BICYCLE UTILIZATION IN UMS, INFLUENCING FACTORS AND IMPACTS TOWARDS SUSTAINABLE TRANSPORTATION: CASE STUDY

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FACULTY OF ENGINEERING
UNIVERSITI MALAYSIA SABAH
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ABSTRACT

University is one of the ideal places to run a cycling program because of the small number of communities that allow for cycling at short distances. Cycling not only helps to reduce pollution, but it also has the added benefit of improving the health of students. However, there is still a lack of research on the use of bicycles towards sustainable transportation in Malaysia, especially the campus area in Sabah. Hence it is necessary to investigate bicycle utilization influencing factors and impacts towards sustainable transportation in University Malaysia Sabah (UMS). The main objectives of this study are firstly, to investigate the impact of socio-demographic factors on bicycle usage among the students in campus. Secondly, to identify the key attitudinal factors that impact a student's decision to cycling. Other than that, to identify the main challenges of cyclist among the students in campus. The last objective is to identify the efficient ways to promote cycling activities in campus. The methodology used by the researcher is a quantitative questionnaire tool via goggle form with 377 respondents participating in this study. To analyse the quantitative data, the researcher employed several tests via SPSS and Microsoft Excel including descriptive statistics frequencies analysis and Chi-Square test. This analysis data method is important to present the interpretation of data or results in a more convenient and efficient manner. Based on the analysis, the researcher found that demographic characteristics have positive significant association with bicycle utilization. Socio-demographics factors such age and family income influence the bicycle usage on campus. The majority believed that bicycle is affordable, means of exercise to keep healthy and fit, environment friendly and it reduce congestion. Respondents also often have problems while riding a bicycle including poor road surface condition, careless behaviour, and lack of regards of drivers for cyclist and bad weather condition. To encourage more students using bicycle in campus, some improvement has been proposed include provision of bicycle service centre in campus, provision dedicated lane for cyclist and fostering the usage of electric bicycle. Results are expected to help give better context to the importance of promoting bicycle as mode of transportation within university campuses that will act as a catalyst for cycling mobility culture and behaviour change to contribute towards enhancing campus sustainability.

ABSTRAK

PENGGUNAAN BASIKAL DI UMS MEMPENGARUHI FAKTOR DAN IMPAK TERHADAP PENGANGKUTAN MAMPAN

Universiti adalah salah satu tempat yang ideal untuk menjalankan program berbasikal kerana bilangan kecil komuniti yang membolehkan berbasikal pada jarak pendek. Berbasikal bukan sahaja membantu mengurangkan pencemaran, tetapi ia juga mempunyai manfaat tambahan untuk meningkatkan kesihatan pelajar. Walau bagaimanapun, masih terdapat kekurangan penyelidikan mengenai penggunaan basikal ke arah pengangkutan yang mampan di Malaysia, terutama kawasan kampus di Sabah. Oleh itu, adalah perlu untuk menyiasat penggunaan basikal yang mempengaruhi faktor dan kesan ke arah pengangkutan yang mampan di Universiti Malaysia Sabah (UMS). Objektif utama kajian ini adalah pertama, untuk menyiasat kesan faktor sosio-demografi terhadap penggunaan basikal di kalangan pelajar di kampus. Kedua, untuk mengenal pasti faktor sikap utama yang memberi kesan kepada keputusan pelajar untuk berbasikal. Selain itu, untuk mengenal pasti cabaran utama pelumba di kalangan pelajar di kampus. Objektif terakhir adalah untuk mengenal pasti cara yang cekap untuk mempromosikan aktiviti berbasikal di kampus. Metodologi yang digunakan oleh penyelidik adalah alat soal selidik kuantitatif melalui bentuk goggle dengan 377 responden yang menyertai kajian ini. Untuk menganalisis data kuantitatif, penyelidik menggunakan beberapa ujian melalui SPSS dan Microsoft Excel termasuk analisis frekuensi statistik deskriptif dan ujian chi-square. Kaedah data analisis ini adalah penting untuk membentangkan tafsiran data atau menghasilkan cara yang lebih mudah dan cekap. Berdasarkan analisis, penyelidik mendapati bahawa ciri -ciri demografi mempunyai hubungan positif yang positif dengan penggunaan basikal. Faktor sosio-demografi seperti umur dan pendapatan keluarga mempengaruhi penggunaan basikal di kampus. Majoriti percaya bahawa basikal adalah berpatutan, cara bersenam untuk menjaga sihat dan sesuai, mesra alam dan ia mengurangkan kesesakan. Responden juga sering menghadapi masalah semasa menunggang basikal termasuk keadaan permukaan jalan yang lemah, tingkah laku yang cuai, dan kekurangan pemandu untuk pelumba dan keadaan cuaca buruk. Untuk menggalakkan lebih banyak pelajar menggunakan basikal di kampus, beberapa penambahbaikan telah dicadangkan termasuk penyediaan pusat perkhidmatan basikal di kampus, peruntukan lorong khusus untuk pelumba dan memupuk penggunaan basikal elektrik. Hasilnya dijangka dapat membantu memberikan konteks yang lebih baik kepada kepentingan mempromosikan basikal sebagai mod pengangkutan di kampus universiti yang akan bertindak sebagai pemangkin untuk budaya mobiliti berbasikal dan perubahan tingkah laku untuk menyumbang ke arah meningkatkan kemampanan kampus.

