E-ISSN: 2528-388X
P-ISSN: 0213-762X

INERSIA
Vol. 19, No. 2, December 2023

An Exploration of Cyclists' Preferences that Influence Route Choice to Recreation in Yogyakarta during COVID-19

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Keywords:
COVID-19
Cyclists
Recreation
Route Choice Factors

ABSTRACT

People's travel behavior has changed significantly as a result of the COVID-19 pandemic. The growing number of cyclists, particularly those who ride for recreation, and how they view the options for recreational riding routes are two of the elements that are being impacted. Cycling route preferences may be viewed differently than they were prior to the pandemic. It will be crucial to understand cyclists' behavior while choosing their routes in order to choose the development, especially for cycling infrastructure. This research aims to explain the perceptions of recreational cyclists regarding the influential factors in determining their routes. The data for this study was collected from 340 respondents who use bicycles for recreation in Yogyakarta City. A questionnaire was used to collect data by examining the factors that influence cyclists in determining their routes, such as infrastructure conditions, traffic conditions, environmental conditions, and travel plans, using a Likert scale. Through the questionnaire, socio-demographic characteristics of the respondents were obtained, revealing that the majority were male, with incomes below Rp 1,500,000, and aged below 25 years. The analysis methods used in this study were descriptive analysis, importance score analysis, and chi-square tests between the characteristics of the cyclists and each factor. The results showed that the most important factors for recreational cyclists in determining their routes in Yogyakarta City are the availability of street lighting facilities (4.34), good road conditions (4.31), the presence of dedicated bicycle lanes (4.30), low traffic volume (4.30), and the natural environment (4.29). Additionally, the frequency of recreational cycling statistically correlates significantly with some factors, such as the availability of bicycle lanes, bike boxes, and low pollution levels.

1. Introduction

During the COVID-19 pandemic, almost all over the country, cycling has been a more popular activity due to its ability to enable social distancing as exercise, transportation, and has low risk of contagiousness [1][2]. According to the previous research, 10% of adults in the US engaged with cycling in a new way during the pandemic [3]. This was supported by a prior result that showed an average 12% increase in bike trips in the USA from July 2019 to July 2020 [4]. Based on [5] , According to several claims, cycling traffic volume increased more in 2019 and 2020 in locations without lockdowns than in comparisons of the two full years with lockdowns, such as Paris, Barcelona, and New York. In Vienna, the percentage of people who biked rose from 7% in 2019 to 9% in 2020. A major transit corridor in Milan with protected bike lanes saw an increase in the percentage of cyclists from 5% in November 2019 to 18% in November 2020. As per the survey respondents, there was a significant increase in bicycle use after the first phase of the COVID-19 epidemic. In Lausanne, 44% of respondents cycled more, and in Geneva, 27%, 5% of respondents cycled again [6]. Furthermore, Indonesia also has similar condition in which cycling has become more popular [7]. According to the Institute for Transportation and Development Policy (ITDP) Jakarta, the cyclist number increased significantly by almost 500% compared to October 2019 [8]. Meanwhile, In Yogyakarta, the cycling also became the most popular activity during COVID-19 pandemic era.

Governments have already responded to the rise in riding frequency by offering incentives for cycling as a space-saving, equitable, sustainable, and low-risk method of transportation that lowers the chance of a COVID-19

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https://dx.doi.org/10.21831/inersia.v19i2.64870
Received August 7th 2023; Revised December 22nd 2023; Accepted December 27th 2023
Available online December 31st 2023

pandemic [9]. Numerous city governments have taken steps to accommodate and encourage more cycling, such as adding more bike lanes, lowering the fees for bike-sharing services, and prohibiting cars on roads [10]. Investing in bicycle infrastructure during the outbreak was a strategic move made by Yogyakarta's local authorities. For instance, the local authorities revived bicycle lanes by leveraging the upsurge in bicycle usage [11].

