the number of people frequenting the establishments since 2020. However, shop employees who ride their bikes to work described similar issues to those found in the survey. They specifically mentioned the intersection between the St John's Bridge exit and Lewins Mead, where buses and taxis must cross the cycle lane infrastructure to access their preferred lane. The image below shows how Lewins Street was divided to accommodate the pop-up cycle lane in the centre of the lanes.

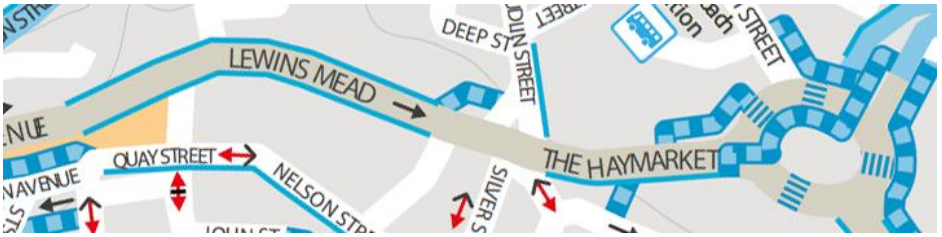


Figure 41 – The map shows in blue existing permanent bike paths in Bristol; focus for route referred to as Pop-up 2. Source: Bristol's Cycling Network Map (Bristol City Council, n.d.).

The following image demonstrates the modification of the bike lane to become a pop-up and the extensive modifications to the intersections and car lanes. Figure 42.

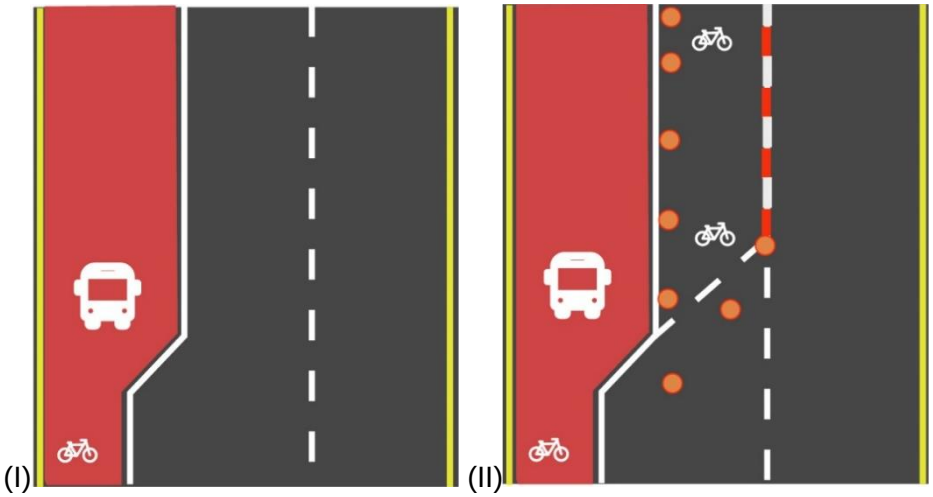


Figure 42 – The map (I) before and (II) after implementing the Pop-up Cycle Path 2 infrastructure, a section located at Lewins Mead road and Lower Maudlin street; Removal of one car lane and implementation of vertical posts to create a cycle lane. Source: Elaborated by the author.

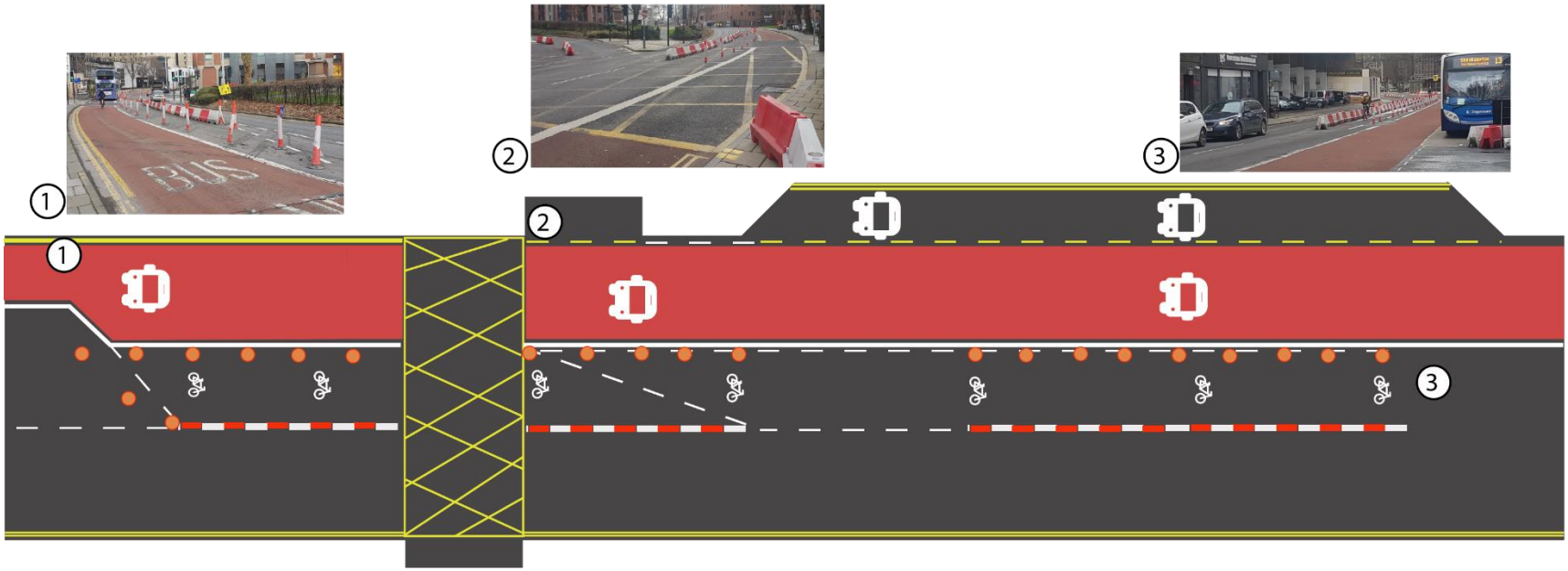


Figure 43 – The map of the Pop-up cycle path 2; Lewins Mead; 1- Beginning of the pop-up cycle lane 2- Crossing area; 3- End of the pop-up without connection to another cycle path.

4.2.2.3. Pop-up 3 – (Counterslip – St Philip's Bridge – Passage Street)

The pop-up 3, also in Bristol's city centre, was the cycle path with the slightest modification to the original urban design. The major highlight of this section was the widening of the pavement on a specific section of the cycle route and the implementation of the vertical posts; however, the planned infrastructure and the division of traffic lanes were not modified. This area is distinguished by construction works taking place now; therefore, there is frequent passage of trucks and people in this block. Figure 44. It justifies the placement of the pop-up lane in an area where there was already a bicycle lane; on the contrary, the frequency of cars parked in the lane's entrance and exit identifies constant difficulty for cyclists. Figure 45.

Figure 44 – The map of Bristol's illustrates the pop-up cycle paths (edited) focus for route referred to as Pop-up 3. Source: Bristol City Council, 2020b.