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LIST OF SYMBOLS

%   Percentage

LIST OF ABBREVIATION

SPSS   Statistical Package for Social Science

UMS   Universiti Malaysia Sabah

CHAPTER 1

INTRODUCTION

1.1 Overview

The act of moving things from one place to another is referred to as transportation. It is also important to note that the term "transportation" is a reference to cars. The meaning of the term "transportation" is the movement of people or things from one place to another, or the modification of an object's physical position, regardless of how it is expressed. Even though many societies have not yet reached a high economic development level, transportation is still necessary. The need for transportation grows as the economy of an area improves. It's not just the economy that benefits from transportation, but it also serves to connect people, whether they're family or friends. People will be able to work where they want and live where they want if the transportation system is improved, and they can do both at the same time.

Transportation also enables people to make the best use of their leisure time. However, transportation is one of the sources of pollution in the environment. Vehicles in traffic produce the emissions during periods of congestion. To achieve a less congested and more environmentally friendly environment, there is an urgent need to reduce the number of vehicles on the road. Transportation should also be prioritised in order to achieve urban sustainability goals; this can be accomplished by regulating various components of travel requirements: public transportation, automobile growth patterns, and effective land-use patterns (Pojani & Stead, 2015). In a world where environmental sustainability, traffic congestion, and physical inactivity are major concerns, cycling presents itself as a viable solution to these problems.

Many countries have widely promoted cycling because of its public health and environmental advantages (Li et al., 2021). As part of the Sustainable Development Goals (SDGs), cycling has been recognised as helping to increase energy efficiency in the transportation area, as well as making cities and human settlements more comprehensive, safe, flexible, and sustainable (Tiwari et al., 2016). Cycling is an

important part of sustainable transportation in growing countries because it helps users' mobility and accessibility, as well as the environment by being emission-free (Timpabi et al., 2021). Therefore, this study is to identify how bicycle use affects the impact and factors to achieve sustainable transportation.

1.2   Research Background

Bicycles have been employed as a new means of daily transportation in several cities throughout the world, including Germany, Paris, Barcelona, Melbourne, and Japan, in order to promote sustainable growth (Rusman. et al., 2013) . Public programmes to encourage city residents to ride their bikes have proliferated in recent years as part of the ongoing search for more environmentally friendly modes of urban transportation (Castillo-Manzano & Sánchez-Braza, 2013) . It was thought that in order to gain a complete understanding of bicycle culture, both the material and social components had to be examined (Rusman. et al., 2013). Bicycles are often the fastest mode of transportation for short distances in urban areas (Jamaludin et al., 2019). In major cities throughout the world, such as Copenhagen, Amsterdam, Uteretch, Beijing, Tokyo, Hamburg, Vienna, Paris, Helsinki, Barcelona, Singapore, Delhi, Singapore, Bangkok, and many more, bicycles are commonly used as a mode of transportation (Jamaludin et al., 2019).

