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Cycling for recreation and transport purposes in Lancaster UK

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Abstract

Introduction: While existing research explores cycling, its positive impact on health and its environmental impact, there remains a dearth of studies on cycling for both transport and recreational purposes. Thus, the primary aim of this study is to investigate how the neighbourhood environment and policies influence cycling, particularly for transport and recreation.

Methods: The case study is based in Lancaster, UK, where 65 participants were recruited to complete a survey. They were asked their socio-economic status, cycling behaviour (e.g., frequency of cycling), opinions on the neighbourhood environment, and experiences with both transport cycling (TC) and recreational cycling (RC). Additionally, interviews were conducted with representatives from the City and County Councils (n=3) to gain insights into relevant cycling infrastructure and policies. These datasets were subsequently compared to assess their alignment and, importantly, to identify the strengths and weaknesses of existing policies and infrastructure.

Results: The study's findings reveal notable distinctions between TC and RC. A higher percentage of participants (87%) expressed the benefits of cycling for recreation, compared to around 79% for TC. Furthermore, perceptions about the quality of cycling routes varied, with 37% considering the routes convenient for TC and 62% finding them suitable for RC.

Conclusions: These results were corroborated by insights from interviews and our observations of the cycling infrastructure, which exposed inadequacies in the city centre's infrastructure, particularly for transport purposes. To promote cycling, it is imperative to establish and maintain continuous and dedicated cycling paths. The study underlines the need for improved cycling infrastructure, not only for recreational purposes but also for transport.

1. Introduction

Cycling provides numerous benefits for both mental and physical health, helping to reduce incidences of depression, anxiety, obesity, cardiovascular diseases, and mortality risk, as emphasized by the World Health Organization [1, 2]. As the understanding of cycling's positive impact on health has improved, many countries have witnessed a notable increase in the number of cyclists [3]. This trend continued even during the COVID-19 pandemic, as individuals sought ways to remain active while avoiding public transportation [4]. Furthermore, governments actively promote physical activity, not only for its health advantages but also to achieve their net-zero targets [4].

Even though the benefits are clear, many individuals still do not take up cycling. Previous studies have explored different factors influencing this perception, including safety-related issues, cycling culture, and infrastructure [5]. For instance, Heinen et al. [6] conducted a literature review to identify the determinants shaping commuting to work. They focused on factors such as the built environment (e.g., trip distance, city size, urban density, bicycle infrastructure), natural environment (e.g., hilliness, seasons, climate, weather), socio-economic factors, psychological factors, cost, travel time, effort, and safety. Additionally,

Goldsmith [7] discussed individual and environmental factors affecting cycling, including environmental concerns, physical and infrastructural features, and land use. Heinen et al. [8] further investigated the factors influencing occasional and frequent cyclists, and found that occasional cyclists are influenced by favourable weather conditions, while frequent cyclists faced practical barriers such as wind speed or the need to reach multiple locations. A 'Bikeability' index has also been developed by researchers to understand different scenarios. For instance, in one study, the index included cycling infrastructure, the presence of separated cycle ways, main roads without parallel cycle lanes, green areas, topography, and land use mix [9]. Another study focused on both observable and non-observable factors. It listed directness and coherence, climate, presence of bicycle infrastructure, and cost of the trip as observable factors, and comfort and attractiveness, traffic safety, and security as non-observable factors [10]. Hence, it is crucial to comprehend the barriers to cycling, considering objective measures (e.g., cycling infrastructure) and subjective measures (e.g., people's safety concerns).

Studies have also delved into the interplay between cycling and environmental attributes, encompassing diverse cycling purposes. For instance, Yang et al. [11] organized cycling into four distinct categories: transportation, recreation, commuting, and general cycling. Transportation cycling involves traveling between places, while commuting pertains to travel from home to a workplace or educational institution. Recreation cycling is undertaken for satisfaction or pleasure, while general cycling encompasses instances where the purpose is not specifically categorized. Through their analysis, Yang et al. identified key determinants for each category. Non-residential destinations and street connectivity emerged as crucial for transportation cycling, while commuting benefited from factors like street connectivity and the presence of cycling paths and facilities. General cycling was found to be influenced by the availability of green spaces, aesthetic considerations, and the presence of cycling paths and facilities. Notably, no significant factors were observed for recreation cycling. However, these discussions show that there are no consistent results regarding the factors affecting cycling, especially in the context of both recreation and transport. Moreover, this highlights the need for further studies focusing on recreational and transport-related cycling.

1.1. Cycling for transport and recreation

Based on the existing literature, it is evident that people use cycling for both recreational and transport purposes. Recreational cycling includes activities like reaching recreational facilities, exercising, or socializing, while transport cycling serves to connect people from one place to another (e.g., commuting to workplaces, schools). Research on these two types of cycling, however, is relatively limited, and studies measuring environmental attributes are also scarce [12, 13]. Moudon et al. [14] found in their study that most cyclists engage in recreational cycling, or both recreational and transport cycling, rather than only transport cycling. They also discussed that the perceived presence of recreational amenities, such as bike lanes and trails, positively influences cycling numbers, while the presence of certain destinations like grocery stores and schools negatively impacts cycling.

Furthermore, Heesch et al. [12] discovered that different factors influence cycling for recreation or transport purposes. For instance, factors such as bike paths or distance to the nearest shops hold significant influence over recreational cycling. In contrast, transport cycling is influenced by factors like distance to central business districts (CBDs) and the existence of bicycle paths, along with the distance to the closest transport station. Other studies have also demonstrated correlations between cycling purposes and various attributes. For instance, Adams et al. [13] found that cycling for transport purposes is closely tied to street connectivity, while Transport for London [15] highlighted the associations between leisure and transport cycling, and attributes like skills and confidence, convenience, and health/fitness considerations. Existing literature highlights various factors influencing both recreational and transport cycling, but consensus on these findings is lacking.

1.1. Aim and research questions

In this research, our primary aim was to investigate the relationship between cycling behavior, cycling infrastructure, and their roles in recreational and transport cycling purposes. By investigating recreational and transport-oriented cycling separately, and utilizing both objective and subjective measures, we aim to contribute to the limited discourse surrounding cycling for recreation and transport purposes.

We seek to address the following key questions:

1. How prevalent is recreational cycling compared to cycling for transport?
2. What are the existing policies pertaining to cycling?
3. What are the barriers hindering cycling, and how can we effectively address them?

By delving into these inquiries, we aspire to shed light on the potential challenges associated with cycling. Through this research, we aim to provide valuable insights and recommendations to enhance cycling infrastructure in cities and promote both recreational and transport cycling for the betterment of public health, urban planning, and sustainability.