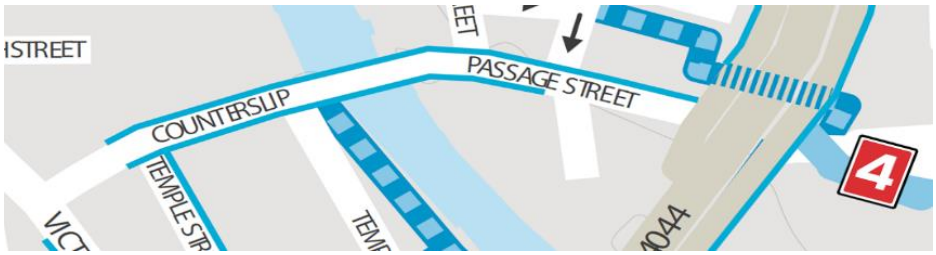


Figure 45 – The map illustrates in blue existing permanent bike paths in Bristol; focus for route referred to as Pop-up 3. Source: Bristol's Cycling Network Map (Bristol City Council, n.d.)

Like the previous analysis, a discontinuity and lack of connections with other cycle lanes before and after the implementation exists in pop-up 3. Therefore, it was observed that there are no connections between pop-up 3 and permanent or temporary cycle lanes. Therefore, to access this cycling path, the cyclists need to cross Victoria Street, which has no cycling infrastructure along its entire length. The route on Victoria Street was previously included on the first map of the pop-up lanes implementation, which would be an essential cycle route connecting the city centre to Bristol's central railway station. Figure 46. During the interview with the council, however, the response obtained regarding the removal of this segment was that modification works would be required to change signage and pavement widths, aspects that were not part of the pop-up infrastructure concept. Figure 47.

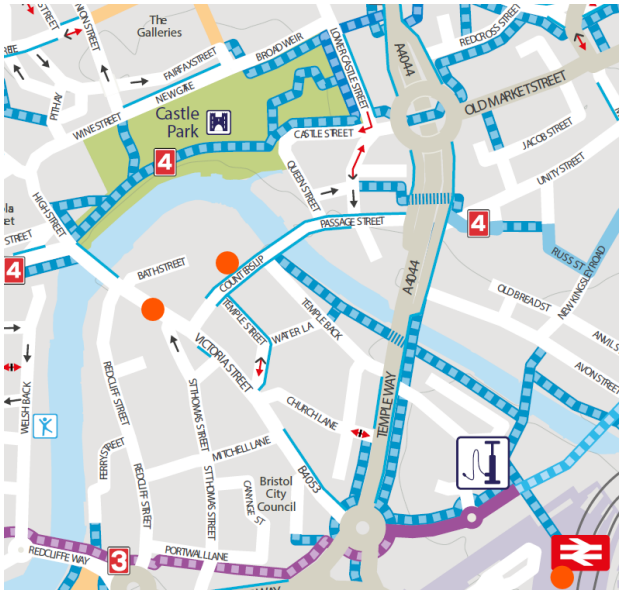


Figure 46 – In the image, orange circles have highlighted the pop-up cycle path 3 (Counterslip), Victoria Street and Temple Meads railway station. Source: Bristol's Cycling Network Map (Bristol City Council, n.d.)

Figure 47 – Diagnostic map of the Pop-up 3 cycle route interruptions. Green line - route of Pop-up 1; Red lines - sections of cycle route interrupted by lack of infrastructure signposting. Source: Edited from google maps by the author.

The image below shows the modification between the old cycling infrastructure and the pop-up bicycle path executed in this project. This suggests that pedestrian infrastructure has been added; however, the cycling route has not changed significantly; only vertical barriers have been installed, and some sections have reduced vehicle space. Figure 48.

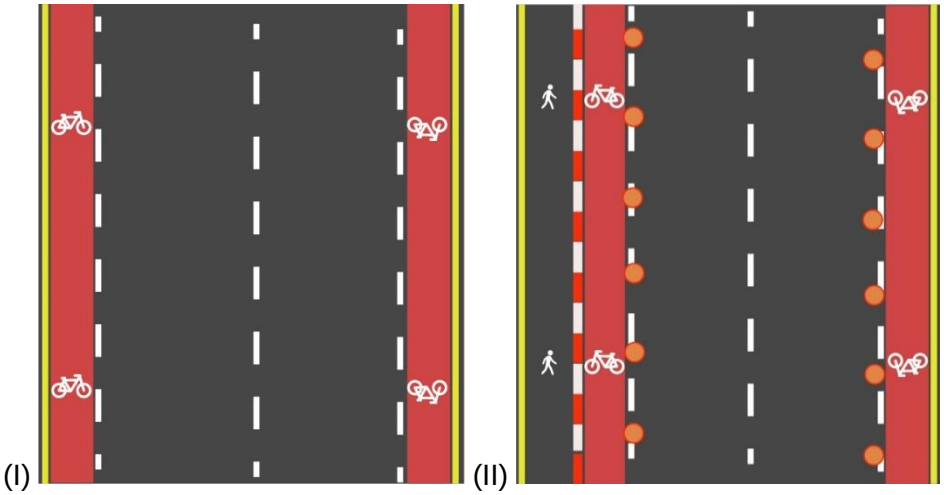


Figure 48 – The Map (I) before and (II) after implementing the Pop-up Cycle Path 3 infrastructure, a section located in Counterslip; Expansion of the pavement space and implementation of vertical posts in the cycle lanes. Source: Elaborated by the author.

Consequently, interviewees reported that the lack of continuity in the cycling infrastructure makes cyclists, inexperienced or recently arrived cyclists, feel lost, without knowing the directions and priorities of passing in that location. The survey also observed that the barriers made the bicycle lane too narrow for cyclists, and questions were raised about the need to implement the project in this area since there was already a bicycle lane there and the primary connection was removed from the project. In addition to the diagnosis made by cyclists in the opinion survey, parking areas at the entrance and exit of the cycle lane and parking where the cycle lane must be crossed were identified. In the short term, these features have a negative impact on cycling flow and damage the paint on the lanes. The map below suggests that vertical posts are sometimes easily removed for parking purposes, adding another impediment for cyclists. Figure 49.