There are some in the community changing their mode of transportation from motor vehicles to bicycles. This is because the use of motor vehicles has caused a negative impact on the environment. There have been numerous issues that have arisen as a result of development, including climate change and pollution, environmental degradation, and the loss of natural resources (Utara, 2015). Germany, Japan, the Netherlands, and Australia are among the countries that have begun to be concerned about green transportation (Utara, 2015). In recent years, cycling has become one of the most important measures to promote sustainability because motorized transportation is the primary source of pollution (Utara, 2015). Emissions from motor vehicles are one of the causes of air pollution that occur in urban areas of Malaysia (Shuhaili et al., 2013). In terms of environmental sustainability, cycling appears to be the greatest and smartest non-motorized mode of transportation (Utara, 2015).

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University is one of the ideal places to run a cycling program because of the small number of communities that allow for cycling at short distances. Cycling not only helps to reduce pollution, but it also has the added benefit of improving the health of students. However, there is still a lack of research on the use of bicycles towards sustainable transportation in Malaysia, especially the campus area in Sabah. To solve this problem, important information about cyclists or non-cyclist among students on campus has been collected. University students represent a big target demographic that may be encouraged to utilize and encourage cycling as the primary modes of transportation in urban areas, as opposed to the usage of personal motor vehicles (Pogačar et al., 2020). The significance of this study is that it will help to improve a cycling culture in the community and raise public awareness of the necessity of environmentally friendly modes of transportation. Next to provide information to town planners or transportation engineers in decision making using the concept of bicycle utilization.

1.3   Problem Statement

A bicycle is a convenient mode of transportation that may be owned and is ideal for campus life. There are a lot of direct benefits to the community when more people ride bicycles at the same time (Planning et al., 2021). Cycling is a physical activity that demands energy from body movements, and it can help to increase a person's ability to think critically as well as provide him with more energy to carry out his daily activities (Borhan et al., 2019). A student who cycles will be able to reduce their stress as well as their problems as well as protect the environment from pollutants like air and noise (Borhan et al., 2019). University of Western Australia researchers found that cycling improves health, fitness, and well-being, saves money on driving expenditures and parking, decreases carbon emissions, and has a positive impact on the environment (Swiers et al., 2017). Cycling has emerged as one of the most important policies in recent years, with the goal of improving sustainability (Utara, 2015). It provides a green mode of transportation that is inexpensive, accessible, and efficient for all people (Utara, 2015).

University had previously been suggested as a suitable location for a healthy-place strategy, but there appears to be little evidence of student cycling (Swiers et al., 2017). First research gap that has been identified from previous study is lack of research for bicycle utilization in Malaysia especially in Sabah. Earlier studies have focused on

measure cycling from a wider point of view in terms of demographics, obstacles, and promotional approaches in Tamale Metropolis, but this study pursues to classify bicycle ridership as well as gain perceptions into how respondents' demographics, attitudes, and experiences among the students affected the position of cycling in UMS. The previous study was more focused on Tamale Metropolis, but the recent study is focused on Sabah. Data on cyclists in Universiti Malaysia Sabah is required to make University Malaysia Sabah a sustainable campus. The second research gap is the lack of research for bicycle utilization in the campus area. University is one of the best places to implement the usage of bicycles due to the small number of people and having short distances between locations. But there is still a lack of study in the campus area, previous study more focused among adults in Metropolis.