According to the People for Bikes (PFB) survey's findings, more people will not cycle in 2020 for regular excursions like those to employment, school, universities, or shopping. Newbie cyclists cited stress relief and mental health (58%), physical fitness and exercise (57%), interacting with friends and family (43%), unwinding (37%), and being outside (33%) as their top five motivations [3]. It can be explained that the frequency of cycling has increased, particularly for recreation and not for commuting [12]. The current COVID-19 pandemic has sparked a renewed interest in recreational riding, according to the prior studies [1][10][13][14][15][16]. Other research explained that during the pandemic, people used bicycles for health and well-being in Yogyakarta [17].

However, there is a lack of previous study that explain the reasons why cyclists chose these routes during pandemic, particularly for recreation. By considering the cyclist's influence factors on route choice, it will help urban planners, government, and policymakers to develop the infrastructure, improve cycling networks, promote active mobility, and enhance safety [18]. There are several studies assessing and explaining the behavior of determining route choice and evaluating the impact of the characteristics of cyclists on route choice [19][20]. The number of lanes, the state of the pavement, the slope, the infrastructure, the kind of parking beside the road, the volume and speed of traffic, the sharing of the road, the road classification, the safety of the land use, the natural environment, the built environment, the length of the trip, the travel time, the intersection, and the signalization all affect the routes that cyclists choose [21].

This research aims to determine the factors that influence the choice of cycling routes for recreational purposes during the COVID-19 pandemic so that this study will be able to provide recommendations regarding actions that must be taken to improve proper cycling infrastructure facilities, enhance safety, and encourage people to cycle for other activities.

2. Literature Review

Travelers choose their routes both consciously and subconsciously, depending on factors that affect the decision to select one option over another [22]. Although these impacts that are associated with an alternative go by several names, such as qualities, they are primarily referred to as factors in the research. The previous study made the case for analyzing cyclists' decisions in order to forecast their routines, trade-offs, and potential behavioral changes following network changes [23]. According to [24], promoting more cycling among cyclists requires a thorough grasp of the architectural features of bicycle networks in addition to network safety and continuity. Several previous studies have explained the factors that influence the preferences of cyclists that have any purpose in determining routes, including infrastructure factors, traffic factors, environmental factors, and travel plans.

Cyclists tend to use roads that have two lanes rather than wide roads with four lanes [25]. Other research also explained that cyclists plan trips using the main roads because wider roads tend to be easy to understand and have facilities to support the trips [26]. Then, cyclists avoid cycling on roads that have not been paved and prefer to use roads that already have pavement and a smooth surface [27]. Poor pavement conditions are the main factor hindering cyclists because poor road surface conditions can reduce sensitivity to safety and encourage cyclists to choose other routes [28]. Routes with steep slopes tend not to be chosen by cyclists [29]. An important attribute considered by cyclists in determining the route is the slope of the road [30]. The existence of infrastructure to support cyclists on the road is one of the factors considered in determining routes, such as special bicycle lanes. Riding a bike on a road with uninterrupted bike lanes is more appealing to cyclists than riding on a road with fewer bike lanes. Regarding preferences for using bike lanes, there was no discernible difference between men and women [31]. In the meantime, women tend to use bike lanes at a rate of 50.7%, compared to 41.7% for males [31]. It is crucial for inexperienced cyclists that this infrastructure exists [32].

Furthermore, based on traffic conditions, cyclists will consider several important things, one of which is the volume of vehicle traffic. Cyclists tend to choose roads with low traffic volumes [32]. Experienced cyclists will not be bothered by the volume and speed generated by other vehicles [33]. Cyclists will choose a longer route to avoid motorized vehicle traffic [32]. Cyclists are not happy to share roads with motorized vehicles, and cyclists will increase the distance traveled up to four times to avoid

high road traffic [24]. Other research states that, apart from motor vehicle traffic conditions, the presence of signalized intersections is a hindrance or distraction for experienced cyclists [24][30]. Previous research conveyed the level of difficulty for cyclists in using a route with many stop signs [27]. This makes cyclists take a break and continue their journey again, thus requiring additional energy, especially on road conditions that tend to be steep. In general, cyclists avoid going through routes with stop signs and traffic lights unless they are going to pass or cross roads with high motor vehicle traffic. Prior research has indicated that the quantity of crossings on a street has a greater impact on cycling than does the density of streets. Moreover, a low number of intersections were rated as important components of the route for bicycles [34].