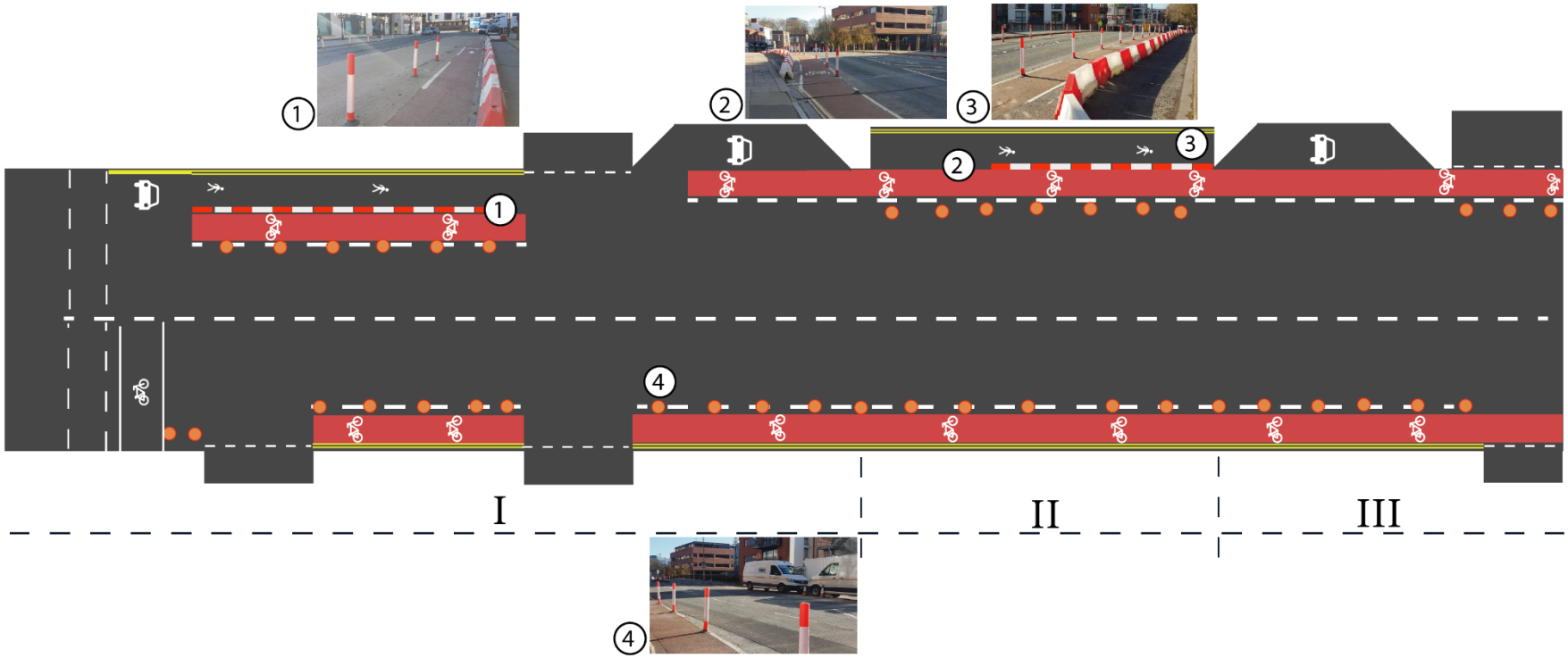


Figure 49 – The pop-up cycle path 3; (I) Counterslip; (II) St Philip's Bridge; (III) Passage Street.; 1- Beginning of Pop-up 3; 2- Beginning of the section of roadway expansion; 3- Pop-up carried out on the bridge; 4 - Cars parked on the cycle lane.

4.2.2.4. Pop-Up 4 – (Mina Road)

Among the pop-ups examined, the pop-up cycle path 4 (Nina Road) is the only one that is located outside of Bristol's city centre, having been implemented in the residential area of St Werburgh. Despite several infrastructure gaps between the two destinations, this cycle path is located on the route that connects national cycle path 4 to Bristol city centre. In this regard, the implementation of pop-up 4 aimed at valuing cycling as a mode of transportation in this region, as it is already a common habit among the local population due to its proximity to the centre. Figure 50.

Figure 50 – The map of Bristol's illustrates the pop-up cycle paths (edited) focus for route referred to as Pop-up 4. Source: Bristol City Council, 2020b.

Because the cycle lane is close to a school, this cycle path was where more children of all ages were observed using the cycle paths during the cycle lane monitoring work. Another thing that was noticed and important for a greater variety of uses was the removal of car parking along the cycle path, which ensured even more safety for cyclists. However, cyclists were observed on and off the path, consequently, this path is used in all directions, although it only has protection for one direction. In addition, like the other pop-up routes, this cycle path has no connections and ends without signposting, making it necessary to know the place to cycle in the region. The lack of places to park bicycles were also noted, causing people to park on posts or grids of residences and parks. Figure 51 and Figure 52.

(I)  (II) 

Figure 51 – (I) Image demonstrates the two lanes of the pop-up; (II) Image demonstrates bicycles parked on garden railings. Source: Photo taken by the author.

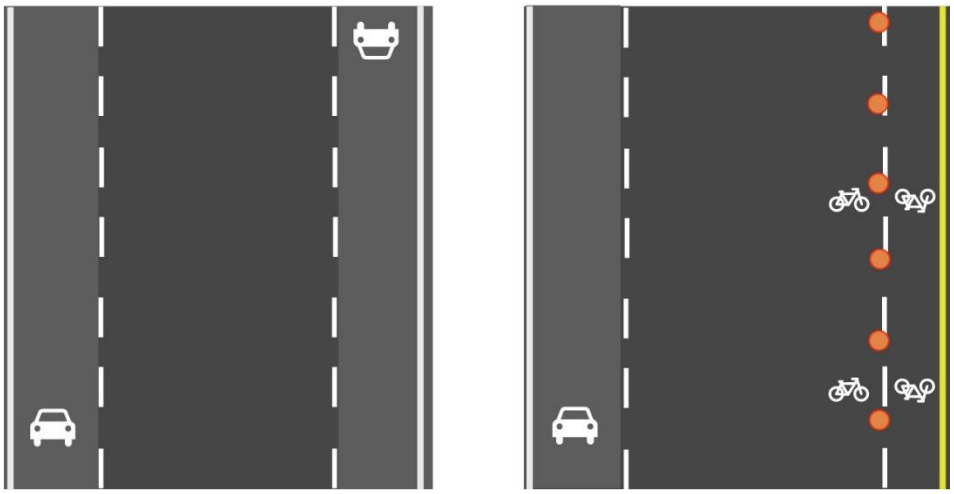


Figure 52 – The map (I) before and (II) after the implementation of the Pop-up Cycle Path 4 infrastructure, a section located in Mina Road; In this section of the cycle path, parking spaces were removed from one side of the road, which is now for the exclusive use of cyclists. Source: Elaborated by the author.

This cycle route, like the other bike paths, was already on the city cycle map; however, when images from years before the pop-up implementation were analysed, less infrastructure was observed than on the downtown cycle paths. 53rd figure. As a result, there was a certain amount of neglect and a lack of prioritisation of active modes in the area. According to users, the need for a better connection with the M32, clearer signposting, a lack of sufficient paint on the pavement connecting the other cycle lane, and protection of the opposite direction by removing parking on the other side of the road. Figure 53 and Figure 54.

Figure 53 – The map shows in blue existing permanent bike paths in Bristol and in black the Mina Road cycle path; focus for route referred to as Pop-up 4. Source: Bristol's Cycling Network Map (Bristol City Council, n.d.)

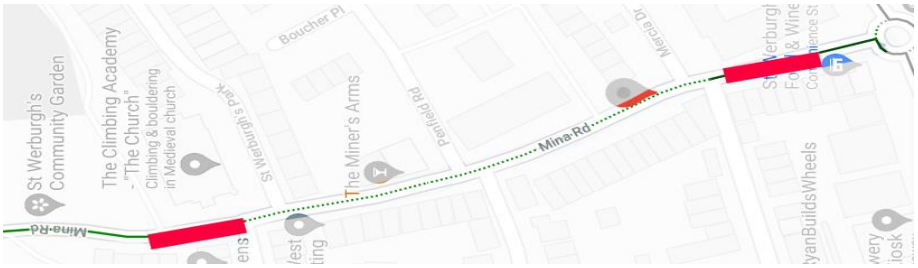


Figure 54 – the diagnostic map of the Pop-up 4 cycle route interruptions. Green line - route of Pop-up 1; Red lines - sections of cycle route interrupted by lack of signposting and connection. Source: Edited from google maps by the author.

