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Exploring the Perceived Attractiveness of Cycling as a Sustainable Transport Mode: Jeddah Residents' Perspectives

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Abstract: *This study examines how residents in Jeddah perceive the attractiveness of cycling as a sustainable transport mode and what would make it more feasible in a car-oriented city. Cycling supports public health, lowers emissions, and can help cities deliver safer, more liveable streets. Primary data were collected through an online questionnaire distributed via social media and cycling groups. The survey included 85 participants from four areas of Jeddah (North, East, West, and South) and used 5-point Likert items plus open-ended questions. Descriptive statistics summarized responses, and one-way ANOVA tested mean differences by area.*

Attitudes were generally positive (56% like cycling; 38% neutral; 4% dislike), but cycling was mainly for exercise and leisure (over half for sport, 33% for leisure) rather than commuting (2.5%). Street readiness was rated low: 65% reported that Jeddah's streets are not suitable for cycling. Key barriers were the absence of bike lanes/paths (80%), poor road conditions and safety/security concerns (75%), long distances (around 70%), and weather (63%). Support for improvements was high, especially for protected lanes, lighting and signage, bike parking/storage, workplace end-of-trip facilities, and awareness programs (most items around 80%). Most respondents would cycle more if public transport allowed carrying bicycles (75%), and preferred bike-share (73%) and park-and-ride (about 75%) over bike rental.

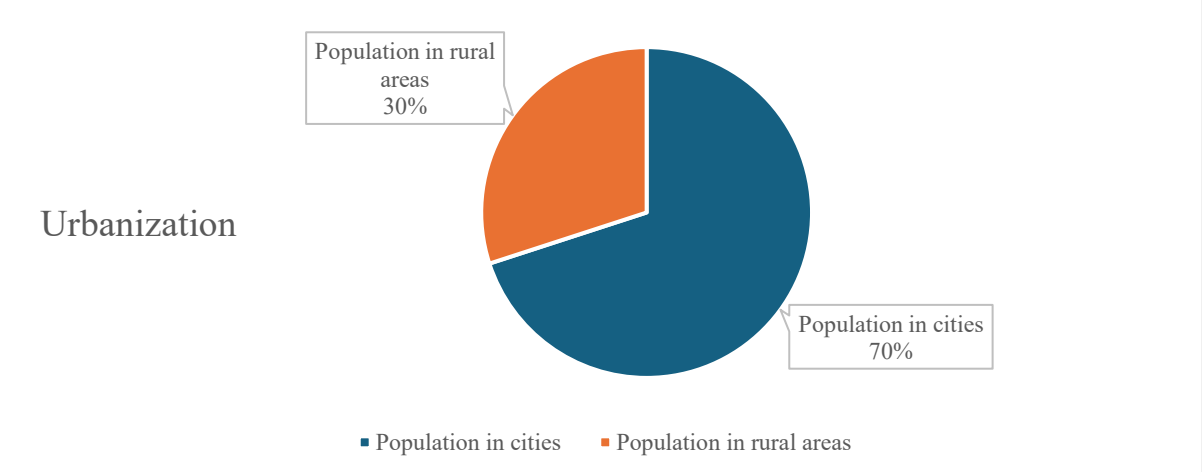
Overall, cycling is viewed as more attractive in Jeddah when a safe, connected network is paired with supportive facilities and multimodal integration.

Keywords: *Cycling, cycling attractiveness, active transportation, quality of life, Jeddah*

1. INTRODUCTION

1.1Urbanization

According to the United Nations, in 2018 about 60% of the world's population live in urban areas. By 2050, the percentage of urbanization is expected to reach 70%, which means that more than two-thirds



of the world's population would live in cities (figure 1). The number of residents in a city in the world has grown rapidly from 751 million in 1950 to 4.2 billion in 2018 [1].

Figure 1 Urbanization

1.2Mobility issues and traffic

Urban areas and cities are the main generators of trips. Most of the cities are car-oriented cities. The population in cities are increasing rapidly, while streets capacity may not increase as fast. An increase in population in a car-oriented city leads to high levels of congestion. Another phenomenon is reflected in consumer choice, where car ownership is a symbol of status, freedom, and prestige, especially in developing countries. Also, the impact of the real estate sector by offering more single home ownership also reinforces car dependency. According to BBC, the world's transport networks remain focused on private cars. Road vehicles – cars, trucks, buses, and motorbikes – account for nearly three-quarters of the greenhouse gas emissions that come from transport [2].

1.3Urban health issues and cycling health benefits

According to the World Health Organization, it is projected that 91% of people who live in urban areas and cities breathe polluted air. In addition, the impact of the missing urban transportation system is massive on the life of urban residents, which imposes many threats including road traffic injuries, air and noise pollution, and barriers to safe physical activity – all leading to higher levels of noncommunicable disease and injuries. "Noncommunicable diseases like heart disease, asthma, cancer, and diabetes are made worse by unhealthy living and working conditions, inadequate green space, pollution such as noise, water, and soil contamination, urban heat islands and a lack of space for walking, cycling, and active living. Diabetes is linked to obesity and physical inactivity in cities lacking good transit and walking/cycling infrastructure. Urbanization is also linked to high rates of depression, anxiety, and mental ill health" [3].

2. Research Aim and Questions

The study explores how Jeddah residents perceive cycling as a sustainable transport mode and identifies the main barriers and priority actions that could make cycling more feasible in a car-oriented context.

1. What are the cycling obstacles based on Jeddah's residents?
2. From Jeddah residents' point of view, is cycling in Jeddah an attractive environmental transport mode?
3. What does Jeddah city need to encourage the residents to cycle more?

3. LITERATURE REVIEW

3.1KSA and Saudi health issues and benefits of cycling

According to an estimate by the General Authority for Statistics, the total population in KSA increased to 34.1 million in 2021. Males accounted for 56.8% of the total population or 19.4 million individuals, females made up 43.2% of the total population, with a population of 14.7 million females.

Based on the General Authority for Statistics, the percentage of individuals who suffer from (diagnosed) chronic diseases in the Kingdom population (15 years and above) was (16.4%). The prevalence of chronic diseases significantly increases with age. The prevalence rate of chronic diseases among the elderly between (65 years and above) was (70.7%), compared to the prevalence rate among young individuals (15-34 years) where it reached (4.4%). Saudi Arabia's top 3 causes of death are as follows; heart disease, road injuries, and stroke, which means that the design of the car-oriented cities is not safe [4].