Factors derived from the external environment might make bikers feel more secure at night, and street lighting arrangements have a significant impact on route selection [24]. 20% of cyclists are concerned about safety while cycling, and 78% of cyclists are worried about accidents while cycling [35]. The variable pollution produced by motorized vehicles is a measure of attitude towards the environment and cycling [36]. Cyclists tend to choose routes with natural environments such as rivers, lakes, and forests [37]. Furthermore, cyclists tend to choose routes with natural scenery and calm conditions, such as low traffic [38]. In addition, the built environment is also a factor that influences route selection [39] [40]. The factor of demographic and socio-economic factors related to cycling for commuting is significantly associated with the built environment [41]. Based on [42], cycling for work, school, or shopping is referred to as utilitarian cycling, whereas cycling for fitness or amusement is referred to as recreational cycling. Many people, both adults and children, who are unable to ride for practical reasons frequently ride for enjoyment or fitness. Riding a bicycle for recreational purposes is a common way to pass the time, as opposed to using it for daily transportation. Families are the main participants in this activity, including multigenerational extended families and unofficial associations of friends and acquaintances. Instead of competition or stellar accomplishments in sports, the aim is leisure activity [43].

3. Methods

The data gathering and analysis of this study are separated into two components. Within the Yogyakarta City agglomeration region, a stratified random sampling approach was employed in the data gathering process. Since the beginning of the COVID-19 pandemic, this location has continuously seen an increase in the number of bicycles being used. There were 340 respondents in total who participated in this study. The Google Form was used to collect data from July to September of 2021. The question variables used in this study are socio-demographics and factors that influence cyclists' route choice for recreational purposes, such as infrastructure conditions, traffic environment, and travel plans. Details of each of these variables are presented in Table 1. In this study, crosstab analysis, the Chi Square Test, important analysis results, and descriptive analysis were the analytical techniques employed. A Chi-Square test is conducted to determine whether an association can be made between age, gender, and frequency of cycling during the COVID-19 pandemic and factors that influence route choice. Segmentation based on gender, age, frequency of cycling, and cycling group of different sizes has been widely used in assessing cyclist behavior and determining route choice [44]–[47]. This test is used on attributes in each fator, while the degree of confidence used in the chi-square test is 5%.

Table 1. Factors that influence the determination of cyclists' routes

Group	Indicator	Source
Infrastructure Condition	Good Road Condition	[21], [26], [28]
	Wide Lane	[25]
	Paved Road	[27]
	Availability of Bike Lane	[30], [32], [48], [49]
	Flat Road	[27], [49]
	Availability of Bike Box	[32]
Traffic Condition	Low Vehicle Traffic	[32], [50], [51]
	Low Vehicle Speed	[24], [32], [33]
	Number of Signalized Intersections	[24], [27], [30], [52]
Environment Condition	Natural Environment	[37]
	Safe Route	[35]
	Availability of Road Lighting	[24]
	Low Pollution	[36]
	Built Environment	[40]
Travel Plans	Travel Time	[29], [30], [33]
	Travel Distance	

4. Results

According to Table 2, there are 340 respondents collected. The dominant respondent is male (63.3%), while female (31.9%). Cyclists in Yogyakarta who have a purpose for recreation are dominated by young people (18–25 years old) at 55.9%. While the educational background is primary senior high school, in which there is 42.4%. The allowance of cyclist respondents is less than Rp 1.500.000 by 55%. It relates to the earlier study that examined whether participants with lower incomes cycled for recreation more frequently than people with higher incomes [12]. The main mode used by cyclists daily is a motorcycle, at 82.6%. Cyclists in Yogyakarta who own one motorcycle are 50.3%, while cyclists who own one bicycle are 48.5%. Cyclists who own a driving license are 85%. The frequency of 130 respondents who are cycling to recreation during the COVID-19 pandemic is only several times in a week, which means more than once for cycling. Lastly, cyclists tend to cycle during the pandemic for recreational purposes with a group of 1–5 people, which is around 53.8%.