The map below depicts the cycling section, which was initially (point 1) only connected by pavement marking completed in one more block of the cycle path. Despite only having barriers central to this infrastructure, the following section, up to point 2 in the image, shows that the cycling path is painted with pavement markings indicating cyclists on both sides of the pop-up. The conclusion of the pop-up entering the tunnel was observed at the end of the image (point 3), where there is also no continuity in cycling signalization. Figure 55.

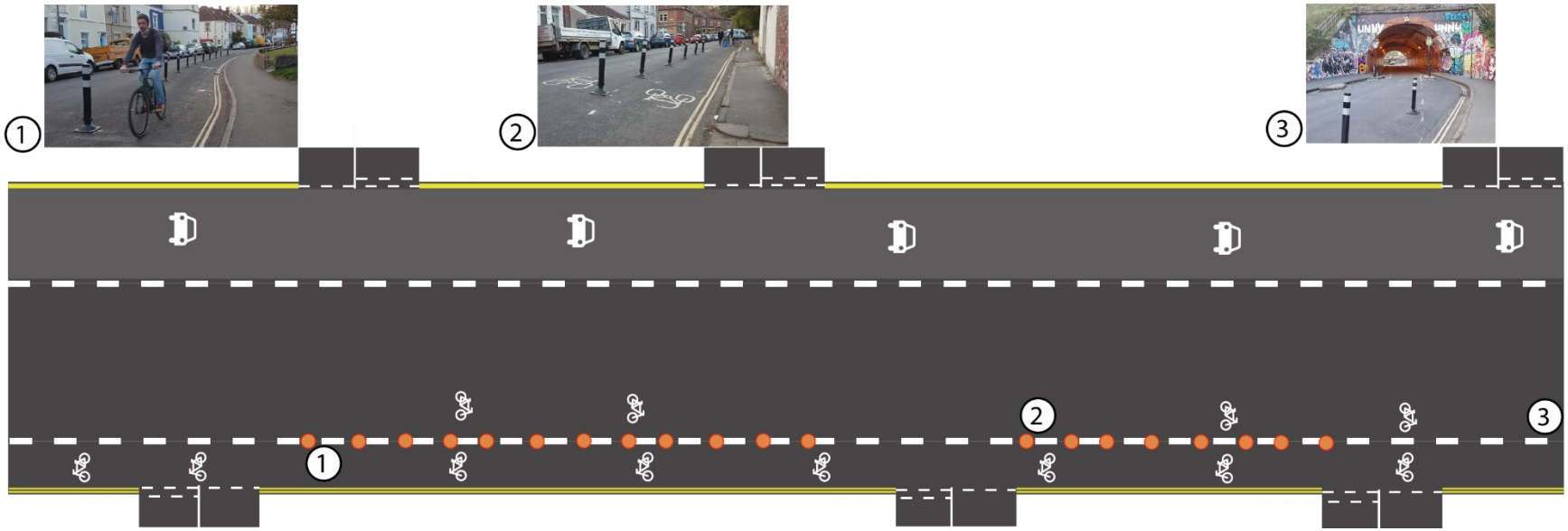


Figure 55 – The Pop-up cycle path 4; (I) Mina Road; 1- Beginning of Pop-up 3, 2- Beginning of the section of roadway expansion; 3- Pop-up carried out on the bridge: 4 - Cars parked on the cycle lane. Source: Elaborated by the author.

4.3. MODAL SHIFT LEVELS

Within the context of modal shift and the impact of pop-up bicycle implementation on modal shift, the two groups of cyclists (pop-up lanes and permanent bicycle lanes only) were asked if there were modal shifts in the type of daily transportation within the pandemic scenario. In this regard, most pop-up users said no (did not change their daily mode of transportation), while 40 cyclists said yes (did change their mode of transportation to cycling on some trips). Figure 56. In comparison, the difference was minor in the group referring only to users of permanent cycle lanes, with 14 cyclists responding that they had changed their mode of transportation to cycling on some journeys. Figure 57.

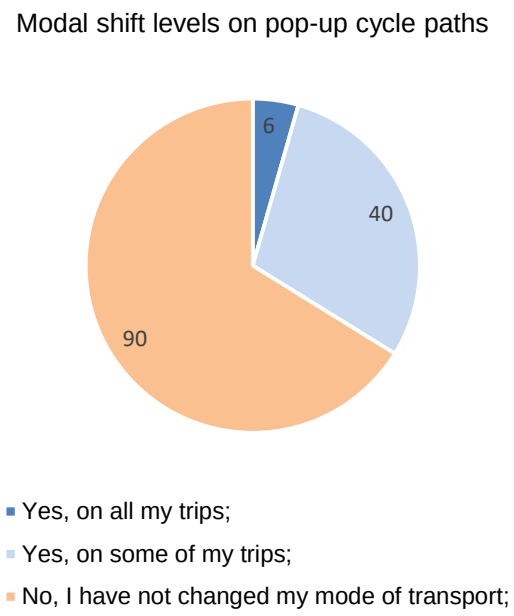


Figure 56 - Graph with the Modal shift levels on pop-up cycle paths. Source: Survey developed by the author.

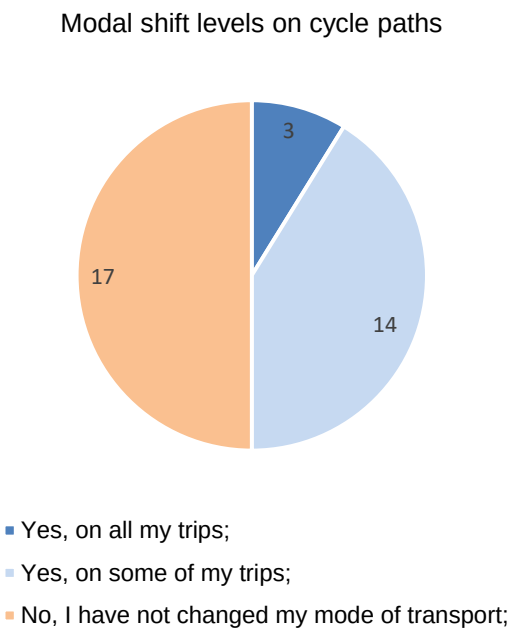


Figure 57 - Graph with the Modal shift levels on cycle paths. Source: Survey developed by the author.

Among the total number of responses, 63 cyclists responded that they had undertaken modal shift to bicycle on all or some of their trips. However, within this number, only six people are beginners in cycling. This number reinforces the idea that due to the poor implementation of bicycle paths in general, few people started to use the bicycle path during the pandemic; meanwhile, only experienced cyclists feel safe using a bike, whether on a pop-up or on a pop-up not. Figure 58.

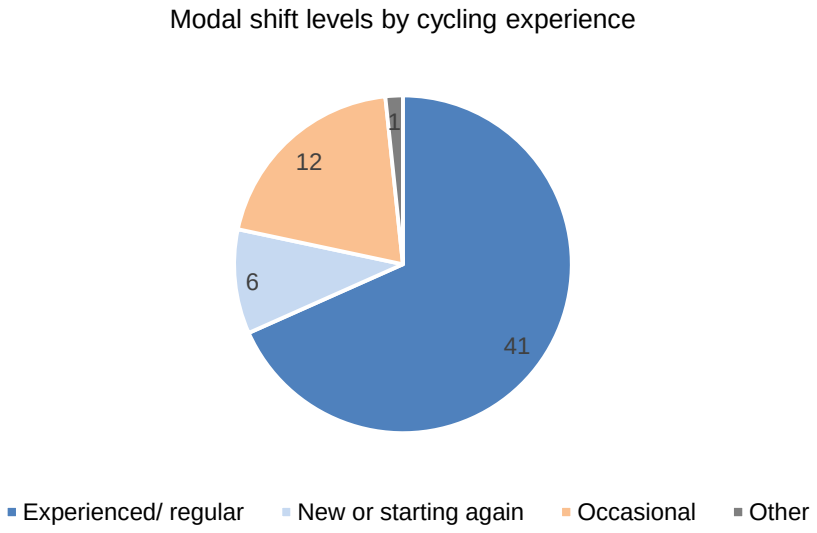


Figure 58 - Graph with the Modal shift levels by cycling experience. Source: Survey developed by the author.