2. Methods

For this study, our focus is on England, where the modal share of cycling (i.e, the share of the different modes of transport in the total traffic volume of a country, region, or city) remains remarkably low at 2%, in stark contrast to countries like the Netherlands (27%), which boasts the highest cycling modal share in Europe [16]. In addition, commuting and leisure activities (e.g., visiting friends, entertainment, sports, holidays, and day trips) dominate the landscape of cycling purposes in England, with 40% of trips being for leisure and 27% for commuting [16].

Within England, Lancaster city (UK) is widely recognized as one of the most bike-friendly cities [17, 18]. Moreover, Lancaster was designated as a cycling demonstration town[1], with government investments promoting cycling from 2005 to 2011 [19]. Due to its reputation as a cycling-friendly city and the

significant investment in cycling infrastructure, Lancaster was deemed an ideal location for conducting this cycling study.

The research methodology involves a combination of a survey study, interview with members of the City and County Councils, and objective measures. To ensure ethical compliance, the study received approval from the Lancaster University Ethics Commission, specifically the FASS LUMS Research Ethics Committee, in August 2022 (Ref: FASSLUMS-2022-0968-RECR-3).

2.1. Survey Study

The survey study was designed using Google Forms to collect data on cyclists' socio-demographics and their perceptions of cycling infrastructure and policies. The survey was distributed between July and September 2022 through social platforms, including the LICA Lancaster University Twitter account and the Lancaster Guardian webpage, as well as local cycling groups, such as Lancaster Women's Cycling Group on Facebook. Prior to participating, potential respondents received a participant information sheet outlining the project's purpose and the survey process. They were required to provide consent before proceeding to the survey questions and were assured that they could withdraw from the study at any time. Additionally, participants were asked whether they reside in Lancaster and, if not, whether they were familiar with the city's cycling infrastructure to ensure relevant and consistent responses. The survey consisted of both open-ended and close-ended questions, with the question format and categories adapted from prior research questionnaires (for example, [20]).

2.2. Interview with the councils

To gain insights into past and present cycling policies, the research team conducted interviews with staff from Lancaster City and Lancashire County Council. Three interviews were arranged with council staff, who were contacted via email and provided with a participant information sheet. This number of interviews provided a representative sample in terms of both quantity and quality, reflecting the capacity of individuals in smaller local and county authorities to effectively engage with transportation-related matters. Their role in the councils varied: one worked as a planning officer, one worked as a senior public health practitioner, and one worked as an active travel manager.

Before the interviews, the staff members gave their consent to participate in the study. The interviews were conducted virtually using Microsoft Teams, and the sessions were recorded for transcription purposes. Interview questions encompassed participants' roles within the council (including the projects they were involved in), their opinions on the cycling infrastructure in Lancaster in general, and strategies employed in Lancaster to promote cycling.

Once the transcriptions were thoroughly reviewed and corrected, the video recordings were deleted to maintain confidentiality and data security. All these procedures and details were transparently shared with the interviewees through the participant information sheet. The interviews were conducted in September 2022.

2.3. Objective measures: Presence and condition of cycling infrastructure

An investigation of Lancaster's cycling infrastructure was carried out using Google Street View (Fig. 1). This approach enabled the research team to assess the presence and condition of bike lanes within the city. By leveraging this technology, valuable data regarding the availability of cycling facilities in Lancaster was acquired. The street view study focused on routes that survey respondents and interviewees repeatedly mentioned. The analysis encompassed aspects, such as the existence of cycle lanes (Yes/No question), the various types of lanes (e.g., on-street cycle lanes), and the connections they establish. The categories of type of cycle lanes are adapted from Houde et al.'s study [21]. Google Street View images date from 2009 until 2022 (with some central images captured in 2022), aligning with the approximate timeline of the interviews and survey study.[2]

3. Analysis and Results

3.1. Objective measures: Infrastructure and street view

Cycling infrastructure in Lancaster is provided by Lancaster City Council and visually represented in Fig. 2. By closely examining the connections using street maps (Fig. 3), distinct cycling routes can be identified in Lancaster. These routes include the path between Lancaster city centre and Lancaster University (shown in purple), the Morecambe connection (shown in green), the river route (shown in blue), and the canal connection (shown in brown), all of which serve as key cycling routes into, and around, the city.

Upon detailed examination of these connections, variations in the infrastructure become apparent. In Lancaster city centre, and around Lancaster University (purple line) and the Skerton neighbourhood (dark blue line), cycling lanes predominantly consist of on-street shared or dedicated lanes. In contrast, along the river, canal, and Morecambe directions, the cycle lanes are mostly off-street, comprising multi-use trails, which accommodate both pedestrians and cyclists, or dedicated off-street bicycle paths. Google Street View observations also showed the changes in bike lanes on transport-purposed routes: dedicated on-street bike lanes change to shared bike lanes at different points, including on both the Lancaster Centre-Lancaster University route and the Lancaster Centre-Skerton route.

As can be seen, the cycling infrastructure covers the connections between Lancaster city centre and Lancaster University through the main A6 road, which also caters to cyclists, as well as the city centre and Morecambe direction. The Morecambe direction leads to Morecambe Bay[3], making it widely used for recreational purposes. The Skerton path establishes a connection between the Skerton neighbourhood and Lancaster city centre, primarily serving transport purposes. The river path serves as a connection to the Crook O'Lune picnic site and Caton village in the east, primarily utilized for recreational cycling. The canal path is another trail that facilitates access to recreational spaces, including the Fairfield Nature Reserve area. Thus, the majority of cycle paths are primarily designed for

recreational use. The Lancaster city centre and A6 connection, on the other hand, serves various facilities such as the Royal Lancaster Infirmary, Lancaster Hospital, retail and commercial establishments, as well as two universities: the University of Cumbria in Lancaster and Lancaster University. Consequently, this route is largely favoured for transport cycling.

3.2. Survey Study

The survey was successfully completed by 66 participants, all aged above 16. This sample size is considered reliable according to studies by Roscoe [22] and Morse [23]. Among the respondents, 78.5% stated that they live in Lancaster, with 55% having resided in Lancaster for over 10 years. For participants who did not live in Lancaster, we inquired whether they had ever cycled in Lancaster or were familiar with the city's cycling infrastructure. One participant acknowledged being unfamiliar with the infrastructure, and as a result, they were directed to the end of the survey and not asked any questions regarding cycling infrastructure or policies. Our final participant count was 65.