Table 3 presents the results of an Importance Score Analysis, which aimed to evaluate the relative importance of various factors on route preferences. After 340 people responded to a survey about their preferences, the analysis involved determining the mean scores for each factor. The table displays the mean scores of different factors influencing route choices, listed in descending order based on their importance. The higher the mean score, the more important or influential the factor is perceived to be in route choices. Availability of road lighting (4.34) means that this factor received the highest mean score, indicating that it is considered one of the most important factors influencing route choices. Good Road Condition (4.31) indicates that this factor also received a high mean score, suggesting that it is perceived as highly influential in route preferences. The availability of a bike lane (4.30) shows that the presence of a bike lane is deemed significant in determining route choices, as reflected by its high mean score. Low private vehicle volume (4.30) mentions that cyclists tend to prefer routes with less traffic, which is evident from the high mean score of this factor. Lastly, the natural environment (4.29) shows that the natural environment, such as greenery or scenic views, is considered important in route selection.

The remaining factors in Table 3 also contribute to route preferences but received relatively lower mean scores compared to the top five factors. These factors include low pollution, travel distance, travel time, low motor vehicle speed, built environment, safe route, number of signalized intersections, availability of bike boxes, flat road, paved road, and wide lane. The factors listed in parentheses represent the five highest-scoring influential factors among the listed ones.

Table 2. Socio demographic characteristics

Characteristics	n	%
Gender		
Female	114	31.9
Male	226	63.3
Age		
<18	39	11.5
18-25	190	55.9
26-35	71	20.9
36-45	28	8.2
46-55	10	2.9
56-65	2	0.6
Education		
Elementary School	2	0.6
Junior High School	12	3.5
Senior High School	144	42.4
Diploma	34	9.5
Bachelor	122	35.9
Postgraduate	26	7.6
Allowance (Monthly)		
< Rp 1.500.000	187	52.4
Rp 1.500.000 - Rp 3.000.000	86	24.1
Rp 3.100.000 - Rp 4.500.000	29	8.1
Rp 4.600.000 - Rp 6.000.000	17	4.8
Rp 6.100.000 - Rp 7.500.000	3	0.8
> Rp 7.500.000	18	5
Main mode		
Car	24	7.1
MC	281	82.6
Online Taxi	15	4.4
Trans Jogja	2	0.6
Walk	18	5.3
MC ownership		
0	26	7.6
1	171	50.3
2	74	21.8
3	35	10.3
4	29	8.5
>4	5	1.5
Bike ownership		
0	7	2.1
1	165	48.5
2	85	25
3	43	12.6
4	13	3.8
>4	27	7.9
Driving License		
No	51	14.3
Yes	289	81
Frequency		
Few times in a year	52	15.3
Once a month	45	13.2
Once a week	91	26.8
Several times in a week	130	38.2
Everyday	22	6.5
Cycling Group		
Solo	150	44.1
Group		
1-5 cyclists	185	53.8
6-10 cyclists	6	1.5
>10 cyclists	2	0.6

Table 3. Importance score analysis results

Preferences of Route Choices	Mean n=340
Availability of Road Lighting	4.34 (1)
Good Road Condition	4.31 (2)
Availability of Bike Lane	4.30 (3)
Low Volume of Motor Vehicle	4.30(4)
Natural Environment	4.29 (5)
Low Pollution	4.23
Travel Distance	4.11
Travel Time	4.04
Low Motor Vehicle Speed	4.01
Built Environment	3.95
Safe Route	3.87
Number of Signalized Intersections	3.82
Availability of Bike Box	3.69
Flat Road	3.56
Paved Road	3.49
Wide Lane	2.92

** Numbers inside ( ) is five highest scoring influential factor*

The Chi-Square test results indicate the relationship between factors influencing route choices and the variables of age, gender, and frequency of cycling during the COVID-19 pandemic. Table 4 shows several factors that have been identified as significant in influencing the route choice.

The p-value for cycling frequency is 0.036, indicating that there is a statistically significant association between the availability of bike lanes and the frequency of cycling. Age (p = 0.661), gender (p = 0.439), and cycling group (p = 0.813) do not show significant associations with the availability of bike lanes.