The Saudi Vision 2030 is built around three primary themes: a vibrant society, a thriving economy, and an ambitious nation. The theme of Vibrant Society includes an overarching objective that is to offer a Fulfilling and Healthy Life, which includes 6 sub-objectives such as promoting a healthy lifestyle, improving livability in Saudi cities, and ensuring environmental sustainability. The vision will be achieved through a number of KPIs such as encouraging healthy lifestyles so that the number of citizens who exercise once a week increases from 13 to 40 percent, and developing Saudi cities so that three are recognized among the 100 top-ranked cities in the world [5].

Saudi Green Initiative (SGI) is one of the Vision 2030 initiatives. The Saudi Green Initiative works on increasing Saudi Arabia's reliance on clean energy, offsetting emissions, and protecting the environment.

It aims to improve the quality of life and protect future generations. SGI aims to achieve net zero emissions by 2060 and plant 450 million trees by 2030.

3.2Info about Jeddah (population, culture, weather, and roads)

Jeddah city is located in the western part of the Kingdom. The western part of Saudi Arabia includes Makkah Region and Madinah Region. Based on the 2010 Census, Makkah Region is the highest region in population with 6.9 million. Jeddah is the second largest city in the Kingdom with a population reaching 4.5 million.

The weather in Jeddah typically varies from 19°C to 39°C and is rarely below 16°C or above 43°C. The average yearly humidity in Jeddah is around 63% and experiences extreme seasonal variation. The rainfall rate in Jeddah city is minimal; however, flash floods are common during the winter season though the amount of precipitation is low. The topography in Jeddah city is almost flat with limited elevations, which is preferable for cycling.

According to the Future City Program Jeddah Profile, the car (or other private vehicles and taxis) is the dominant transportation mode in Jeddah. This represents over 96% of all daily travel and concurrently many of Jeddah's roads experience high levels of congestion. The enormous traffic volume and resultant congestion threaten not only the quality of the environment and the safety of road users, but in the long term can additionally undermine the economic prosperity of the city. Dealing effectively with traffic congestion and its effects will be critical to ensuring an environment in which the population can live, work, and move about in comfort and safety [6].

3.3Health and Environmental advantages of cycling

According to the World Health Organization, more than 1 billion people worldwide are obese 650 million adults, 340 million adolescents and 39 million children. This number is still increasing. WHO estimates that by 2025, approximately 167 million people – adults and children – will become less healthy because they are overweight or obese [7].

Globally, there are two main causes of obesity and being overweight. First, the increase in the calories consumed is based on energy-dense foods that are high in fat and sugars. Second, the decrease in physical activities, which is the main cause of urbanization. For example, the increase in work hours, modes of transportation, and availability of fast food. Some health consequences of being overweight and obesity are cardiovascular diseases (mainly heart diseases and strokes), musculoskeletal disorders, and cancers (including endometrial, breast, ovarian, prostate, liver, gallbladder, kidney, and colon) [8].

"Cycling and walking can help fight being overweight and reduce physical inactivity, which causes one million deaths per year in the European Region. Both means of active transport can also help to reduce air pollution that claims more than half a million deaths every year. Evidence shows that investments in policies that promote safe cycling and walking can play a crucial role in shaping health, mitigating climate change, and improving the environment" [9].

Studies have proven the link between physical activity, health, and active transport modes. The impact of walking and cycling is as follows: Walking for 30 minutes or cycling for 20 minutes on most days reduces mortality risk by at least 10%; Active commuting is associated with about a 10% decrease in risk for cardiovascular disease and a 30% decrease in type 2 diabetes risk; and cancer-related mortality is 30% lower among bike commuters [9].

WHO 2021, active transport can help to reduce air pollution that claims more than half a million deaths every year. The shift from car to active travel is possible for trips up to 16 km in length, and those trips are responsible for 40% of carbon emissions from vehicles. Even if not all car trips could be substituted by cycling and walking, the potential for decreasing emissions is considerable.

3.4International best-practice cycling cities and lessons learned

Internationally, Copenhagen, Amsterdam, and Utrecht are often used as reference points because cycling is treated as a mainstream transport mode, not a recreational add-on. Their performance is linked to long-term investment in a connected network, clear separation from fast traffic where needed, and day-to-day operational details that make cycling feel normal and safe for a wide range of users including children and older adults [10, 11].

In Copenhagen, the cycling approach is framed around making cycling safe, fast, and comfortable for everyone, supported by a coherent network and a prioritized set of routes with higher requirements for

width, maintenance, and winter service. This is a useful planning lesson: infrastructure quality and operations are treated as part of the service, not extra [10].
In Amsterdam, the Long-term Bicycle Plan (2017–2022) is organized around three practical objectives: smooth cycling, easy parking, and better biking. The plan highlights continuous investment in route quality and connections, expanding bicycle parking especially at stations and busy areas, and measures that shape behavior and sharing of limited street space. The key lesson here is that when cycling volumes grow, cities manage cycling like any other major mode: through network upgrades, parking supply, and operational measures, not only new lanes [11].
Utrecht provides a clear example of how end-of-trip facilities and public transport integration support cycling on a scale. The municipality notes that the Stations Lein bicycle parking facility has 12,500 spaces, is delivered and managed jointly with rail partners, and includes operational features (access control, digital guidance to available spaces, and links to public-transport bicycles). The lesson is simple: if parking and station access are solved well, cycling becomes easier to combine with transit and more attractive for daily travel [12].
Lessons for Jeddah can be drawn from these cases without copying them directly: start with a connected backbone of safe routes (not isolated segments), treat bicycle parking and end-of-trip facilities as core infrastructure, and plan cycling as part of a multimodal system alongside public transport. Finally, give maintenance, lighting, signage, and clear operating rules the same attention as construction, because these details often determine whether residents feel comfortable using a bicycle day-to-day.