3.2.1. Participant demographics and cycling habits

In terms of socio-demographics, the participant breakdown was as follows: 21 females (32%), 43 males (66%), and one participant who did not provide gender information. Regarding age distribution, 28% fell between 35 and 44, 21.5% were aged 45–54, 20% were aged 55–64, and 15% were 65 and above. With regards to employment status, 65% of the participants were employed full-time, 17% were retired, and 12% were employed part-time.

When considering participants' cycling habits and knowledge of cycling areas in Lancaster, the results varied. An overwhelming 98% of the participants (64 individuals) owned a bicycle. Among them, 73% were experienced regular cyclists, while 17% were experienced, occasional cyclists. Notably, 28% of respondents cycled every day, and 52% cycled 2–5 times per week, with none reporting never riding a bike.

Figure 4 illustrates the responses to the question, "Why do you ride a bike?". Participants were allowed to select multiple options. The highest number of participants (N = 59, 92%) cited cycling for leisure as their primary reason for cycling in Lancaster. This was followed by cycling for commuting (N = 49, 77%) and cycling for health reasons (N = 41, 64%).

Among the participants, 25% (N = 16) confirmed their involvement in cycling groups. Subsequently, these individuals were asked about the names of the cycling groups they are associated with and the frequency of their participation in cycling events. Figure 4 offers an overview of the various cycling groups in Lancaster, highlighting a total of 10 distinct groups. According to the findings, events organized by these groups typically occur on a weekly basis or two to three times per week. This user-centric perspective provides a comprehensive glimpse into the diverse cycling activities occurring in Lancaster.

3.2.2. Perceptions of the neighbourhood and purpose for cycling

Participants were also questioned about their perceptions of the neighbourhood environment and their travel experiences for different purposes, aiming to gain subjective insights into the built environment. The majority of respondents expressed positive views about their neighbourhood environment. Specifically, over 50% of participants stated that the neighbourhood is free from litter, while more than 70% considered it safe in terms of crime and anti-social behaviour.

Regarding cycling experiences, participants reported that their neighbourhood environment is conducive to cycling. More than 50% stated that it is pleasant for cycling, and over 60% noted the availability of places to cycle to, such as shops or restaurants.

However, some of the survey results raise concerns (Fig. 6). Notably, 41% of the cyclists disagreed with the notion that cycling is safe considering traffic safety. Additionally, 31% expressed that there are not enough convenient routes available for cycling, while more than 41% believed that separated lanes, routes, or paths for cycling were lacking. It was also reported that there are limited cycling routes, with over 45% stating that they have to use the same route repeatedly, and 42% expressing concerns about the lack of safe places to cross roads.

When considering cycling for either recreation or transport specifically, more than 65% stated that they cycle for travel, whereas more than 68% stated that they cycle for recreation without really thinking about it. The majority reported that cycling for both travel (79%) and recreation (87%) is beneficial for them (Fig. 7). Furthermore, 65% of participants mentioned that cycling for transport is something they do automatically without much thought, while this percentage increased slightly to about 69% for cycling for recreation. The most significant difference between these two purposes lies in the last question regarding convenient cycling routes. Only 37% of cyclists stated that there are convenient routes for cycling for transport, whereas this percentage significantly increased to more than 60% for cycling for recreation. This finding suggests that participants perceive the availability of suitable cycling routes to be more favourable for recreational purposes compared to transport purposes.

Finally, we asked participants about their suggestions for increasing cycling rates. The question was intentionally left open-ended, and we categorized the answers based on participants' responses (Fig. 8). The results reveal that a significant number of respondents emphasized the need for separated cycle lanes (21%), the maintenance of existing bike routes/lanes (11%), and the importance of safe cycle lanes (10%). Additionally, cycling education for both drivers and cyclists (8%) was listed as a priority. Participants also highlighted various other concerns related to infrastructure, safety, and policies.

3.3. Interviews with the Councils

As previously mentioned, we conducted three interviews with City and County Council staff. One of the initial questions posed to the participants was about the groups or organizations that might support

cycling developments in Lancaster. All three participants mentioned Dynamo, a local group that aims for the Lancaster district to be a friendlier and healthier place for cyclists and pedestrians. They also mentioned additional active groups, including Sustrans and Friends of the Earth. Council staff further referenced some of the local cycling groups that were listed in the survey results:

“I know there’s still the Dynamo, the campaign group that exist. … There’s a number of environmental Friends of the Earth-type groups... I guess things like, you know, ‘Friends of’ neighbourhoods and parks-type groups tend to sometimes be interested that they, you know, groups concentrated around schools... I mean sports clubs potentially; I mean I'm a member of the local triathlon club and we would generally sort of support things that made cycling and walking and easier in Lancaster.” (Council Staff-3).

Another question related to Council staffs’ perspective on the cycling infrastructure in Lancaster and the overall cyclability of the city. All three participants responded positively, expressing that the cycling infrastructure is quite efficient, especially with regard to the path between Lancaster and Morecambe:

“We've got an amazing network of some disused railways and we've got the canal as well… So we have got an amazing route of off-road routes” (Council Staff-1).

“There's some really, really good pieces of infrastructure. So, for example, you can cycle from Lancaster to Morecambe pretty much without seeing a car all the way down there” (Council Staff-2).

“I think it's OK. I mean, I think it could be a lot better. Uh, we've obviously made good use of the old… railway network, so you do have those sorts of main arms and which are useful, and they're useful for a leisure perspective as well. You know, people going up and down the river” (Council Staff-3).

Indeed, while the interview results indicated overall satisfaction with the cycling infrastructure in Lancaster, there were also concerns raised specifically about cycling for transport purposes. The interviews highlighted that there were areas where improvements were needed to cater to the needs of cyclists for their daily commutes:

“… But the big problem you've got in Lancaster is you've got a city centre that's dominated by vehicles… So the big problem here is the city centre. So if you live in the north of Lancaster, say you've just lived over the river in Skerton and you work at one of the biggest employers in the city, the hospital, you're probably about a mile away from your place of work, yet to cycle in there would be absolutely abysmal. It would be a shocking experience for you. If you lived in Morecambe and you work at the hospital, similar…” (Council Staff-2).

“Probably the main, I would say, the main kind of issues that we have problems or, you know, bit where we've got missing infrastructure is the city centre and the route down to the university are the main ones” (Council Staff-1).

“I think it probably is that people generally think you know that that sort of main leisure network is good. But then how do they get onto it? So, if they live in South Lancaster and they wanted to go up to the

Crook O'Lune, let's say, how do they get from South Lancaster, though, to meet those big networks? So, I think a lot of people think there should be something on the A6, which is obviously the key route through Lancaster" (Council Staff-3).