4.4. DISCUSSION OF THE RESEARCH RESULTS

When analysing the pop-up cycling infrastructure both individually and within the city network, one can see numerous problems regarding the implemented infrastructure, such as connectivity between bike lanes. It was concluded that the implemented infrastructure may not have prioritised bicycles over cars, a problem that affects the safety of both modes, but makes cycling more difficult. The idea that some infrastructure is better than no infrastructure does not apply to bicycle paths, as they have several barriers instead of just using the road as usual. A cycle path, which is sometimes painted, will confuse the cycle route much more than total freedom to cycle where it is simple.

According to the factors investigated in this research, the pop-up infrastructure implemented in Bristol does not cover all types of cycling because the implementation has occurred at a disproportionate size to unconventional cycling modes. As a result, in the interview, when a cargo bike, for example, needs to cross a point or make a turn on a public road, this cycling mobility presents challenges. This type of difficulty was also reported on traditional bicycles, with users reporting that changing routes once inside the pop-up becomes difficult. The outcome suggests, the infrastructure depatterning is non-inclusive and difficult to use. Furthermore, the lack of vehicle protection has an impact on the executed infrastructure because when there are no barriers to prevent vehicles from crossing the cycle lanes, they damage the paint on the bike lanes. The results suggest that the existence of cycle lanes where cars must pass through demonstrate a lack of prioritisation of active mobility in the urban environment.

This dissertation will also address the lack of a proper standard for creating pop-up bike lanes in Bristol. Besides getting more people to make the modal shift and use the bicycle, the temporary bike lanes also work as a prototype of the permanent bike lane, needing to comply with widths and standards and adequate infrastructure.

In terms of connectivity, several gaps were observed in temporary infrastructure and its connection with permanent bicycle paths. It was determined that the pop-up was used to improve cycling conditions in areas where there were already cycling lanes, and that it was used to expand this network due to gaps in infrastructure quality. However, because the pop-up proposal did not apply to roads that required structural modifications, some streets were left out of the plan even after the routes were determined. As a result, only a few parking zones in the pop-up sections were removed, and vertical posts were installed in the cycle paths. However, the results found suggest that the urban modification carried out are not enough to establish a more efficient cycling network than the previous one. There are still several barriers to route continuity and no new connections were established between these segments. To exemplify, in one of the interviews was highlighted by the interviewee that the impression left by Bristol City Council is to prioritise the fastest access routes for the car and cycle lanes are positioned on parallel streets. Thus, the cyclist normally opts for a longer and safer route rather than the fastest route to reach their destination. Therefore, this study questioned the positioning of bicycle paths and concluded that they were located in places where there would be high visibility, regardless of the cycling levels of the environment.

Indeed, all cycle paths could receive better infrastructure. Pop-up one should receive a wider bike lane width and protections for the frequency of vehicles passing through the area. Instead of vertical barriers, pavement markings would solve problems of path changes and paint wear. In pop-up two, the bus lane could be widened to allow cyclists to overtake, and among the priorities should be route connectivity (pop 1 and 2). To improve the pop-up, the council should think about the infrastructure that connects this area with the leading local destinations of cyclists. In the same sense, pop-up four could focus on implementing cycle lanes in both route directions and establish better parking infrastructure and signage for the surrounding cycle routes.

Many vehicles parked on both sides of the road and on dual carriageway streets are a distinctive urban feature of Bristol. These characteristics are the result of years of underinvestment in public transportation and a failure to encourage active modes. As a result, when the tactical urbanism mode was associated with temporary pop-up measures to encourage active modes at the start of this research, it was discovered that pop-up urbanism has as its main characteristic the execution of urban works in communities or local streets, as opposed to the focus given to temporary bike lanes in Bristol.

When the use of pop-up cycle paths in Bristol and the objectives targeted in the implementation of this infrastructure are examined, it is concluded that, despite significant implementation problems, pop-up cycle path 4, the only cycle path built in a residential area, was the most successful. This result is not based on the number of survey respondents or the percentages raised. This bike lane was the most transformed and accepted by the public based on public opinion, user diversity, and the transformation of urban space to favour active modes.

There is a specific reason why administrative centres receive more substantial investment for urban modifications. Many factors are involved in these modifications, including emergency vehicles, buses, delivery vehicles, and the population, which has the right to choose their mode of transportation. The failure of these bike paths can be explained by the concept of pop-up infrastructure in comparison to the results obtained in Bristol. The lack of continuity, explicit destination, and signposting on the cycle paths is easily explained by the lack of defined objectives in the design of each route created. To illustrate, when pop-up bike lanes were implemented in the urban core during a period when a large portion of the population was under lockdown, the infrastructure shifted away from the widespread need to create a safe environment, in this case for mobility. This result thus suggests, that as conclusion the implementing of that temporary bike lane model in communities or neighbourhoods has greater social relevance.

5
CONCLUSION

According to the research objectives, this research has contributed to presenting an overview of the pop-up cycle paths carried in Bristol, UK, exploring pop-up infrastructure's effects on the possible increase in cycling levels in the city. Within these contexts, pop-ups' effects were studied: the implementation process of temporary bicycle lanes; the quality of the implemented infrastructure; and the effect of pop-ups on modal shift choice.

Given the evaluation of the implementation process and the fact that the majority of the emerging lanes were implemented on already existing cycle routes, it was expected that the emerging lanes planning would provide a better connection between existing and new pop-up lanes. As a result, no other reason for selecting locations was discovered other than to improve existing routes. However, it was believed that the pop-up would possibly have benefited more locations in the city centre and in important city areas.

On the infrastructure side, they present disconnection within the pop-up system and sometimes on the route itself, in addition to disconnection with the urban cycling network. This is due to a lack of priority given to cycle paths in urban areas, resulting in interruptions by bus stops or parking lots. In this regard, the frequency with which other vehicles must use the bike paths harms the existing infrastructure.

Regarding the modal shift, it should be noted that, despite the positive responses, it cannot be guaranteed that the population will continue to use these cycling sections after the temporary cycle lanes are removed. As a result, after the lockdown ends and the existing cycle paths in the city centre have been significantly improved, a more concrete modal shift could possibly be expected.

According to this set of analyses, the main deficiency of implemented cycle paths is a lack of connection. Physical infrastructure problems can be repaired; however, poor planning in choosing cycling routes, combined with a lack of clarity about the population's cycling destinations, in general, leads to investments in unnecessary routes. In this case, areas with more significant influence receive fewer resources for infrastructure improvement. Pop-up enforcement in areas with well-established cycling flows is viewed as an ineffective solution for infrastructure improvement. This is because pop-ups, according to research, are easily removed and have a limited life.