Research performance related to the factor use of bicycles is still lacking. Factors in terms of safety aspects, bicycle facilities and physical environments less discussed in the previous study. The issues that are widely discussed are related to social demographics. Due to the lack of relevant previous studies thus, there is a need to investigate the use of bicycles influencing factors and effects towards sustainable transportation, particularly in Universiti Malaysia Sabah. Mainly to identify the impact of socio – demographic factors on bicycle usage among the students in campus, and to identify the key attitudinal factors that impact a student's decision to ride or to stop cycling. Besides, based on research one of the factors that reducing the numbers of people cycling in Universiti Malaysia Sabah is due to many hilly areas in campus. Also, the bicycle rental place is a bit too far from student's hostel and there is lack of safety for bicycle parking facility. Therefore, from this research, efficient ways need to be proposed to overcome this matter, so a sustainable transportation in campus can be achieved.

1.4   Definition

Title of this project is Bicycle Utilization In UMS, Influencing Factors and Impacts Towards Sustainable Transportation. Each term in this title will be discussed in detail as shown in Table 1.1 below.

Table 1.1 : Definition of Terms in Tittle of Project

No.	Terms	Definition	Source
1.	Bicycle	Bicycles are a non-motorized mode of transportation with several advantages, including less environmental impact and lower travel expenses. The four primary features that identify a bicycle are the design vehicle, the physical dimensions, the speeds, the stopping distance, and the capacity to climb.	(Planning et al., 2021)
2.	Bicycle Utilization	Bicycle utilization is used as a mode of transportation, a recreational activity, and a sport.	(Planning et al., 2021)
3.	Sustainable Transportation	The term "sustainable transportation" refers to methods of transportation that adhere to the ideals of sustainability, such as minimising CO_2 emissions in urban mobility.	(William et al., 2020) (Badassa et al., 2020)
		In the transportation industry, a sustainable transportation system is defined as one that is easily accessible, secure, environmentally friendly, and affordable.	

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1.5 Objectives of the Study

The aim of this study is to identify factors and impacts of bicycle utilization towards sustainable transportation in UMS. The aim will be addressed through the following objectives:

1. To investigate the impact of socio-demographic factors on bicycle usage among the students in campus.
2. To identify the key attitudinal factors that impact a student's decision to ride.
3. To identify the main challenges of cyclists among the students in campus.
4. To identify the efficient ways to promote cycling activities in campus.

1.6 Significance of Study

This research seeks to determine bicycle ridership as well as gain understanding into how respondents' demographics, attitudes, and experiences among the students affected the status of cycling in UMS. It will become a big help to provide information to urban planners or transportation engineers for them to make decisions based on the concept of bicycle utilization. The information gathered will be useful in the future for research on bicycle use. Thus, it is essential to perform this case study.

This investigation is necessary to evaluate students' reactions to the use of bicycles, which is a viable mode of transportation that is environmentally friendly. User feedback is important as a benchmark in increasing cycling activities on campus since it significantly promotes sustainable transportation. Also, this study will help to establish a cycling culture in the community and raise public awareness of the importance of sustainable transportation options. For that reason, the findings can help future researchers to see a clearer view in deciding efficient ways to increase cycling activities in campus.

1.7   Scope of Study

The main focus of this research was to study factors and impacts of bicycle utilization towards sustainable transportation. University Malaysia Sabah (UMS) was the primary focus of this research, which was aimed at promoting green investment and reducing the campus's carbon footprint. The chosen location was due to the potential of the campus as an approach to encourage more students to use bicycles to travel to nearby areas. In addition, the location of choice is also important for future studies conducted by other researchers as there is still a lack of studies done on the bicycle utilization towards sustainable transportation in UMS.

This study used questionnaires to get information from different respondents. The survey's primary target audience consisted mostly of students on campus who answered the survey's questions. To collect information about the factors and consequences that influence cycling activities on campus, questionnaire surveys were conducted using an online survey method as the primary data collection method. At the end of this research, the efficient ways that is suitable to promote cycling activities in campus was proposed for more users use bicycle in campus in the future.