Age (p = 0.598), gender (p = 0.471), and cycling group (p = 0) do not demonstrate statistically significant associations with the availability of bike boxes. However, cycling frequency exhibits statistically significant associations with the availability of bike boxes. This implies that cycling frequency may play a role in the preference for routes with bike boxes.

Cycling frequency and cycling group exhibit a statistically significant association with choosing routes with low pollution (p = 0.032 and p = 0.029), while age and gender do not show a significant association (p = 0.205 and p = 0.503, respectively). The cycling group has a statistically significant association in the route choice factor with travel time (p = 0.001), whereas age, gender, and frequency of cycling do not have a significant association (p = 0.546, p = 0.512, and p = 0.372, respectively).

Table 4. Chi square test

Influence Route Choice's Factors	Person Chi-Square Test			
	Age	Gender	Freq	Cycling Group
Good Road Condition	0.325	0.598	0.147	0.274
Wide Lane	0.079	0.170	0.209	0.636
Paved Road	0.154	0.304	0.268	0.142
Availability of Bike Lane	0.661	0.439	0.036*	0.813
Flat Road	0.378	0.485	0.079	0.295
Availability of Bike Box	0.598	0.471	0.005*	0.184
Low Vehicle Traffic	0.693	0.288	0.412	0.931
Low Vehicle Speed	0.573	0.160	0.381	0.150
Number of Signalized Intersections	0.053	0.535	0.211	0.882
Natural Environment	0.664	0.438	0.065	0.797
Shared Route	0.553	0.231	0.517	0.304
Availability of Road Lighting	0.130	0.616	0.058	0.679
Low Pollution	0.205	0.503	0.032*	0.029*
Built Environment	0.397	0.172	0.152	0.214
Travel Time	0.546	0.512	0.372	0.001*
Travel Distance	0.564	0.603	0.542	0.103

Statistically significant (p<0.05)

In this case, there are several factors that show a significant relationship with cycling frequency but not with age and gender. Factors such as the availability of bike lanes, bike boxes, and pollution levels demonstrate a significant association with cycling frequency. This suggests that these factors play an important role in determining an individual's cycling frequency, regardless of their age and gender. However, factors such as good road conditions,. wide lanes,. and travel time do not show a significant relationship with age, gender, or cycling frequency.

Crosstabs aims to explore the relationship between two categorical variables. In this paper, the frequency of cycling during the pandemic and the reasons influencing route choice, along with frequency counts and percentages for each combination of categories. This analysis provides valuable insights into the preferences and behaviors of individuals in relation to cycling frequency and route choice, informing policymakers and urban planners about the importance of cycling facilities in promoting recreational purposes during the pandemic. These are several results of crosstab between the frequency of

cycling during the pandemic and the reasons influencing route selection such as variable availability of bike lanes (Table 5), availability of bike boxes (Table 6), low pollution (Table 7). Furthermore, there are also crosstab between the cycling group, low pollution factor, and the travel time factor (Table 8 and Table 9).

Table 5. Crosstab between cycling frequency for recreation during pandemic and reason in choosing the route is the availability of bike lane

Cycling frequency for recreation during pandemic	Reason in choosing the route is by the availability of bike lane					Total
	TD	D	N	A	TA	
Few times in a year	0	4	0	29	19	52
Once a month	0	2	0	21	22	45
Once a week	0	4	1	50	36	91
Several times in a week	0	8	1	57	64	130
Everyday	1	4	0	6	11	22
Total	1	22	2	163	152	340

TD= Totally disagree; D=Disagree; N=Neutral; A=Agree; TA= Totally Agree

Table 6. Crosstab between cycling frequency for recreation during pandemic and reason in choosing the route is the availability of bike box

Cycling frequency for recreation during pandemic	Reason in choosing the route is by availability of bike box					Total
	TD	D	N	A	TA	
Few times in a year	0	8	3	34	7	52
Once a month	0	8	5	26	6	45
Once a week	0	19	8	54	10	91
Several times in a week	0	32	3	66	29	130
Everyday	1	5	0	9	7	22
Total	1	72	19	189	59	340

TD= Totally disagree; D=Disagree; N=Neutral; A=Agree; TA= Totally Agree

Table 7. Crosstab between cycling frequency for recreation during pandemic and reason in choosing the route is the low of pollution