4. METHODOLOGY

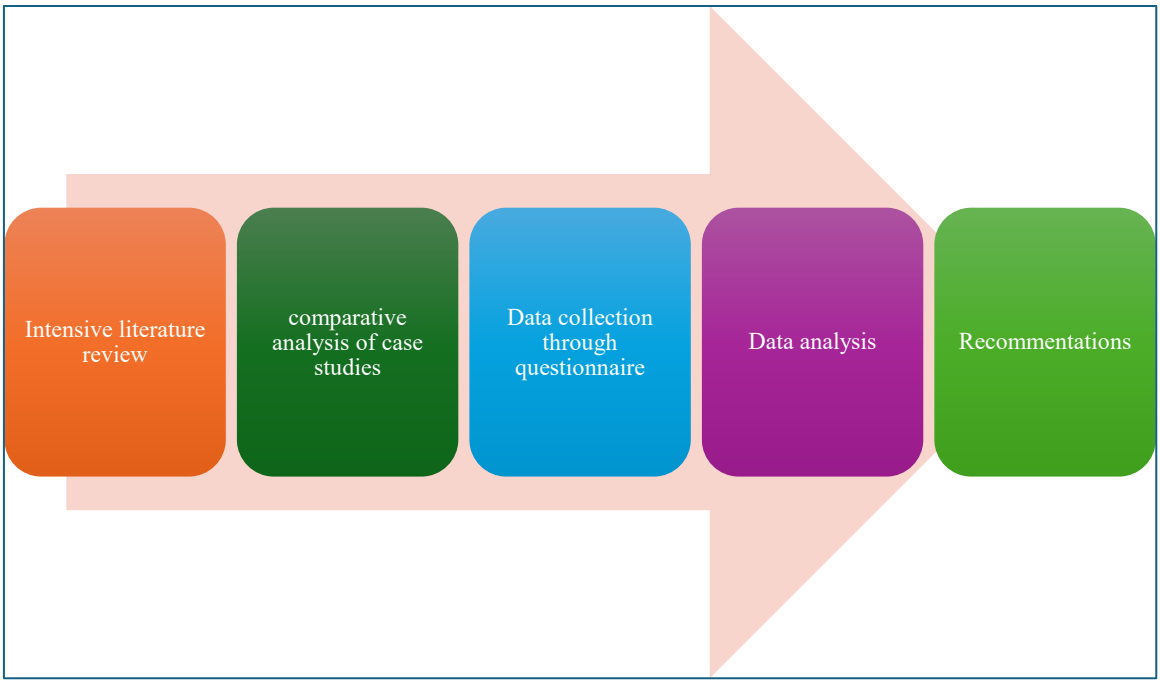


Figure 2 Research process (illustration by author)

In this paper, the researcher depends on primary data through applying a survey to collect the citizen's needs and requirements to cycle more in Jeddah. To answer the research question, the methodology of the research goes through five steps (figure 2):
First, an Intensive literature review is to find out the advantages and disadvantages of cycling. Second, a comparative analysis of national and international case studies finds out the major pillars in question. Based on the literature review, these cities are "often cited as high-cycling benchmarks" are Copenhagen, Amsterdam, and Utrecht. Third, conduct a questionnaire to investigate the point of view of Jeddah residents. The questionnaire was developed through Google Forms and distributed through various social media applications. Fourth, analyzing data to find out the obstacles/setbacks of activating cycling. Fifth, developing a set of recommendations to help decision-makers improve cycling in Jeddah.

4.1Study design

This study used a cross-sectional survey to examine Jeddah residents' perceptions of cycling attractiveness, perceived barriers, and priority improvements that could encourage cycling as a sustainable transport mode.

4.2Data collection and participants

Conducting a survey is one of the most popular ways to collect a citizen's point of view openly and allows customization based on the research needs. The data used in this research is a mix of quantitative and qualitative data. The primary data was collected using an online questionnaire developed in Google Forms. The survey reached a wide variety of residents living in Jeddah including the cycling community, in addition there was a range of responders from different age groups, different income levels, and different health stages. The distribution of the questionnaire was through various social medial platforms such as Twitter and WhatsApp.

4.3Questionnaire structure and measures

The questionnaire is designed based on the Likert Scale which is 5-point scale that allows the individuals to express how much they agree or disagree with a particular statemen. The questionnaire included multiple choice and open-ended questions. It started with an introduction of the research and researcher, the goal of the questionnaire, and a declaration. The questionnaire included 4 sections and 22 questions. The first section included general questions about age, gender, educational level, and the area you live in the city. The city was divided into 4 areas, as shown in (figure 3) (North, East, South, and West) The second section was about cycling and that included 6 questions. The third section was about cycling infrastructure and that includes 4 questions. The last section involved the management of cycling, which talked about the new ways of using cycling. In conclusion, the questionnaire included the following topics: type of favorable transportation mode, bicycle ownership, cycling infrastructure, and safety and security.

4.4Data analysis

Quantitative responses were summarized using descriptive statistics (frequencies and percentages for categorical variables, and central tendency measures for Likert items). To explore whether perceptions differed by location, mean scores were compared across the four city areas using one-way ANOVA. Open-ended responses were reviewed and grouped into common themes to complement the quantitative findings.

4.5Limitations

The study used a convenience sample (N=85) recruited online, including cycling groups. Results therefore reflect perceptions of participating residents and should be interpreted as exploratory rather than representative of all Jeddah residents. In addition, Likert items are ordinal and area sub-samples were uneven (e.g., West n=9), which may limit the robustness of mean comparisons. These constraints are acknowledged in the interpretation of results and recommendations.

Figure 3 the city was divided into four areas

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5. RESULTS

The questionnaire was developed and distributed through social media, such as Twitter, WhatsApp and many cycling groups. Data collection lasted approximately two weeks, starting on 28 October 2022, and resulted in 85 completed responses. The questionnaire included the following sections:

5.1General Information:

As shown in (figure 4) 73% of the participants were male and 27% were female. Based on the result of the questionnaire, it shows that females are less interested in cycling than males. Also, it is part of the culture of Saudi Arabia, where females are less interested in outdoor activities than males.