Certainly, the alignment between the interview results from council staff and the survey results reinforce the notion that difficulties in cycling for transport purposes are a recognized concern in Lancaster. The feedback from council staff and the survey responses both point to challenges faced by cyclists when using bicycles for practical purposes, such as commuting to school or work.

3.3.1. Policy-related decisions/steps from the councils

Some of the recent projects in and around Lancaster were described by the Council staff during the interviews, which include the Lune Valley Greenway project (a cycle way up into the Lune Valley) and a new garden village project in northern Lancaster [24]. Though Council staff perceived these projects to be effective, as they served recreational purposes, they often created additional road traffic in the centre, rather than providing a solution for cyclists wishing to commute to work. One project aims to cover the centre and ease movement by creating sustainable travel corridors and an inclusive environment: Lancaster City Centre Movement and Public Realm Strategy [25]. Different options were introduced in the cited report to promote cycling and walking; however, these ideas have not yet been implemented in the centre.

4. Conclusion

This study aimed to understand cycling behaviour in Lancaster for both recreational and transport purposes, as well as to gain insights into current policies and infrastructure. In examining cycling infrastructure, we focused on five routes based on interview and survey results. Three routes predominantly serve recreational purposes (Morecambe- river and canal paths) while two routes are primarily designated for transport (Skerton-Lancaster Centre and Lancaster Centre-Lancaster University paths). The canal, river, and Morecambe paths consist mostly of dedicated off-street bike lanes; however, the other two routes mainly feature shared or dedicated on-street bike lanes. These differences highlight the distinct characteristics of cycle lanes for the two purposes.

Additionally, our objective data results revealed variations in the cycle lanes along transport routes: while they begin as dedicated on-street lanes, they intermittently merge with traffic and transition into shared lanes at certain points. This observation underscores the inconsistency of cycle lanes along transport routes, which could contribute to reduced cycling uptake. Notably, prior research emphasized the importance of separated bike lanes in ensuring safer cycling conditions [26], a factor that could also influence the number of cyclists opting to cycle for transport purposes.

Regarding the survey study, the majority of our respondents fall within the age range of 35 to 54 (49%), are employed full-time (65%), and predominantly identify as male (66%). Leisure emerged as the most frequently cited reason for cycling in Lancaster, followed closely by commuting. Cycling for recreational

purposes was also favoured by a higher number of individuals in previous studies done in the US [14]. Moreover, in the Netherlands, cycling for leisure accounted for 33%, shopping for 21% and commuting for 18% [27]. Additionally, it was reported that 76% of the Dutch population cycles for enjoyment, contributing to 700 million trips annually. Given these statistics, it might not be surprising to observe higher leisure cycling percentages in England or within the context of Lancaster. However, the Lancaster example demonstrates that these percentages can be influenced by infrastructure-related issues, and the potential for increased cyclist numbers exists with the development of appropriate solutions.

In addition, we discovered different active cycling groups in Lancaster that promote cycling through events and raising awareness campaigns. Upon analysing the built environment, our survey results revealed several noteworthy insights. A significant portion of participants expressed concerns about the lack of convenient cycling routes (31%), the perceived unsuitability of their local neighbourhoods for cycling due to safety concerns (41%), and the demand for additional, segregated cycle lanes and routes (41%). These findings shed light on the prevailing challenges associated with cycling in Lancaster.

Furthermore, our survey results reveal that Lancaster has a dedicated cycling community, with individuals cycling for various reasons, including transport and recreation. However, when comparing the experiences for different purposes, we discovered that cycling for recreational purposes was more pleasant for cyclists than cycling for transport purposes. While a substantial proportion of participants indicated the presence of convenient cycling routes for leisure (over 60%), the corresponding figure dropped to approximately 37% for transport cycling. This observation aligns with our findings from the Google Street View analysis, underscoring the need for improvement in transport routes. One way to do that is through continuous, segregated cycle lanes, which our survey respondents consistently emphasized. Our finding aligns with previous research, which highlights the significance of recreational amenities, such as the existence of bike lanes and trails [14], and other factors, such as street connectivity, as incentives to increasing the number of cyclists for transport purposes [11, 13].

Our discussion with the council staff revealed the need for safer cycle lanes in the centre of Lancaster. A 2020 report from Lancaster/Lancashire City/County Council was developed with the intent of establishing sustainable travel corridors, primarily focusing on the central area. However, tangible changes in addressing these gaps have not yet occurred. Furthermore, all three council staff members reiterated the issue with cycling infrastructure in Lancaster. They emphasized the necessity for solutions within and around the centre, particularly on the A6 route connecting the centre to the university area, calling for the implementation of separated cycle lanes. As we move forward, finding a solution to enhance cycling infrastructure in the centre will be essential for fostering a more cyclist-friendly environment and encouraging healthier transportation choices in the city. But, as one of the council staff stated clearly:

“So the idea shouldn't be: “ I'm gonna go out on my bike today because I want to save the planet”, or “I'm gonna go out on my bike today because I'm gonna be environmentally aware”, or “I'm gonna go out my bike today to improve my health”… You got on your bike because we've designed urban space, urban

realm, the infrastructure around you to make it the easiest, the most pleasant and the most obvious choice for you to do that." (Council Staff-2).

The question then arises: how can we modify dense city centres, considering existing streets to improve the health of cyclists? How can we create continuous or separated cycle lanes in dense areas? Many city centres encounter similar issues, as exemplified by the situation in Lancaster. Perhaps this is why it is comparatively simpler to establish trails for recreational cycling, while the creation of continuous, segregated lanes for transport cycling within city centres poses greater challenges. Additionally, investment can prove more complex when substantial cycling infrastructure already exists within cities [28]. In their study, Gerike and Jones [28] outlined various steps to address these issues in urban centres. This entails identifying and prioritizing origins and destinations, amalgamating them into desired routes, and translating these routes into physical infrastructure, considering both links (e.g., cycle lanes, parking spaces) and amenities (e.g., seating) required by people. If the available street space does not suffice for this approach, several options can be pursued:

- Pragmatic solutions adhering to lower standards can be explored: reduced standards can be developed if the difference between available and minimum required spaces is small,
- Street functions can be downgraded (either in terms of places and/or links): for example, part of the place or link function can be transferred to other street sections,
- Strategic measures can be implemented, including discouraging car usage: this can help accommodate user needs in constrained environments,
- Alternatively, origins and destinations can be redefined to propose alternative solutions.

These solutions can be adopted, and bespoke alternatives can be devised for distinct scenarios. In doing so, cities could be taking active steps to addressing the barriers that hinder cycling, particularly cycling for transport, which could go some way to improving the physical and mental health of cyclists.