A lack of data on cycling levels prior to the pop-ups was one of the challenges in obtaining more comprehensive answers to the research questions. In this regard, the available cycle count data was insufficient, making analysis with differences in usage impossible. Finally, due to cyclist inconsistency, the unusually high levels of circulation restrictions imposed in the city as a result of the coronavirus crisis made monitoring the cycle paths difficult.

5.1. FUTURE RESEARCH

Temporary cycle path research addresses a wide range of issues within the context of urban policies that promote sustainable modes of transportation. In this regard, the theme is directly related to tactical urbanism initiatives like mobility, transportation, community, and urban equipment. As a result of the limitations presented in this work, several directions for future research, focusing or not on the case study approach, could be suggested. As a suggested result, temporary bicycle paths that can be used as research routes are contributing to the improvement of the urban cycling network.

- Evaluation of the urban cycling network before and after the implementation of temporary cycle paths;
- Comparisons of cycling efficiency after infrastructure implementation discovered between cities;
- Identification of the best routes for the implementation of temporary cycle paths;
- Study of usage levels after the infrastructure is made permanent.

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6

APPENDIX

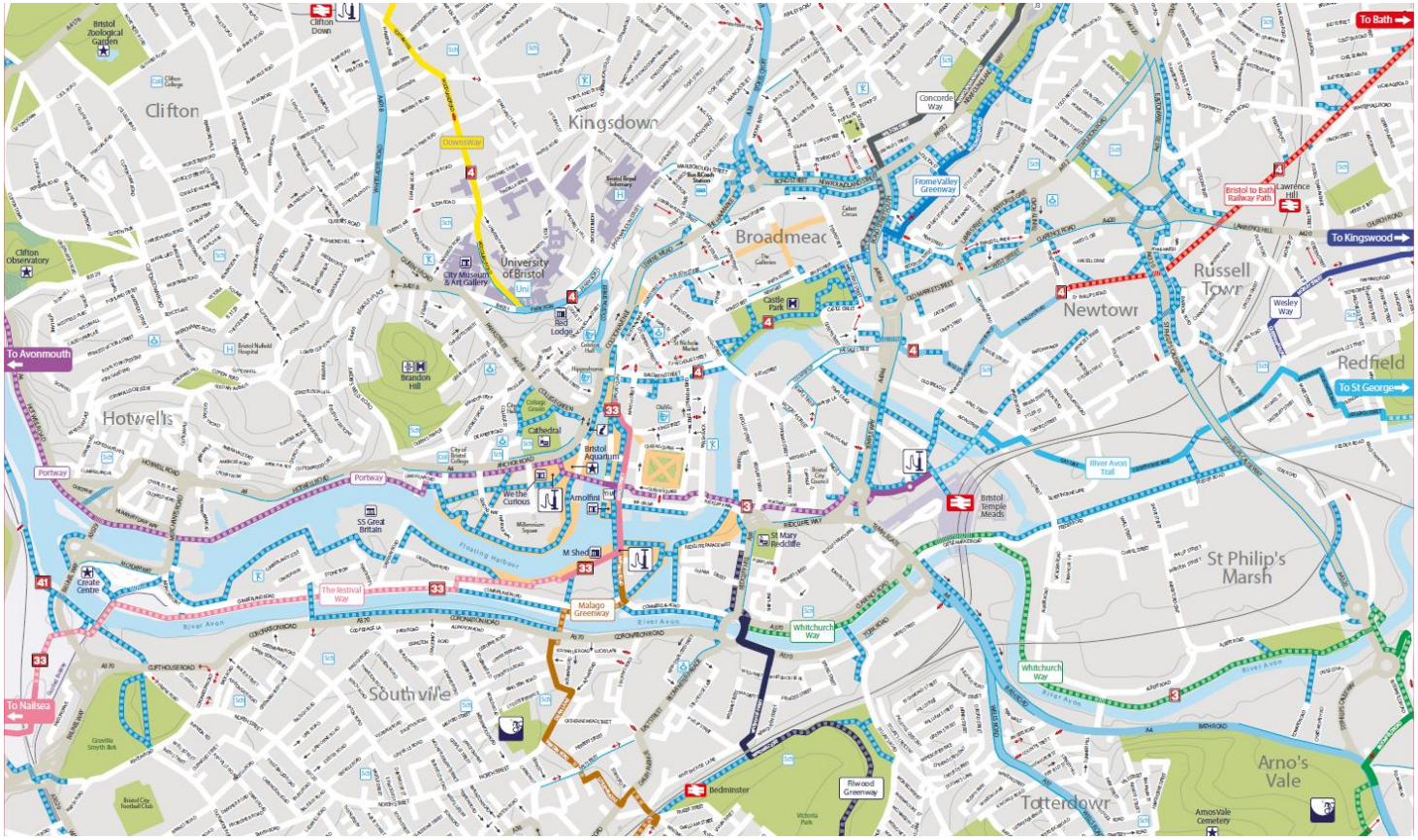
APPENDIX I – BRISTOL'S CYCLING NETWORK MAP (2019)

APPENDIX II – SURVEY POP-UP CYCLE LANES

APPENDIX III – ADDITIONAL RESULTS FROM BRISTOL POP-UP BIKE SURVEY

APPENDIX IV – INTERVIEW WITH BIKE SHOPS LOCATED NEAR POP-UP CYCLING ROUTES IN BRISTOL

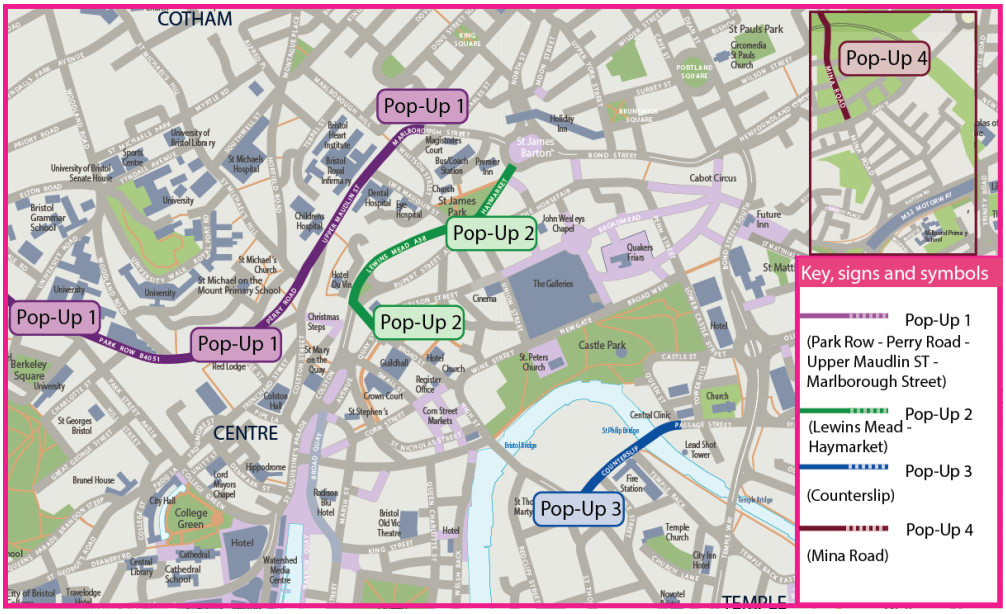
APPENDIX I – BRISTOL'S CYCLING NETWORK MAP (2019)



APPENDIX II – SURVEY POP-UP CYCLE LANES

SECTION 1 - CYCLING BEHAVIOUR IN BRISTOL, UK.