CHAPTER 2

LITERATURE REVIEW

2.1 Overview

Universiti Malaysia Sabah (UMS) introduced the idea of sustainable campus (EcoCampus) accompanied by the establishment of EcoCampus Management Centre In the scope of proposal, which is Universiti Malaysia Sabah campus, issue like climate condition, topography of the campus and location of the campus need to be well taken into consideration. This climate condition is one of the comfort factors for cyclists. Factors such as fighting the heat, dealing with long walks between buildings and the discomfort of dealing with crowds may contribute to the uncomfortable conditions of cycling in campus.

Studies in campus master planning should be considered to encourage students to ditch their vehicles and start riding bicycles instead. Pedestrian and bicycle-friendly improvements include bike lanes on main streets, bike parking, pedestrian crossings, and associated master plans. Universiti Malaysia Sabah campus have planting trees along the sidewalk could help in creating shaded area for comfort of the users. Electric Pedal Assisted Bicycle (EPAB) also provided in the campus which aimed at promoting green technology through green practices by the young people, especially university students.

Location of the campus is the most strategic location comparing to other campuses. This is because commercial areas and shop areas are within walking distance to the campus itself. The campus is also surrounded by recreational parks as well. So, bicycle riding could be a good type of transport in reducing the use of fuel-based vehicles. The bike sharing system could help a lot in promoting the use of bicycle in UMS campus considering the ground surface of the campus. Hilly areas may be an issue for students who drive fuel-powered automobiles, but by utilising a bike sharing system, students are able to move from higher land to lower ground using bikes while still being able to use campus buses.

The majority of university students who live on campus and use transportation to get to school choose cars, motorcycles, and buses over bicycles, and the number of bicycle riders appears to be lower than non-riders. To encourage students of the benefits of riding a bicycle to school as the healthiest and most environmentally friendly mode of transportation, the reasons for preferring other modes of transportation were studied. A quantitative study was done among students residing on a campus at one of Malaysia's institutions to assess the current condition and the feasibility of cycling between them. The goal of this study was to investigate the possibility for increase in student riding habits.

In this section, the background related to the use of bicycles will be described in detail. How the use of these bicycles can contribute to sustainable transportation, as well as the challenges that bicycle users commonly face and the reasons why people do not use bicycles as a mode of transportation daily, are explored. Before conducting a thorough background study, the key areas of choice will focus on the global and Malaysian situation. In presenting a more constructive finding, this chapter will discuss the use of bicycle as a cardinal term in the study.

The study included a few crucial examinations, which are as follows; 1. Bicycle utilization; 2. Socio-demographic factors; 3. Student decision to ride or to stop cycling; 4. Main challenges of cyclist; 5. Efficient ways to promote cycling activities; 6. Sustainable transportation; 7. Impacts of bicycle utilization towards sustainable transportation and finally the summary of the chosen articles. The completion of this chapter merely encompassed of previous research published by authored.

2.2   Bicycle Utilization

As a non-motorized transportation mode, bicycles have demonstrated their ability to boost mobility, accessibility, and the environment in main cities and suburban areas in countries for instance the Netherlands, Denmark, and China (Shaheen et al., 2011). Despite the several advantages of using bicycles as a mode of transportation in Ghana, little effort has been made to maintain and improve their use in some urban areas (Timpabi et al., 2021). Between 1989 and 2012, survey data collected from 150 countries around the world exposed that bicycle ownership ranges from 20 percent to 81 percent, include nine countries in Northern Europe and one in West Africa (Burkina

Faso) having the highest percentage and 62 countries in West, Central, and North Africa and central Asia having the lowest percentage (Oke et al., 2015).

The metropolis provides as an excellent case study for any plan that seeks to encourage bicycles as a sustainable mode of transportation in Ghana, as it is widely regarded as the country's most bicycle-friendly urban environment (Timpabi et al., 2021). In Chapel Hill Households, they also use bicycle as one of the transportation to achieve sustainable transportation (Isaacs, 2017). Aside from that, the metropolis is also known as the country's bicycle capital. Motorcycles, tricycles, and shared taxis are the primary modes of transportation for most daily activities, according to observations made along major city corridors. In Northern Ghana, however, the evidence suggests that bicycle ownership and usage are both common in a significant amount of the population (Timpabi et al., 2021).