4.1. Next Steps

Further studies could delve into a more comprehensive exploration of people's safety concerns, particularly within the context of England and the Lancaster example [29]. Subsequent research could also shift focus towards recent or upcoming urban planning decisions within local authorities to gain deeper insights into the future of cycling-friendly cities. Finally, adopting a participatory approach to rating cycling infrastructure, using digital technology like Google Street View or FixMyStreet, might provide additional data that would yield rich insights into local cyclists' experiences.

Overall, this study contributes to cycling research by examining both recreational and transport cycling, utilizing a combination of objective and subjective measures to assess cycling infrastructure and needs in Lancaster. Our observations regarding transport cycling challenges in Lancaster's city centre may have broader applicability to other English cities, allowing for comparative analyses between transport and recreational cycling using similar methodologies. If this trend is consistently observed, it suggests

that while improving recreational cycling infrastructure, particularly outside city centres, is important, addressing issues in city centres is also imperative for a meaningful increase in cycling participation.

Declarations

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Author Contributions

D.Y., R.C.D., and C.B. conceptualized the work; D.Y. collected, analysed, and visualized the data; D.Y., R.C.D., and C.B. drafted the manuscript.

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Data Availability

The data are available upon request.

Ethics approval

The study received ethical approval from the Lancaster University Ethics Commission, specifically the FASS LUMS Research Ethics Committee, in August 2022 (Ref: FASSLUMS-2022-0968-RECR-3). The research was conducted in accordance with the ethical guidelines and regulations of Lancaster University.

Consent to participate

Informed consent was obtained from all individual participants included in the study.

Consent to Publish

The authors affirm that participants provided informed consent for publication.

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Footnotes

1. The Cycling Demonstration Town (CDT) program, funded by the UK Department for Transport (DfT), provided funding for cycling initiatives in six towns during the periods of 2005–2008 and 2008–2011.
2. Although Google Street View has been used reliably to evaluate micro-level design features of physical environments [30, 31], the authors recognise the disadvantages of using such online sources (e.g., portions of images may be blocked by vehicles; images of cycle paths, held by Google Maps, do not correspond to the period when the research occurs).
3. Morecambe Bay is a vast estuary situated in northwest England, encompassing the largest expanse of intertidal mudflats and sand across the United Kingdom. It is often celebrated as one of the wonders of Northern England [32].

Figures



a. b. c.

Figure 1

Different types of cycling paths in Lancaster, UK. a. on-street bike lane, b. on-street bike lane that becomes shared with vehicular traffic, c. dedicated off-street bike lane.

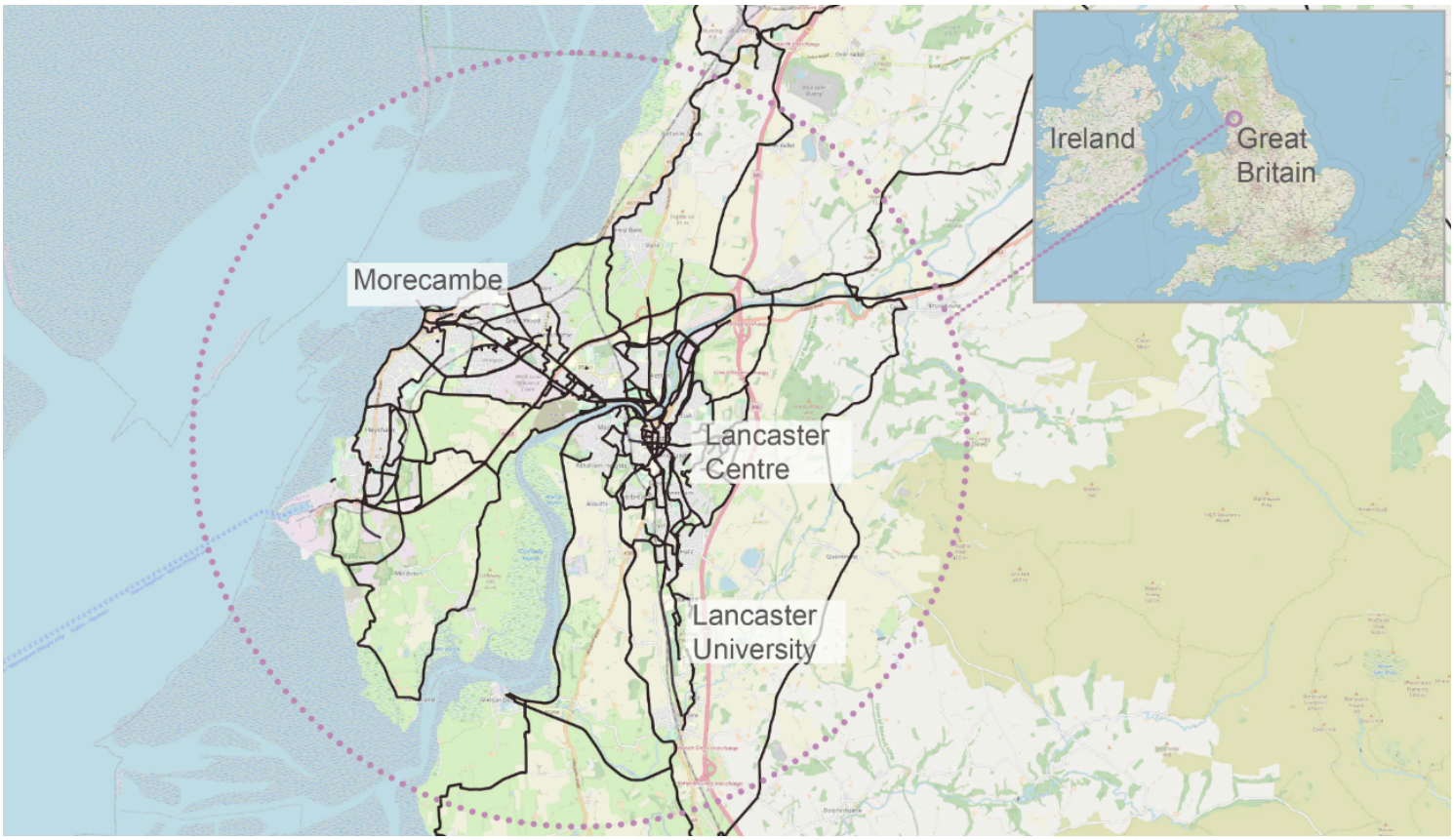


Figure 2

Map showing location of Lancaster city in Great Britain and its surrounding. Black lines show the cycle routes. Source: Lancaster City Council.