1. Since August 2020, have you cycled on any of the following sections of Pop-up cycle lanes in Bristol?



a. Cycled on Pop-up cycle lanes
b. Cycled, but never on Pop-up cycle lanes
c. Never cycle

SECTION 2 - POP UP CYCLE PATHS

THIS SECTION IS DEDICATED TO ANALYSING THE QUALITY OF THE POP-UP CYCLE PATHS IN BRISTOL AS A DETERMINANT OF CYCLING BEHAVIOUR. WILL BE ANALYSED FACTORS SUCH AS CYCLING INFRASTRUCTURE AND SAFETY BASED ON CYCLISTS OPINIONS. ALSO ANALYSING THE CYCLING FREQUENCY LEVELS BETWEEN AUGUST 2020 AND APRIL 2021.

2. Since August 2020, which of the following pop-up cycle lanes have you cycled in Bristol?

a. Pop-up 1 (Park Row - Perry Road - Upper Maudlin ST - Marlborough Street)
b. Pop-up 2 (Lewins Mead - Haymarket)
c. Pop-up 3 (Counterslip)
d. Pop-up 4 (Mina Road)

3. Before the Pandemic lockdown rules (March 23rd), how often did you cycle in Bristol?

a. Never
b. Some Days a year
c. Some Days a month
d. Some Days a week
e. Every week day
f. Every weekend day
g. Everyday

4. Rate the influence of the Covid-19 Pandemic on your choice to cycle?
   1 = Very low influence 5 = Very high influence

	1	2	3	4	5	
Very Low Influence						Very High Influence

5. Rate the influence of the Covid-19 Pandemic on your choice to cycle?
1 = Very low influence 5 = Very high influence

	1	2	3	4	5	
Very Low Influence						Very High Influence

6. Between August 2020 and March 2021, how often did you cycle, excluding full lockdown times?

a. Never
b. Some Days a year
c. Some Days a month
d. Some Days a week
e. Every week day
f. Every weekend day
g. Everyday

7. Rate the following statements with regard to their influence on your use of the Pop-up bike lanes.
   1 = Strongly disagree 5 = Strongly agree

	1	2	3	4	5	
Strongly Disagree						Strongly agree

8. Rate the quality of infrastructure of the Pop-up cycle lanes according to your experience and opinion. 1 = Very unsatisfied 5 = Very satisfied

	1	2	3	4	5	
Very Unsatisfied						Very satisfied

9. Rate the feeling of safety of the Pop-up bike lanes according to your experience and opinion.
1 = Very unsatisfied 5 = Very satisfied

	1	2	3	4	5	
Very Unsatisfied						Very satisfied

10. Is there any other aspect, such as infrastructure and safety, that you would like to describe that influences the use of the pop-up bike lanes?

*Open Question

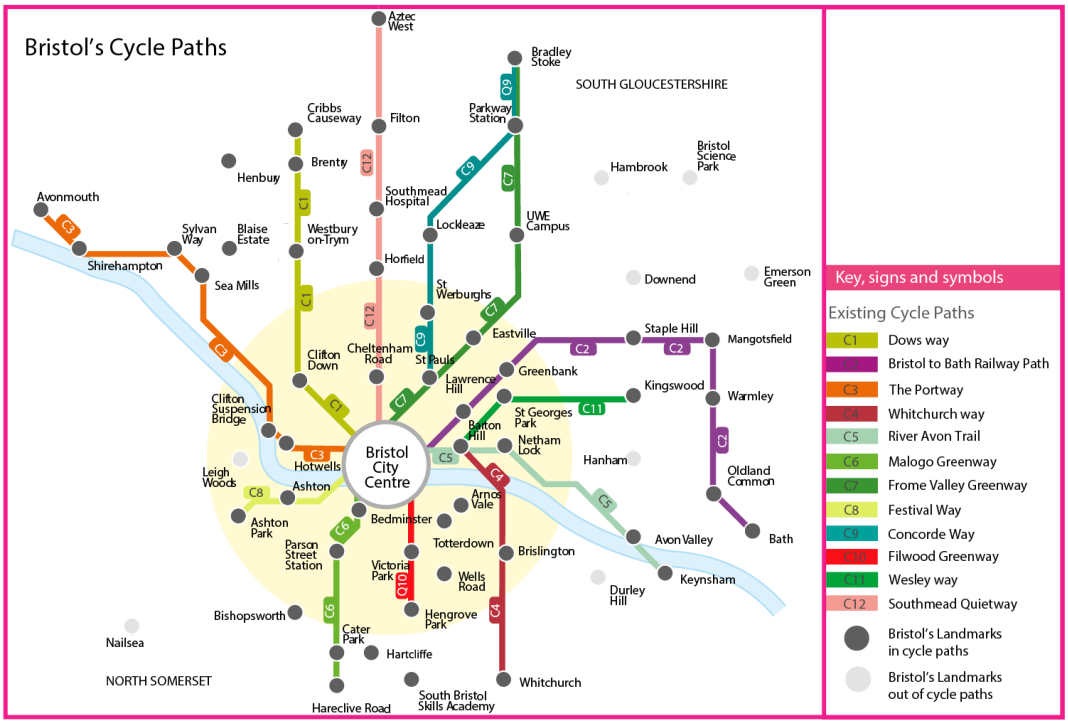
11. During this pandemic scenario, have you changed any of your everyday transport modes to the bicycle for habitual journeys?

a. Yes, on all my trips;
b. Yes, on some of my trips;
c. No, I have not changed my mode of transport;

SECTION 3 - CYCLE PATHS

THIS SECTION IS DEDICATED TO ANALYSING THE QUALITY OF CYCLE PATHS IN BRISTOL AS A DETERMINANT OF CYCLING BEHAVIOUR. WILL BE ANALYSED FACTORS SUCH AS CYCLING INFRASTRUCTURE AND SAFETY BASED ON CYCLISTS OPINIONS. ALSO ANALYSING THE CYCLING FREQUENCY LEVELS BETWEEN AUGUST 2020 AND APRIL 2021.

12. Since August 2020, have you cycled on any of the following sections of cycle lanes in Bristol?



a. C1- Dows way (From Woodland Road - To Cribbs Causeway);
b. C2 - Bristol to Bath Railway Path (From Trinity Street, Newtown Park– to Bath);
c. C3 - The Portway (From Trinity Street, Newtown Park– to Bath);
d. C4 - Whitchurch way (From A370, Clarence Road - To Whitchurch);
e. C5 - River Avon Trail (From Gas Lane – To St George);
f. C6 - Malago Greenway (From Wapping Road – To Hartcliffe);
g. C7 - Frome Valley Greenway (From Wellington Road – To UWE);
h. C8 - Concorde Way (From Wilson street – To FiltonAbbey Wood);
i. C9 - Festival Way (From Prince street – To Nailsea);
j. C10 - Filwood Greenway (From Whitehouse street – To Filwood);
k. C11 - Wesley way (From AvonVale Road – Kennard Road);
l. C12 - Southmead Quietway (From Elton Road– To Southmead Hospital);
m. Other;

13. Before the Pandemic lockdown rules (March 23rd), how often did you cycle in Bristol?

a. Never
b. Some Days a year
c. Some Days a month
d. Some Days a week
e. Every week day
f. Every weekend day
g. Everyday

14. Rate the influence of the Covid-19 Pandemic on your choice to cycle?
1 = Very low influence 5 = Very high influence

	1	2	3	4	5	
Very Low Influence						Very High Influence

15. Rate the influence of the cycle lanes on your choice to cycle?
1 = Very low influence 5 = Very high influence

	1	2	3	4	5	
Very Low Influence						Very High Influence

16. Between August 2020 and March 2021, how often did you cycle, excluding full lockdown times?

a. Never
b. Some Days a year
c. Some Days a month
d. Some Days a week
e. Every week day
f. Every weekend day
g. Everyday

17. Rate the quality of infrastructure of the cycle lanes according to your experience and opinion. 1 = Very unsatisfied 5 = Very satisfied

	1	2	3	4	5	
Very Unsatisfied						Very satisfied

18. Rate the feeling of safety of the cycle lanes according to your experience and opinion.
1 = Very unsatisfied 5 = Very satisfied

	1	2	3	4	5	
Very Unsatisfied						Very satisfied

19. Is there any other aspect, such as infrastructure and safety, that you would like to describe that influences the use of the cycle lanes?