Cycling frequency for recreation during pandemic	Reason in choosing the route is by the low of pollution					Total
	TD	D	N	A	TA	
Few times in a year	0	3	3	32	14	52
Once a month	0	5	0	27	13	45
Once a week	0	4	0	57	30	91
Several times in a week	0	8	2	67	53	130
Everyday	0	1	0	7	14	22
Total	0	21	5	190	124	340

TD= Totally disagree; D=Disagree; N=Neutral; A=Agree; TA= Totally Agree

Table 8. Crosstab between cycling group and reason in choosing the route is the low pollution

Cycling type	Reason in choosing the route is by the low pollution					Total
	TD	D	N	A	TA	
Solo	0	12	3	82	53	150
Group of 2-5 cyclists	0	9	1	106	67	183
Group of 6-10 cyclists	0	0	1	2	2	5
Group of >10 cyclists	0	0	0	0	2	2
Total	0	21	5	190	124	340

TD= Totally Disagree; D=Disagree; N=Neutral; A=Agree; TA= Totally Agree

Table 9. Crosstab between cycling group and reason for choosing the route is the travel time

Cycling type	Reason in choosing the route is by the travel time					Total
	TD	D	N	A	TA	
Solo	1	27	3	75	44	150
Group of 2-5 cyclists	0	14	3	107	59	183
Group of 6-10 cyclists	1	0	0	2	2	5
Group of >10 cyclists	0	0	0	1	1	2
Total	2	41	6	185	106	340

TD= Totally Disagree; D=Disagree; N=Neutral; A=Agree; TA= Totally Agree

Table 5 indicates that across different frequencies of cycling, a consistent trend emerges regarding the significance of bike lane availability in route selection. Notably, among individuals cycling a few times a year or even once a month, there's a significant proportion who express agreement (A) or strong agreement (TA) with the

importance of bike lanes when choosing routes. As cycling frequency increases to once a week or several times a week, this inclination intensifies notably, with a majority strongly agreeing (TA) that bike lane availability is a crucial factor in route selection. Even among individuals cycling daily for recreation during the pandemic, a considerable portion maintains a preference for routes equipped with bike lanes. This underlines a prevalent and increasing inclination towards selecting routes with available bike lanes, especially among those cycling more frequently, highlighting the pivotal role of bike lane availability in route preferences for recreational cycling during the pandemic.

Then, Table 6 indicates that across varying frequencies of cycling, there's a discernible trend regarding the utilization of bike boxes as a criterion for route selection. Notably, among those cycling a few times a year, once a month, or even once a week, a considerable segment expresses disagreement (D) with or neutrality (N) towards the availability of bike boxes when choosing routes. However, as cycling frequency increases to several times a week or daily, there's a notable rise in individuals who agree (A) or strongly agree (TA) with the importance of bike box availability in route choice. This suggests that among more frequent cyclists during the pandemic, there's a heightened preference for routes with access to bike boxes, indicating their significance in facilitating and influencing route choices for this subset of cyclists.

Table 7 shows that among those cycling a few times in a year, a significant portion expressed agreement (A) or strong agreement (TA) with the preference for low pollution when choosing routes. Similarly, individuals cycling once a month or once a week also exhibit a considerable inclination towards this criterion, with a majority favoring low pollution as a factor in route choice. Notably, the trend strengthens among those cycling several times a week or daily, where an overwhelming majority aligns with preferring low pollution in route choices. Even within groups cycling less frequently, there is a noticeable segment favoring routes with low pollution levels. This comprehensive breakdown highlights a pervasive preference for environmentally conscious route choice, emphasizing the significance of low pollution as a pivotal criterion across various frequencies of recreational cycling during the pandemic.

Tabel 8 shows that solo cycling (150 total), a significant portion comprising 82 individuals, strongly agree (A) with choosing a route due to low pollution, while 12 respondents disagree (D) and 3 are neutral (N). Among groups of 2-5 cyclists (183 total), 106 respondents agree (A) with low pollution as a route choice criterion, followed by 9 disagreeing (D) and 1 being neutral (N). For larger cycling groups (6-10 cyclists and >10 cyclists), the numbers are smaller, but the trend continues, indicating a predominant agreement (A) with choosing routes based on low pollution. This breakdown emphasizes the considerable inclination towards favoring low pollution as a factor in route choice across different sizes of cycling groups.