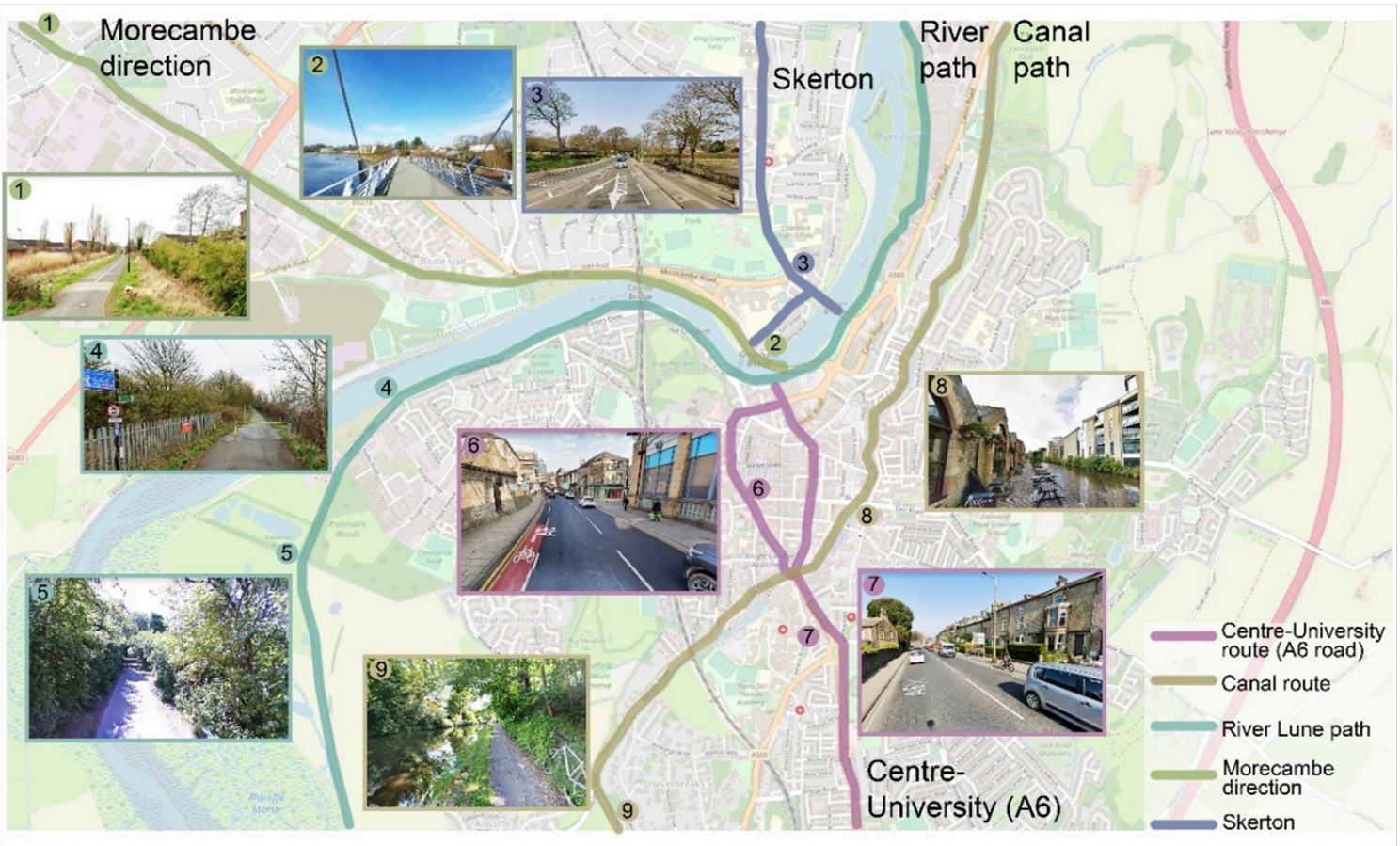


Figure 3

Map showing different routes around Lancaster city. Street images show the conditions of the cycle lanes. The numbers on the map correspond to approximate locations where the Google Street View images were captured and objective measures were collected and analysed; the coloured frames around the images indicate the respective routes associated with each image.



Figure 4

Answers for the question, "Why do you ride bike?".