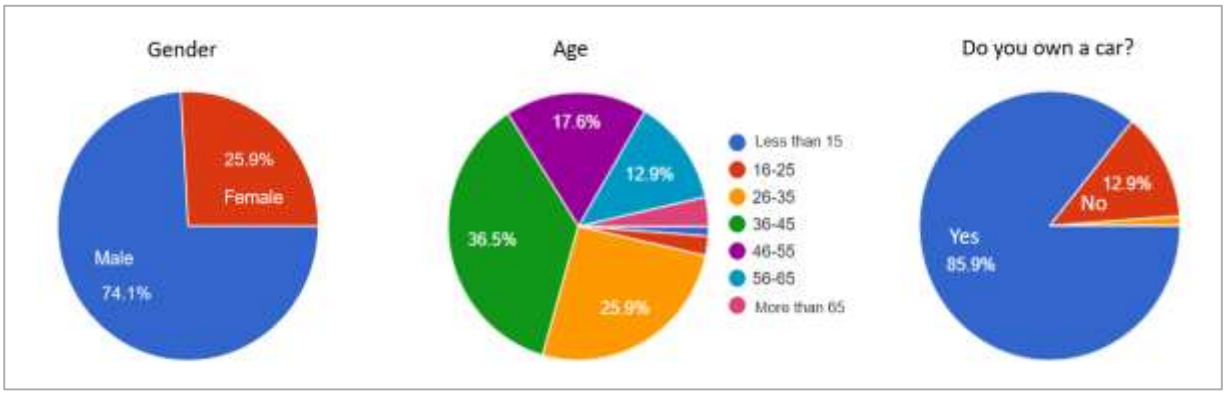

Figure 4 General information (gender, age, and car ownership)

Most of the participants were in the age group 36-45, which accounts for 35%. The second highest age group was from 26-35, which accounts for 26.5%. Interestingly, 17% were participants from the age group 56 and older.

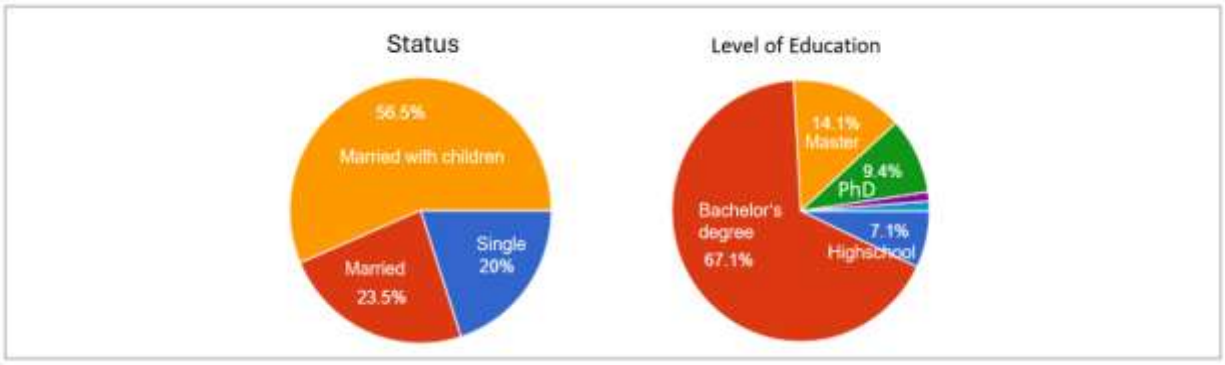

Figure 5 General information (status and education)

In reference to their educational background, as shown in (figure 5) about 70% of the participants were bachelor's degree holders. Also, 22 percent of the participants had higher than a bachelor's degree.

In addition, 56% percent of the participants were married and have children. 24% of the participants are married with no children and 20% were single.

Regarding career status, 68% of the participants were employed. Around 40% of the responders work in the public sector, while 28% were employed in the private sector. Around 15.5% of the participants have their own businesses.

Based on the recent changes in the city of Jeddah due to the demolition of the informal settlements, which account for about 40 sq km^2, 50% of the participants live in the northern area of the city. The rest were almost distributed equally in the east, west, and south of Jeddah city. When the participants were asked about car ownership, the results reflected that 86% of the participants own a private car. In comparison, only 13% do not own a car.

5.2Information Related To Cycling

The first question in the second section was, "do you like to cycle?". As shown in firgure 6 56% of the participants like to cycle, while 38% were neutral about cycling. However, only 4% do not like to cycle.
When participants were asked about the reason for cycling more than 50% of the participants selected that they cycle for exercising/sports and 33% cycle for leisure/fun. In comparison, only 2.5% of the participants cycle for commuting. The study shows that over 95% of the study sample do not cycle for commuting where policies and development need to take place to encourage residents to cycle.
Based on the results of the questionnaire 62% of the participants ride a bicycle one time a month. While 38% ride a bicycle at least once a week. Only 4% of the participants cycle every day. The majority of the cyclists in the study cycle within their neighborhood. While 31% cycle on the main and sub streets. On the other hand, only 13% cycle on sidewalks.
When participants were asked about the average distance traveled by bicycle a week; Almost 40% cycle less than 5 km a week. 12% cycle from 6-10 km a week and 8% cycle from 11-20 km a week. Interestingly, 13% cycle more than 20 km a week. While only, 17% cycle less than 1 km a week.
44% of the participants preferred to cycle in a group, while 17% do not prefer to cycle with a group of people. 38% neutral about cycling with a group of cyclists.