Bicycles are a non-motorized mode of transportation that has many advantages, including the reduction of environmental problems and the reduction of transportation costs. The four most important characteristics that define a bicycle are: the design vehicle, the physical dimensions, the speeds, the stopping distance, and the ability to climb stairs (Planning et al., 2021). The most amazing thing about bicycles is that, of all the machines and animals that move, they are the most efficient mode of transporting weight over a long distance for a fixed amount of energy consumption. While cycling is defined as the use of bicycles, it can also be defined as a mode of transportation, a recreational activity, or a sport.

According to other researcher, cycling is a transportation that have many benefits to cyclist and society include health improving , low pollution and low cost (Handy et al., 2014). Also, cycling is the activity of riding bicycles, unicycles, tricycles, quadricycles, and other similar human-powered vehicles on roads and trails (Planning et al., 2021). Bicycle is one of the sustainable modes of transportation available on campus, as it is both flexible and environmentally friendly (Planning et al., 2021). In addition, bicycles also suitable not only for short trips but also for medium distance trips. Cycling has almost no environmental impact, promotes health through physical activity, takes up little space, and is cost-effective in terms of both direct user costs and public infrastructure expenses. Cycling was found to be an environmentally, socially, and economically sustainable mode of transportation (Pucher & Buehler, 2017).

2.3   Socio – demographic factors of bicycle usage

2.3.1 Age

Age has been seen as a factor for cycling. A previous survey established that young people were the predominant bicycle users, with 38.3 percent of bikers being under the age of 25, 35.5 percent being between the ages of 26 and 35, 16.8 percent being between the ages of 36 and 45, and 9.5 percent being over the age of 46 (Wang et al., 2020). Children and teenagers have the greatest cycling rates in practically every nation, while the elderly in the Netherlands, Denmark and Germany also have the highest rates. People in the Tamale Metropolis have moved to motorised modes such as motorcycles in their later years of life in order to demonstrate improved living conditions or due to a lack of ability to ride.

Based on a World Bank urban transport strategy study, most students in Vietnamese high schools go to school by bicycle, but for ages 25 to 35, they use motorcycles as a means of transportation. Also (Timpabi et al., 2021), based on a logistic regression model, it was found that people over 50 have a 92% lower chance of riding a bicycle in Bangalore city. Australia has a low number of older people who cycle. In contrast to many European cities, just 18 percent of Australians over the age of 50 cycled in the past year, compared to 50 percent of those between the ages of 10 and 29, and 39 percent of those between the ages of 30 and 49 years (Zander et al., 2013).

2.3.2 Gender

In the past, research has shown that there are large differences between countries when it comes to how often men and women cycle (Timpabi et al., 2021). Among cyclists in Australia, more men than women ride bikes for transportation. Most of the cyclists who go to work by bicycle in Queensland are men, but only 24% are women but in Sydney, only 17% of bicycle commuter trips are made by women and in Melbourne only 25% (Heesch et al., 2012).

Although gender differences in cycling appear to be context specific, such as in high-cycling countries in Europe and Asia, several studies have revealed that men cycle more than women in general (Prati et al., 2019). Women, on the other hand, have

been found to withdraw from cycling in countries where gender is important to cycling, such as the United States, Canada, the United Kingdom, and developing countries, due to a perceived danger of riding in motorised traffic and in other cases where cultural barriers tend to masculinize female cyclists (Timpabi et al., 2021).

Among other things, gender difference in cycling for transportation in Australia and other car-dependent countries reflect the distinct mobility patterns, requirements, and objectives of men and women. For example, considerations such as safety, comfort, and accessibility to destinations appear to be more significant to women than they are to males when it comes to their overall travel behaviour (Heesch et al., 2012). In terms of gender, most studies have found that men are more likely than women to use the service (Du & Cheng, 2018). First, when compared to women, men perceive less difficulties during cycling and more positive attitudes toward cycling (Prati et al., 2019). Also, in Melbourne, the proportion of male users of public bicycles is 76.6%, in Montreal, the proportion is 58%, and in Washington, the proportion is 57%. This is because men like to cycle, and women are more likely to work near where they live (Du & Cheng, 2018).