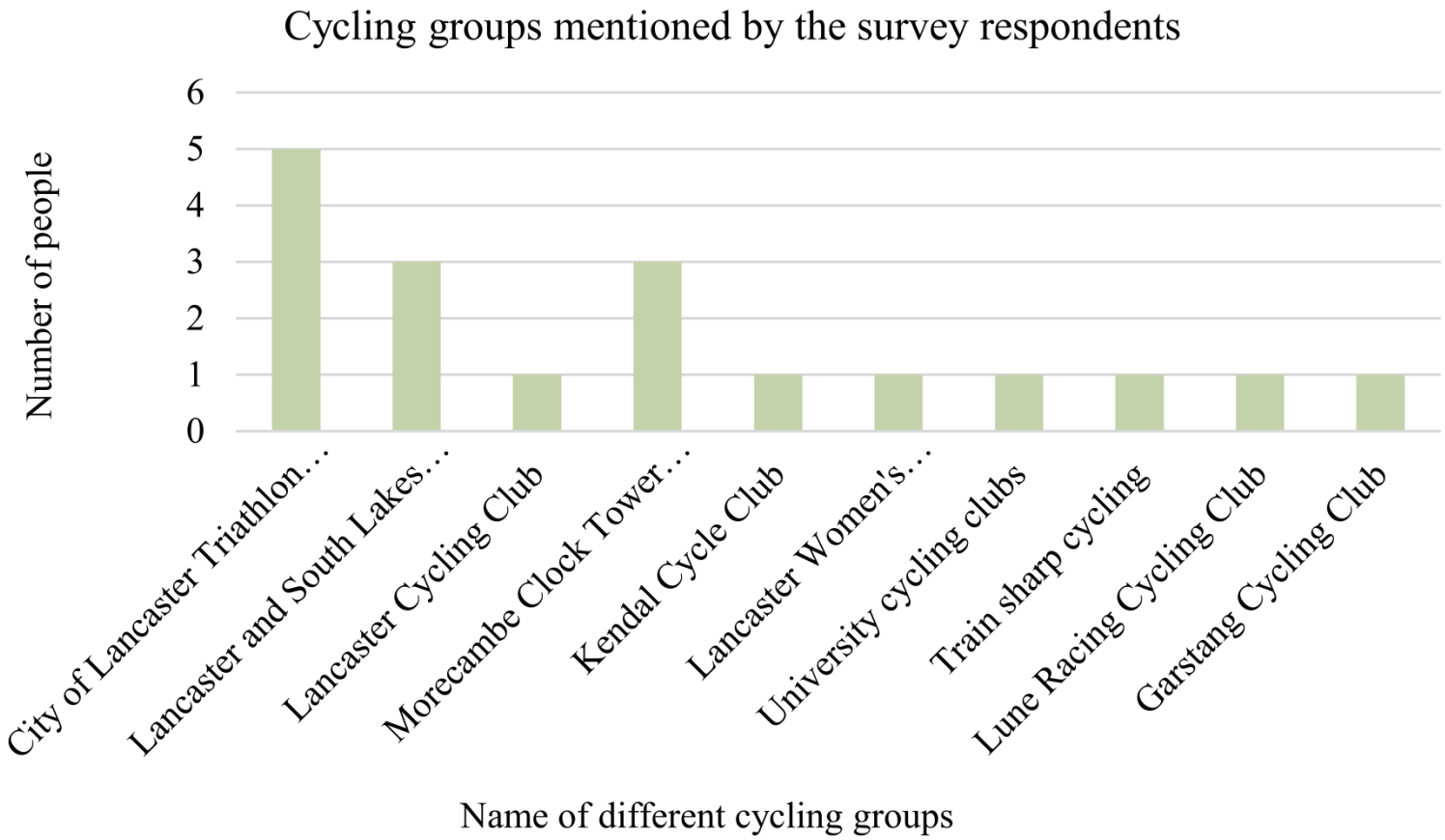


Figure 5

Responses to the question about the cycling groups.

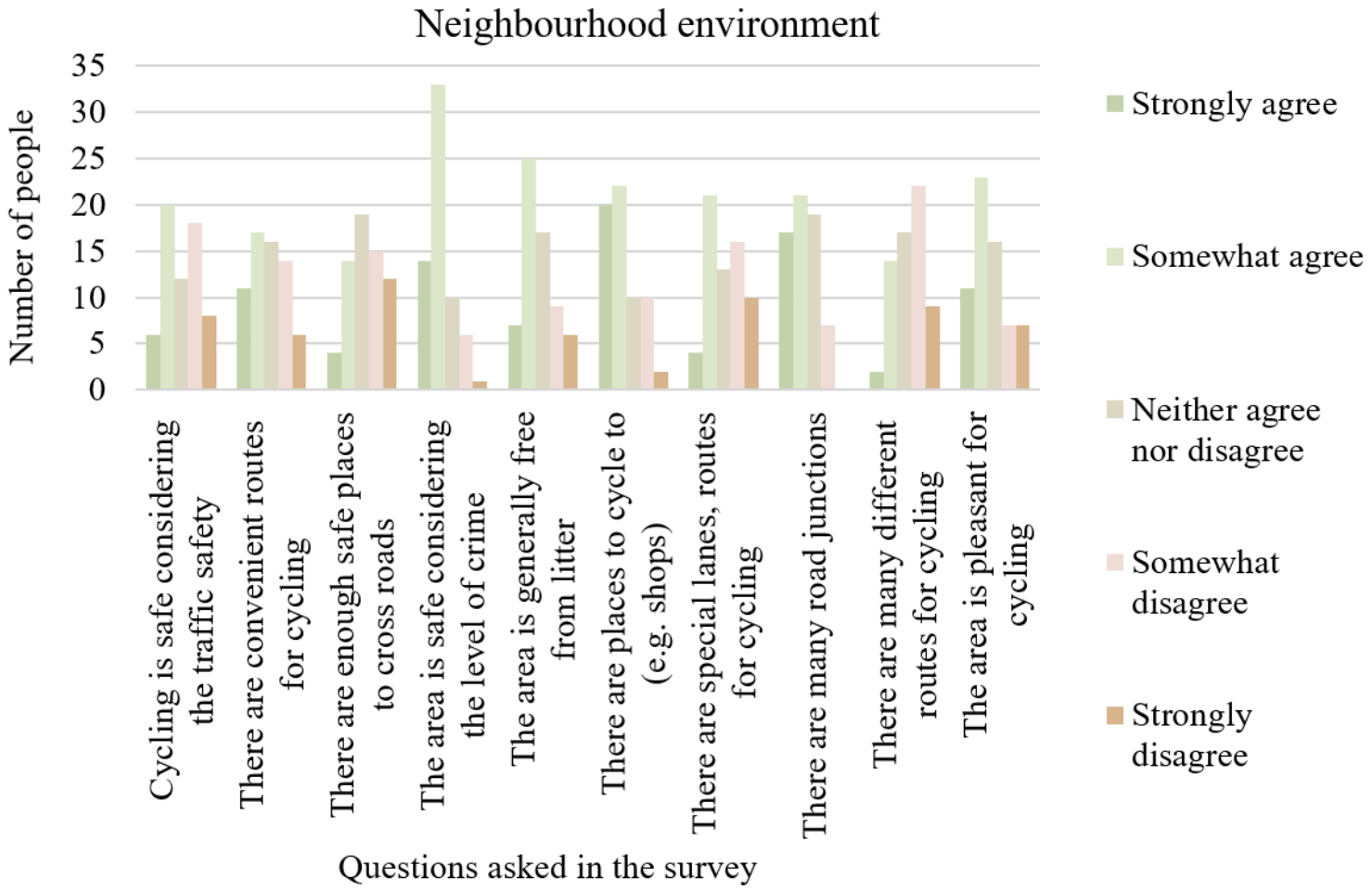


Figure 6

Survey results for the neighbourhood environment.