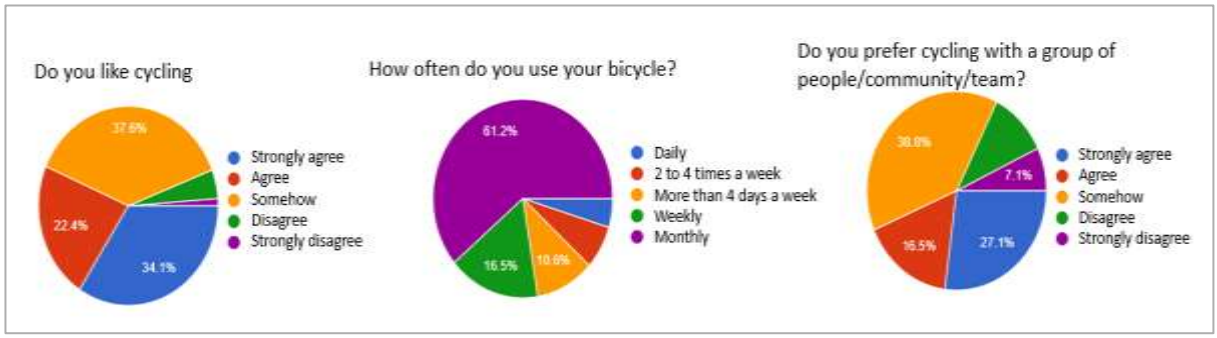

Figure 6 Cycling information

5.3Cycling Infrastructure

65% of the participants agreed that Jeddah city's streets are not suitable or ready for cycling. 26% are neutral about the streets of Jeddah city. While only 8% of the sample size agree that Jeddah city's streets are acceptable for cycling.
When the participants were asked about the reasons that prevent or discourage them from cycling; About 70% of the participants strongly agree or agree that bikeways/roadways are in poor condition. While only 7% think that bikeways/roadways are in acceptable condition. 80% of the participants strongly agree or agree that the absence of bike lanes/paths is the main reason that prevents them from cycling. On the other hand, about 70% of the participants revealed that one of the main reasons preventing them from cycling is that the destinations are too far away. 63% strongly agree or agree that weather condition is an important element for cyclists. On the other hand, only 47% strongly agree or agree that an erratic schedule, working "on call", or "working at night" might be the reason behind cycling less. The result shows that an unpredictable schedule, working "on call", or "working at night" is not a strong reason to prevent Jeddah residents from cycling. 75% of the participants strongly agree and agree that safety and security are major elements, which prevent residents from cycling, however, only 11 percent don't agree.
When the participants were asked which of the following improvements would influence them to cycle more often. 80% of the participants strongly agree or agree that increasing bike lanes (separate lanes) on main streets would encourage them to cycle more often. The result shows that most of the participants about 80% believe that developing bicycle boulevards (shared roadways designed with priority to cyclists) and/or widening outside/curb lanes on major streets (easier to share lanes with cars) would encourage them to ride more. Also, 80% of the participants believe lighting bike lanes, on-road bike signage, bicycle maintenance, bicycle parking/storage, and showers and lockers at work are important elements of the cycling infrastructure that is missing today.
Another important question was asked to the participants, "would you bike more if there was a full network of public transportation (buses and metros), which allows you to move the bicycle with you?". As shown in (figure 7) the result is as follows; 75% strongly agree or agree that an available full network of

public transportation (buses, metro) would make them cycle more. 20% of the participants were neutral about having a full network of public transportation (buses, metro) would make them cycle more.

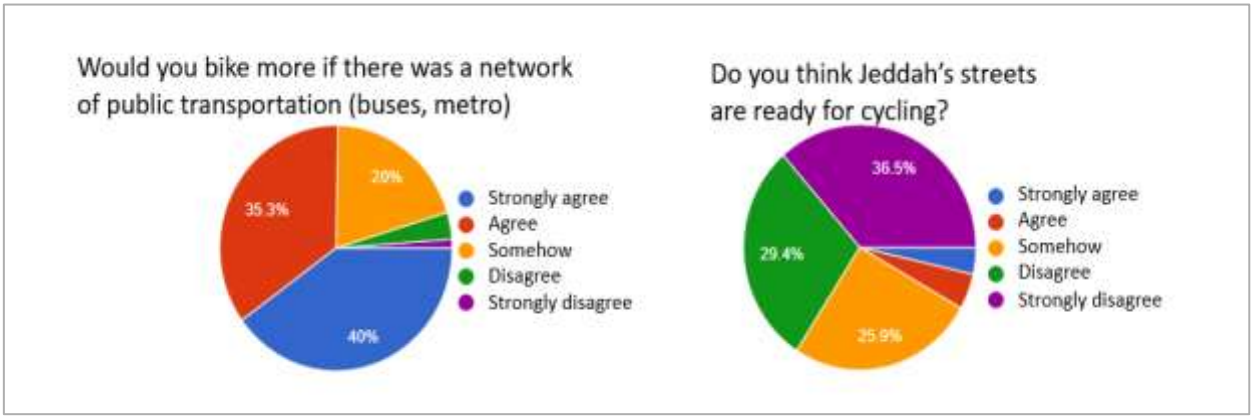

Figure 7 Cycling Infrastructure

5.4Managing Cycling Within The City

In this section, the questionnaire included questions about bike ownership and bike-share. The study shows that about 50% of the participants do not own bicycles. As shown in (figure 8) 50% of participnts strogly agree or agree that cycling would be their primary mode of transport is cycling infratrucutre and safty measures were in place. When the participants were asked about the their preferred systems and methods for cycling, 73% preferred to have a bike-share system in the city. While bike rental did not seem to be an interesting way to encourage residents to cycle more. On the other hand, about 75% of the participants preferred to have park-and-ride system as one of the methods to encourage cycling in the city of Jeddah.

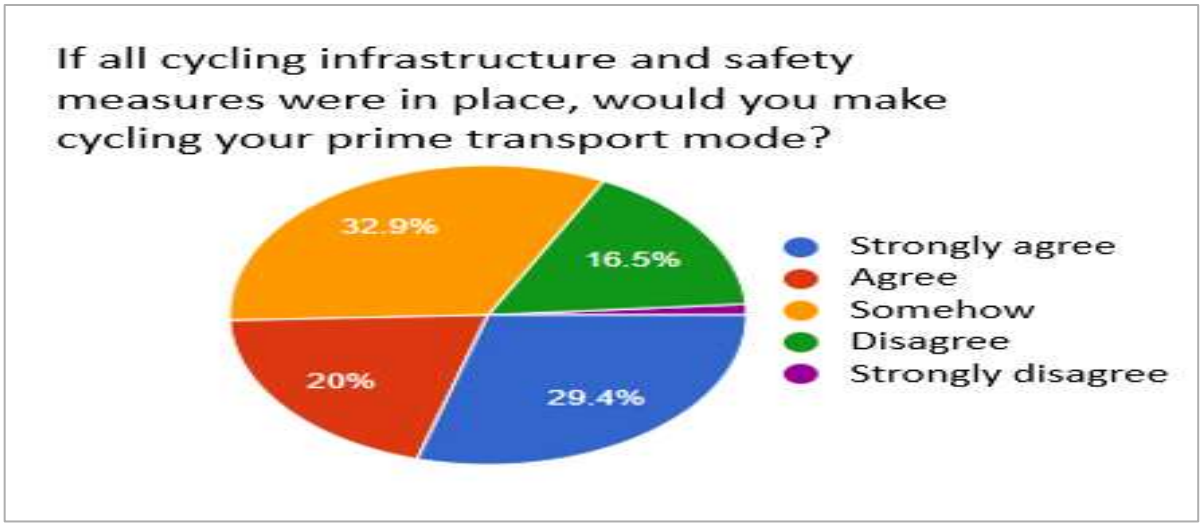

Figure 8 Managing Cycling Within the City

When participants were asked if there are any other obstacles preventing them from cycling; 54% of the participants included obstacles such as weather conditions, far distinctions, safety and security, lack of greenery and shading, lack of awareness, cycling infrastructure, lack of enforcement (cycling police), and traveling with other passengers.