*Open Question

20. During this pandemic scenario, have you changed any of your everyday transport modes to the bicycle for habitual journeys?

a. Yes, on all my trips;
b. Yes, on some of my trips;
c. No, I have not changed my mode of transport;

SECTION 4 - MODAL SHIFT

THIS SECTION IS DEVOTED TO ANALYSING WHETHER THERE HAVE BEEN RELATIVE BEHAVIOURAL CHANGES IN SWITCHING BETWEEN OTHER MODES OF TRANSPORT TO CYCLING IN BRISTOL BETWEEN AUGUST 2020 AND APRIL 2021.

21. If you answered yes, what was the usual mode of transport by which you made this trip?

a. Car;
b. Motorbike;
c. Bus;
d. Walking;
e. Other;

22. What is the purpose of the journey you are now making by bicycle?

a. Work;
b. Study;
c. Shop Essentials.
d. Exercise;
e. Leisure;
f. Other;

SECTION 5 - CONTACT FOR AN INTERVIEW

23. To complete this research, we will be developing a number of interviews to explore the individual experience with the Bristol pop-up lanes. If you are available to take part in such interviews, please leave your email contact details for us to get in touch.

*Open Question

SECTION 6 - SOCIODEMOGRAPHIC DATA

THIS INFORMATION SERVED TO DESCRIBE THE SAMPLE OF THIS STUDY, NOT ALLOWING TO IDENTIFY THE PEOPLE INTERVIEWED.

24. Gender

a. Male;
b. Female;
c. Other;

25. Age
a. 0-15;
b. 16-24;
c. 25-34;
d. 35-44;
e. 45-59;
f. 60+;

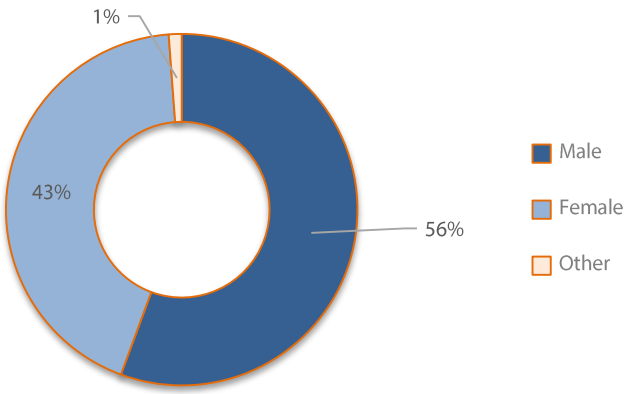
26. Current Occupation
a. Work;
b. Study;
c. Unemployed;
d. Retired;
e. Other;

27. Cycling Experience
a. New or starting again;
b. Occasional;
c. Experienced regular;
d. Other;

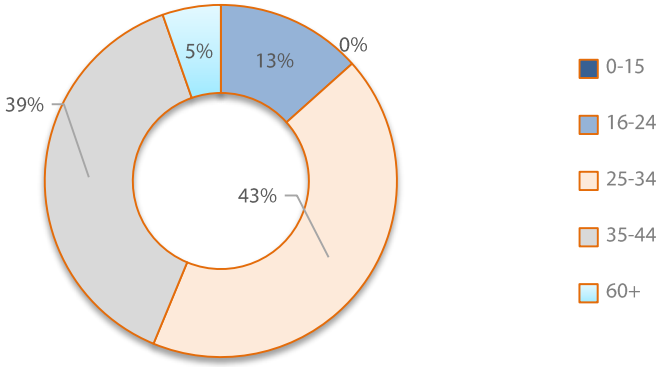
APPENDIX III – ADDITIONAL RESULTS FROM BRISTOL POP-UP BIKE SURVEY

This site was divided to collect information on the part of the population that contributed to the survey, identifying the characteristics of the people who use bike roads in the city of Bristol, being pop-up and permanent.

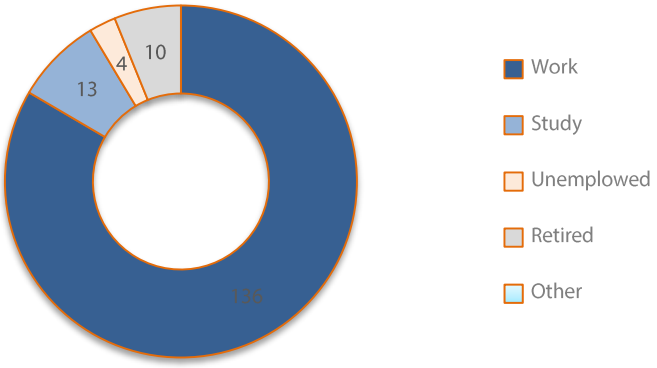
1. Gender



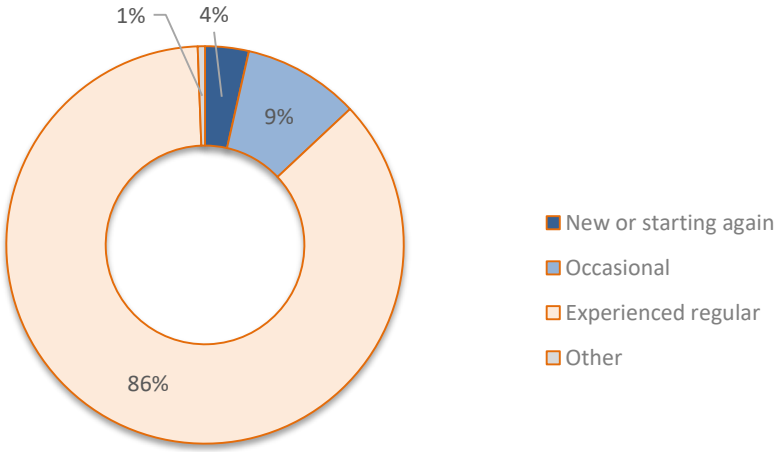
2. Age



3. Current occupation



4. Cycling Experience



APPENDIX IV – INTERVIEW WITH BIKE SHOPS LOCATED NEAR POP-UP CYCLING ROUTES IN BRISTOL

Survey of Bicycle Shops	
1.	Name and working establishment.
2.	Has this establishment remained open during lockdown times?
3.	What jobs does the shop do for cyclists?
4.	If the cyclist needs a quick repair, can this be done at the same time?
5.	Have you seen any effect on people cycling after the implementation of the pop-up bicycle infrastructure?