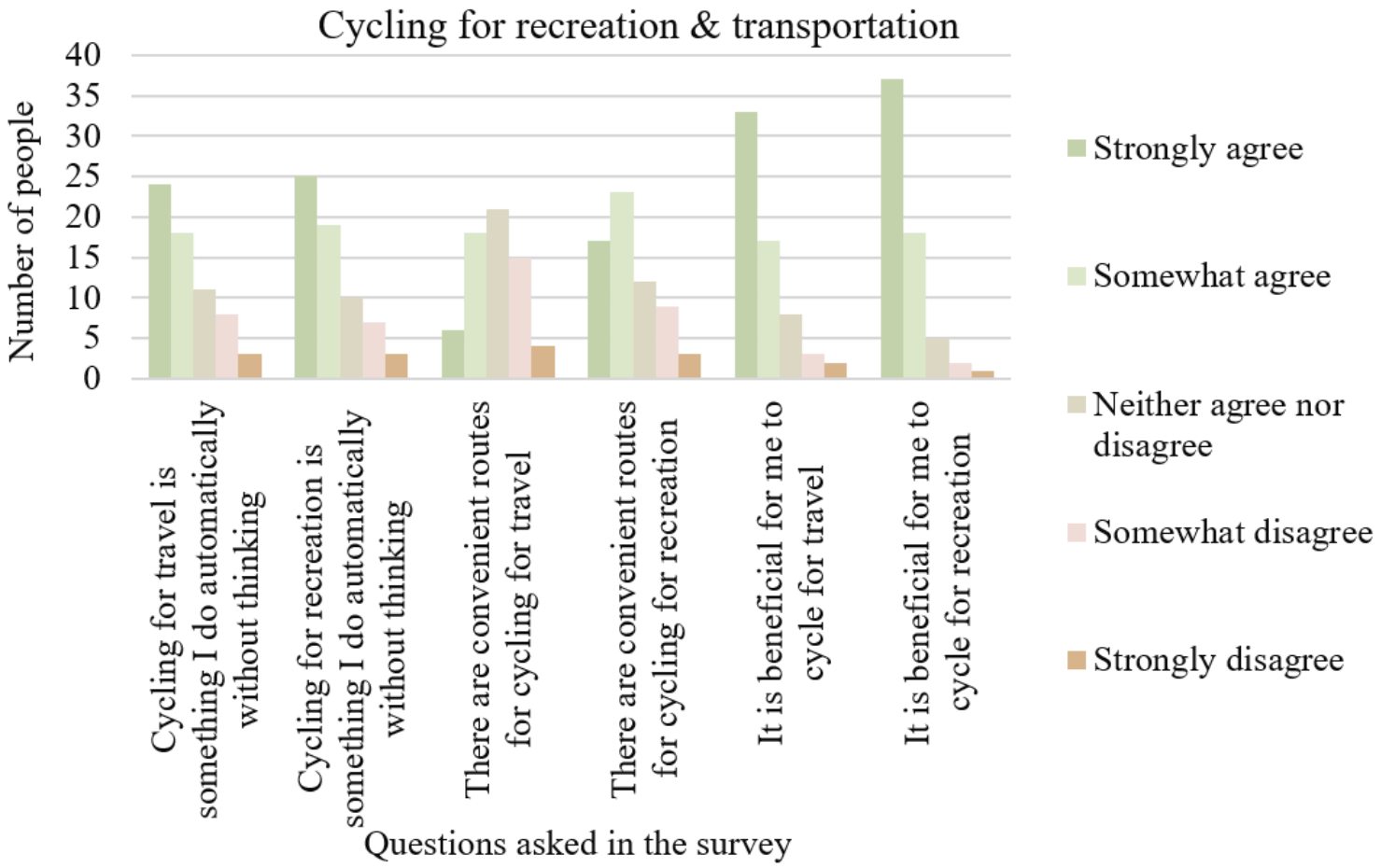


Figure 7

Survey results for recreational and transport purposed cycling

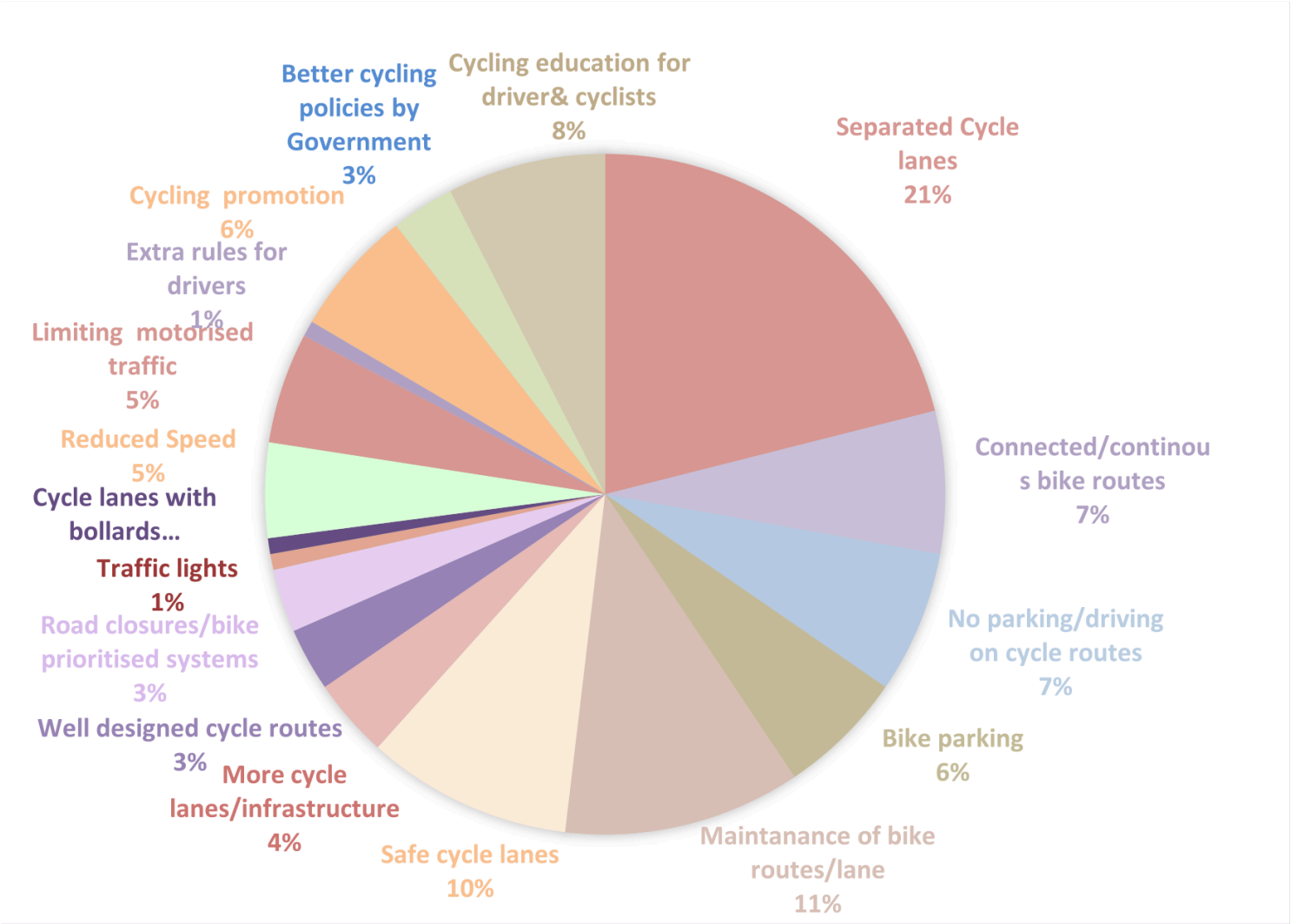


Figure 8

Survey results showing participants' thoughts to increase cycling rates.