When participants asked about any other suggestions or comments. 38% of the participants wrote suggestions ideas such as cycling should be included in the curriculum, celebrate cycling week, reduce bicycle prices, adding shading to cycling paths, enforcing cycling lanes within the new land subdivions, and more cooperation between the traffic department and the municipality.

Table 1 Mean ± SD by location

Section	Questions	North (n=48)	East (n=11)	West (n=9)	South (n=13)
Information related to cycling	I like cycling	3.52 ± 0.90	4.18 ± 1.17	4.44 ± 0.88	4.23 ± 0.93
	I prefer cycling with a group (team)	3.27 ± 1.28	3.73 ± 1.10	3.56 ± 1.13	4.00 ± 1.08
Cycling infrastructure	Jeddah streets are suitable / ready for cycling	1.94 ± 0.95	2.18 ± 1.08	2.33 ± 1.00	2.31 ± 1.25
	Barrier: bikeways/roadways are in poor condition	4.06 ± 1.00	3.91 ± 1.04	4.11 ± 1.17	4.46 ± 0.78
	Barrier: absence of bike lanes/paths	4.46 ± 0.92	4.09 ± 1.04	3.89 ± 1.45	4.31 ± 1.18
	Barrier: destinations are too far	3.88 ± 0.96	4.09 ± 1.04	4.00 ± 0.87	3.92 ± 0.95
	Barrier: weather conditions	3.90 ± 1.12	4.09 ± 1.22	4.00 ± 1.00	3.92 ± 1.12
	Barrier: erratic schedule / on-call / night work	3.40 ± 1.13	3.82 ± 1.17	3.22 ± 1.09	3.77 ± 1.17
	Barrier: safety and security	4.04 ± 1.17	4.18 ± 1.17	4.44 ± 1.13	4.54 ± 0.66
	Improvement: increase separated bike lanes on main streets	4.25 ± 1.10	4.36 ± 0.81	4.56 ± 0.73	4.54 ± 0.66
	Improvement: bicycle boulevards (shared roads with cyclist priority)	4.25 ± 1.07	4.36 ± 0.81	4.44 ± 0.73	4.54 ± 0.66
	Improvement: lighting for bike lanes	4.19 ± 1.08	4.36 ± 0.81	4.56 ± 0.73	4.62 ± 0.51
	Improvement: widen sidewalks on main streets	4.15 ± 1.23	4.09 ± 0.83	4.33 ± 0.87	4.38 ± 0.77
	Improvement: on-road bike signage	4.29 ± 1.00	4.55 ± 0.69	4.44 ± 0.73	4.69 ± 0.48
	Improvement: bicycle parking / storage	4.35 ± 0.89	4.55 ± 0.69	4.44 ± 0.53	4.62 ± 0.51
	Improvement: cycling awareness programs	4.31 ± 0.95	4.64 ± 0.50	4.33 ± 0.71	4.77 ± 0.44
	Improvement: storage + showers/lockers at work	4.27 ± 0.97	4.36 ± 0.67	4.33 ± 0.71	4.54 ± 0.52
	Would cycle more if public transport (bus/metro) allows carrying the bicycle	4.04 ± 1.01	4.27 ± 0.90	4.22 ± 0.67	4.08 ± 0.86
Managing cycling within the city	Would make cycling my main mode if safe infrastructure exists	3.46 ± 1.15	3.73 ± 1.19	3.33 ± 1.12	4.15 ± 0.90

	Preferred system: bike-share (Bikeshare)	3.62 ± 1.10	3.82 ± 0.98	3.89 ± 0.93	4.15 ± 1.14
	Preferred system: bicycle rental	3.42 ± 1.16	3.18 ± 1.08	3.44 ± 1.01	3.62 ± 1.56
	Preferred system: park-and-ride (drive then cycle)	3.67 ± 1.04	3.91 ± 0.94	3.78 ± 0.83	4.46 ± 0.66

Table 2 Median, IQR by location

Section	**Questions**	**North (n=48)**	**East (n=11)**	**West (n=9)**	**South (n=13)**
Information related to cycling	I like cycling	3 [3–4]	5 [3–5]	5 [4–5]	5 [3–5]
	I prefer cycling with a group (team)	3 [3–4]	3 [3–5]	4 [3–4]	4 [3–5]
Cycling infrastructure	Jeddah streets are suitable / ready for cycling	2 [1–3]	2 [1–3]	2 [2–3]	2 [1–3]
	Barrier: bikeways/roadways are in poor condition	4 [3–5]	4 [3–5]	5 [3–5]	5 [4–5]
	Barrier: absence of bike lanes/paths	5 [4–5]	4 [3–5]	5 [2–5]	5 [4–5]
	Barrier: destinations are too far	4 [3–5]	4 [3–5]	4 [3–5]	4 [3–5]
	Barrier: weather conditions	4 [3–5]	4 [3–5]	4 [3–5]	4 [3–5]
	Barrier: erratic schedule / on-call / night work	3 [3–4]	4 [3–5]	3 [3–4]	4 [3–5]
	Barrier: safety and security	5 [4–5]	5 [3–5]	5 [4–5]	5 [4–5]
	Improvement: increase separated bike lanes on main streets	5 [4–5]	5 [4–5]	5 [4–5]	5 [4–5]
	Improvement: bicycle boulevards (shared roads with cyclist priority)	5 [4–5]	5 [4–5]	5 [4–5]	5 [4–5]
	Improvement: lighting for bike lanes	5 [4–5]	5 [4–5]	5 [4–5]	5 [4–5]
	Improvement: widen sidewalks on main streets	5 [4–5]	4 [4–5]	4 [4–5]	5 [4–5]
	Improvement: on-road bike signage	5 [4–5]	5 [4–5]	5 [4–5]	5 [5–5]
	Improvement: bicycle parking / storage	5 [4–5]	5 [4–5]	5 [4–5]	5 [4–5]
	Improvement: cycling awareness programs	5 [4–5]	5 [4–5]	5 [4–5]	5 [5–5]
	Improvement: storage + showers/lockers at work	5 [4–5]	5 [4–5]	5 [4–5]	5 [4–5]