2.3.3 Income

When comparing income levels especially in countries like Netherlands and Denmark, it is said that the cycling rate is similar across all income groups. The situation is different for most growing countries where income is said to play an important part in people's choice to cycle (Timpabi et al., 2021). Cycling is considered a luxury in some poor countries and cities that rely solely on walking as a mode of transportation, while in other developing countries, consumer bicycles are replacing cycling as a mode of transportation due to cycling's association with low-income level, low technology, and shortage of innovation (Timpabi et al., 2021). People with higher incomes were found to be more willing to ride bicycles, according to a study on the relationship between income and transportation demand (Du & Cheng, 2018).

Research from England and Wales has found that those with a lower income are less likely to cycle to work, which is similar with the findings of this study. People with lower incomes, on the other hand, are more likely to utilise public bicycles in China, according to the study's findings (Du & Cheng, 2018). In addition, low-income and ethnic minority populations in the United States have greater rates of cycling (Thorne

et al., 2020). Cyclists have grown and bicycle infrastructure hasn't been abandoned because of citizens' involvement and an understanding of the demographic consequences of cycling (Timpabi et al., 2021).

Denmark has been ranked as one of the secure and most satisfying countries to walk or cycle in because of initiatives including reducing the price of bicycles, incorporating cycle infrastructure into urban planning, and limiting the use of motorised vehicles. There has been an increase in the percentage of people who use bicycles in Dar-es-Salaam, a Tanzanian city that is still growing, from 3% in 2002 to 5% in 2007. This was mostly due to educational programmes that made people aware of the benefits and importance of cycling. This supports the idea that employing education as a means of dealing with low-income level tagging of bicycles in developing countries is a good idea (Timpabi et al., 2021). However, in Australia and the United Kingdom, low-income populations use bicycles less frequently or at the same rate as high-income communities (Thorne et al., 2020).

2.4 Factors Influencing Decision Factors For Students Cycling or Not Cycling

2.4.1 Students Decision Factors For Cycling
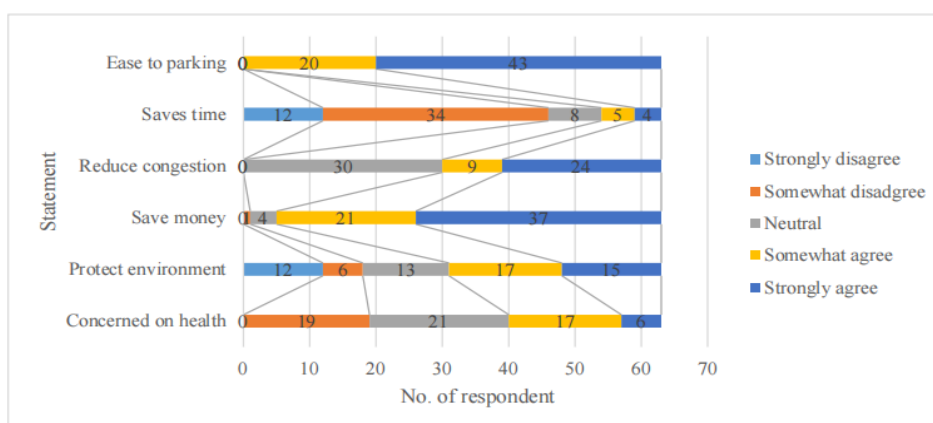
Figure 2.1 : Reasons Student to use Bicycle in Islamic University Malaysia (IIUM) Gombak Campus.

Source : (Planning et al., 2021)

A bike is one that can be owned and is perfect for life on campus. Figure 2.4.1 shows the reasons student to use bicycle in campus. Based on the graph above, most students agree that it is convenient to park a bike. Considering the factors that encourage respondents to ride bicycles on campus, the vast majority of those who responded strongly agreed that "ease to parked bicycle" was one of the most important factors motivating them to ride bicycles on campus (Planning et al., 2021). Students also agreed that bicycle can reduce traffic congestion, protect environment, and save money. Therefore, this will encourage them to use bicycle in campus.