Meanwhile, in Table 9, among solo cyclists (150 total), the majority, constituting 75 respondents, strongly agree (A) with using travel time to choose a route, while 27 individuals disagree (D) and 3 are neutral (N). A group of 2-5 cyclists (183 total) showcases a similar trend, with 107 agreeing (A) with the travel time factor and 14 disagreeing (D). Notably, among larger cycling groups of 6-10 cyclists (5 total) and >10 cyclists (2 total), the overall number is smaller, but the trend persists, with a clear emphasis on agreement (A) regarding travel time as a route choice factor. This breakdown highlights the prevailing inclination, predominantly towards agreement, among cyclists when choosing routes based on travel time, with fewer individuals leaning toward disagreement or neutrality in this aspect.

5. Discussion

The findings of this research align with numerous previous studies that have highlighted the importance of bike lanes, bike boxes, travel time, and low pollution as influential factors in determining cycling routes. Research has consistently shown that the availability of dedicated bike lanes contributes to increased cycling rates and improved safety for cyclists, particularly for recreational purposes. Research conducted in various cities has demonstrated that the presence of separate bike infrastructure encourages more people to choose cycling as a mode of transportation during the pandemic. The inclusion of bike boxes at intersections has also been recognized as an effective measure to enhance cyclist safety and reduce the risk of accidents. Previous research has demonstrated that bike boxes provide a dedicated space for cyclists, improving visibility, and minimizing conflicts with motorized vehicles. This contributes to a safer and more convenient cycling experience, particularly in urban areas.

The COVID-19 pandemic has significantly changed the way people choose cycling routes [7]. The other study also added that with the availability of bike lanes separated from motorized traffic, cyclists can feel safer and more comfortable while cycling [53].The presence of adequate bike lanes provides an opportunity for cyclists to engage in physical exercise and maintain their physical health

while adhering to the established health protocols during the pandemic. The presence of bike boxes allows cyclists to have better and safer access when navigating busy intersections [54]. Sufficient bike box facilities can help reduce physical contact with motorized vehicles and enhance cyclist safety [55].

With the decrease in motorized vehicle activities due to travel restrictions and remote work practices, air pollution levels in Yogyakarta have also decreased [56]. Cyclists now tend to choose routes through areas with low pollution levels to breathe fresh air and maintain respiratory health [15]. This factor is crucial in preserving physical fitness and overall health during the COVID-19 pandemic in Yogyakarta, particularly for recreational purposes. Also, travel time has been a significant factor influencing cyclists' route choice behavior during the COVID-19 pandemic. With more people working from home and reduced road traffic, cycling faced fewer barriers, leading to an increase in cycling trips, such as recreational ones [10].

6. Conclusions

The result of the research described in this paper is to determine the importance of factors that influence cyclists' route choice preferences, particularly for recreational purposes during the COVID-19 pandemic. By knowing these factors, the government can determine appropriate policies which encourage the use of bicycles for other purposes.

Most of the respondents (44.7%) were frequent cyclists because they cycled more than once a week. The factors that are prepared to be asked are 16 factors influencing the route choice for recreational during the COVID-19 pandemic, on a 5-point scale ranging from "very important" coded as 5 to "very unimportant" coded as 1. In the questionnaire, the respondent was also asked about personal and trip characteristics such as gender, age, frequency of cycling, the number of bike own, the number of motorcycle own, main mode, allowance, education [15].

The result explained the frequency of recreational cycling during the COVID-19 pandemic and several factors influencing route choice (the availability of dedicated bicycle lanes, bike boxes, travel time, and low pollution). Meanwhile, the important factors in route choice during the COVID-19 pandemic were the availability of road lighting, with 4.34 scores. The next is good road condition with a 4.31 score, followed by the availability of bike lanes and a low volume of motor vehicles, both of which have the same score (4.30). The least important score is cycling on a wide lane (2.92).

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