	Would cycle more if public transport (bus/metro) allows carrying the bicycle	5 [4–5]	5 [3–5]	4 [4–5]	4 [3–5]
Managing cycling within the city	Would make cycling my main mode if safe infrastructure exists	3 [3–4]	4 [3–5]	3 [3–4]	4 [3–5]
	Preferred system: bike-share (Bikeshare)	4 [3–5]	4 [3–5]	4 [3–5]	5 [4–5]
	Preferred system: bicycle rental	3 [3–4]	3 [2–4]	3 [3–4]	4 [2–5]
	Preferred system: park-and-ride (drive then cycle)	4 [3–4]	4 [3–5]	4 [3–4]	5 [4–5]

As shown in Table 1 (Means, SD) and Table 2 (Medians, IQR), cycling attitudes and priorities varied across the four areas (North n=48, East n=11, West n=9, South n=13), while the overall pattern was broadly consistent.

Table 3 Heatmap of mean ratings of Information related to cycling

Question	North (n=48)	East (n=11)	West (n=9)	South (n=13)
I like cycling	3.52	4.18	4.44	4.23
I prefer cycling with a group (team)	3.27	3.73	3.56	4

Table 4 Heatmap of mean ratings of cycling infrastructure readiness, barriers, and improvement priorities by area in Jeddah

Questions	North (n=48)	East (n=11)	West (n=9)	South (n=13)
Jeddah streets are suitable / ready for cycling	1.94	2.18	2.33	2.31
Barrier: bikeways/roadways are in poor condition	4.06	3.91	4.11	4.46
Barrier: absence of bike lanes/paths	4.46	4.09	3.89	4.31
Barrier: destinations are too far	3.88	4.09	4	3.92
Barrier: weather conditions	3.9	4.09	4	3.92
Barrier: erratic schedule / on-call / night work	3.4	3.82	3.22	3.77
Barrier: safety and security	4.04	4.18	4.44	4.54
Improvement: increase separated bike lanes on main streets	4.25	4.36	4.56	4.54
Improvement: bicycle boulevards (shared roads with cyclist priority)	4.25	4.36	4.44	4.54
Improvement: lighting for bike lanes	4.19	4.36	4.56	4.62
Improvement: widen sidewalks on main streets	4.15	4.09	4.33	4.38

Improvement: on-road bike signage	4.29	4.55	4.44	4.69
Improvement: bicycle parking / storage	4.35	4.55	4.44	4.62
Improvement: cycling awareness programs	4.31	4.64	4.33	4.77
Improvement: storage + showers/lockers at work	4.27	4.36	4.33	4.54
Would cycle more if public transport (bus/metro) allows carrying the bicycle	4.04	4.27	4.22	4.08

Table 5 Heatmap of mean ratings of Managing cycling within the city

Questions	**North (n=48)**	**East (n=11)**	**West (n=9)**	**South (n=13)**
Would make cycling my main mode if safe infrastructure exists	3.46	3.73	3.33	4.15
Preferred system: bike-share (Bikeshare)	3.62	3.82	3.89	4.15
Preferred system: bicycle rental	3.42	3.18	3.44	3.62
Preferred system: park-and-ride (drive then cycle)	3.67	3.91	3.78	4.46

In Information related to cycling, respondents reported generally positive attitudes. North Jeddah recorded lower liking of cycling (M=3.52, Table 1; Median=3, Table 2), whereas East, West, and South showed higher central tendencies (medians typically 4–5). Preferences for cycling with a group followed a similar pattern, with higher agreement in South than North (Tables 1–2).

In Cycling infrastructure, perceived street readiness was low across all locations (means close to 2). North reported the lowest readiness (M=1.94, Table 1; Median=2, Table 2). Across locations, the most highly rated barriers were consistently infrastructure and safety related, particularly poor road conditions, absence of bike lanes/paths, and safety/security (Tables 1–2). In comparison, schedule-related constraints were rated lower than the physical and safety barriers.

Support for improvements was high across locations. Proposed actions (e.g., separated bike lanes, signage, lighting, bike parking/storage, awareness programs, and workplace end-of-trip facilities) generally showed mean scores above 4 (Table 1) and medians at the upper end of the scale (typically 5, Table 2).

In Managing cycling within the city, willingness to make cycling a main mode of transport varied by location, with higher agreement in South (M=4.15, Table 1; Median=4, Table 2) than North (M=3.46, Table 1; Median=3, Table 2). For system preferences, park-and-ride and bike-share were rated more favorably than bike rental across locations (Tables 1–2).

Tables 3–5 visualize the results using heatmaps based on mean (Likert) scores only (North, East, West, South), offering an at-a-glance view of the mean differences and overall patterns reported in Table 1.

6. DISCUSSION

This section addresses the outcomes of the questionnaire, which includes recommendations to solve the raised issues and encourage Jeddah residents to cycle more. Based on the gender gap the study shows 73% of the participants were male and 27% were female. According to the results, it reflects that females worldwide are less attracted to cycling than males, this is supported in the following, "Most recent studies show women make just 25 percent of all bicycling trips. Plus, on average women in the U.S. are less likely than men to ride, and among those who do, women ride less often and more exclusively for recreation

(not transportation)" [13]. There is a strong need to encourage female ridership. According to Liz Cornish Jones, "Gender is just one aspect of our identity. Encouragement programs seeking to get more women on bikes must be designed to meet women at the intersections of their identities" [14]. In addition, some female travel with children, which suggests our streets have to be cautiously safe. As a result, the city of Jeddah should develop female cycling awareness designed upon on the needs of females and operated by female staff. Also, the streets must be designed to allow cyclists to travel with children.

Based on the result of the study there is a relationship between cycling and education. About 92% of the participants were bachelor's degree holders and higher. This reflects that there is more interest in cycling for the more educated residents than others. As a result, there is a need to develop awareness programs and ways to support financing bicycles.

Awareness programs do not only aim to encourage people to cycle more but also to educate car drivers. Cycling awareness programs should include the following: health, financial, and environmental benefits of cycling, cycling safety requirements, obeying traffic rules, types of cycling, maintenance courses, and educating car drivers about sharing the street with cyclists. According to the World Economic Forum "In China, 37.2 percent of the population use bicycles. In Belgium and Switzerland, 48 percent of the population rides. In Japan, it is 57 percent, and in Finland it's 60 percent." [15].

86% of the participants own a private car. While only 13% do not own a car. "There are several levels of automobile dependency with their corresponding land use patterns and alternatives to mobility. among the most relevant indicators of automobile, dependency is the level of vehicle ownership, per capita motor vehicle mileage, and the proportion of total commuting trips made using an automobile. A situation of high automobile dependency is reached when more than three-quarters of commuting trips are done using the automobile"

The result of the quesnneire shows that more than 50% of the participants cycle for exercising/sports and 33% cycle for leisure/fun, which means there is a desire for Jeddah residents to commute by bicycle if the infrastructure is in place. Today, only 2.5% of the participants cycle for commuting. In most bike friendly cities the main reasor for cycling is commuting. "The Danish capital, Copenhagen, is considered the most bicycle-friendly city in the world. It's known as the "City of Cyclists," where 52 percent of the population uses a bike for the daily commute" [15].

The study shows that 70% of the participants believe that the main reason that prevents them from cycling more in Jeddah city is the absence of cycling infrastructure. As a result, the city of Jeddah should start investing in building adequate cycling infrastructure, such as providing adequate and varied bicycle parking facilities, building bicycle lanes, making streets safer, and designing cycling-oriented boulevards. As a recommendation, all new street and pavement upgrades and/or new projects should include cycling paths or cycling walkways.

Also, 60% of the participants believe that the reason that prevents them from cycling more in Jeddah city is the weather condition. However, the weather conditions are one of the least elements that can be changed dramatically. "Evapotranspiration, alone or in combination with shading, can help reduce peak summer temperatures by 2–9°F (1–5°C)" [16]. As a recommendation, the city of Jeddah should shift the sprawl planning to compact planning. In addition, planting more trees, which is the Saudi Green Initiative to plant 450 million trees by 2030 should help reduce the temperatures to around 5°C degrees.

Another intervention that would increase cycling ridership is implementing TOD. "TOD", or transit-oriented development, means integrated urban places designed to bring people, activities, buildings, and public space together, with easy walking and cycling connection between them and near-excellent transit service to the rest of the city. It means inclusive access for all to local and citywide opportunities and resources by the most efficient and healthful combination of mobility modes, at the lowest financial and environmental cost, and with the highest resilience to disruptive events. Inclusive TOD is a necessary foundation for long-term sustainability, equity, shared prosperity, and civil peace in cities" [13].

Based on a study undertaken by UN-Habitat to calculate access to the two city centers of Al Balad and Al Rawdah within a 15-minute, 30-minute and 60-minute drive distance from anywhere in the city. The accessibility study reveals travel times between these centers and the city only via private modes of transportation. The study found that 48% of the population, equivalent to two million people, have

access to the urban core within a 15-minute drive distance[6]. As a result, other than the existence of a public transit system, Jeddah city has the initial features of embracing the TOD concept.

In addition to developing the cycling infrastructure, the city of Jeddah should shift gears and start implementing a public transit system. As the study showed 75% of the participants strongly agree or agree that a full network of public transportation (buses, metro) would make them cycle more. Public transit systems help reduce the usage of private cars, which reduces carbon emissions. In addition, linking cycling and other modes of transportation increases the ridership of cyclists and transit users.

Meanwhile, some quick wins initiatives should be taken to encourage the usage of cycling such as micro-mobility options such as bicycles, e-bikes, electric scooters, and shared bicycle fleets. 73% of the study participants prefer to have a bike-share system in the city. As an initial stage, Bike-share should be placed within mega public facilities such as King Abdulaziz University, Jeddah University, and Jeddah historic district.

7. CONCLUSION

To answer the question of Measuring cycling attractiveness as an environmental transport mode according to Jeddah's residents' point of view, this study is based on primary data collected by the researcher through the questionnaire.

With the increase in population and urbanization, cities are becoming denser and facing new challenges. Car-oriented cities are a result of single-home ownership, which is the main source of greenhouse gas emissions. As a result, 91% of people who live in urban areas and cities breathe polluted air. Cycling and walking can help fight overweight and reduce physical inactivity, which causes one million deaths per year in the European Region. Both means of active transport can also help to reduce air pollution that claims more than half a million deaths every year

Noncommunicable diseases like heart disease, asthma, cancer, and diabetes are known as urban diseases, which are linked to physical inactivity in cities lacking good transit and walking/cycling infrastructure.

Jeddah is the second largest city in the Kingdom hosting about 4.5 million residents. The car in Jeddah city represents over 96% of all daily travel and concurrently, many of Jeddah's roads experience high levels of congestion.

The result of the data collection and data analysis show that Jeddah city residents believe that cycling is an attractive transport mode after implementing the following interventions:

First, Jeddah city needs to implement a cycling awareness campaign to encourage Jeddah residents to cycle more and to educate car drivers about sharing the roads with cyclists. Second, the city of Jeddah should focus on investing in building adequate cycling infrastructure such as providing varied bicycle parking facilities, building bicycle lanes, making streets safer, and designing cycling-oriented boulevards. Third, planning in the city of Jeddah should shift toward compact planning. Planning more Transit-Oriented Development centers to integrate people, activities, buildings, and open space with walking and cycling connections with the presence of a transit system connected with the rest of the city.

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Conflicts of Interest: The authors declare no conflicts of interest.

Ethics Approval and Consent to Participate: The questionnaire was administered online, and participation was voluntary and anonymous. No personally identifiable information was collected. Informed consent was obtained from all participants at the start of the survey. The study involved minimal risk and focused on residents' perceptions of cycling and related urban conditions in Jeddah.

Data Availability: The dataset generated and analyzed during the current study is not publicly available to protect participant privacy but is available from the corresponding author upon reasonable request.

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