According to Fernández-Heredia and students, among the positive factors that encourage bicycle use are efficiency, which includes avoiding traffic jams, convenient parking, and door-to-door transportation, flexibility, economics, the environment, health, and fun (Pogačar et al., 2020). They also identify safety as a positive factor. According to them, the most important factors that encourage cycling are convenience and affordability (Pogačar et al., 2020).

2.4.2 Students Decision Factors for Not Cycling

Figure 2.2 shows that barrier influencing students not cycling from the previous study. It is including personal factors, social factors and physical environment factors.
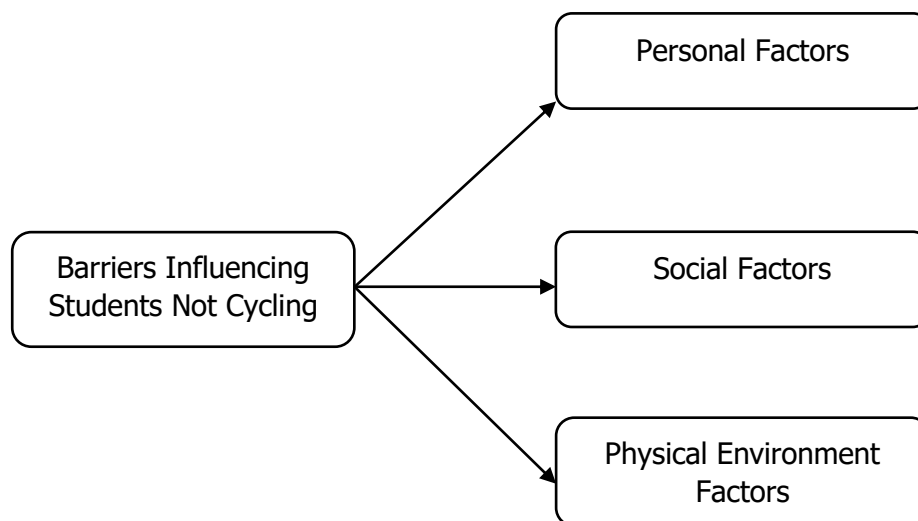
Figure 2.2   : Barriers Influencing Students Not Cycling

Source   : (Fazamimah & Ariffin, 2016)

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Hilly roads are one of the factors that discourage students from cycling. It was difficult to bicycle commute on the UPM campus because of its hilly terrain and sloping roadways, which made it difficult to get around by bicycle. Pedalling cyclists experience hilliness in a much more obvious way than drivers of motorised vehicles do (Fazamimah & Ariffin, 2016). In Qatar , hilly roads one of the factor that influence people not go to cycling (Shaaban, 2020). Individual perceptions indicate that some of them have a negative attitude toward bicycle use, and that a lack of confidence in cycling skills is also a factor in their decision not to ride bicycles.

Perceptions and personal barriers about cycling have been adversely affected by the belief that it is an uncomfortable mode of transportation. The factor of not riding a bicycle is associated with negative social perceptions and a lack of confidence in cycling skills. Individuals who began cycling at a young age, around the age of ten, had a higher level of confidence in their cycling abilities than those who began later in life (Fazamimah & Ariffin, 2016).

Not having a bike is also one of the factors for students not cycling. The lack of a bicycle is one of the most common reasons given by respondents for not cycling on campus. Respondents did not take bicycles from their hometowns to the university, resulting in them having to rely on the campus bus system for their journeys within the university (Utara, 2015). Bad weather influencing students not to cycle. Numerous of the respondents stated that they would not be willing to cycle in inclement weather, such as extreme heat or heavy rain (Utara, 2015). Other researcher mention that bad weather also influence the individual daily travel by using bicycle (Böcker et al., 2013). This is due to the fact that the weather in Malaysia is typically hot and rainy, making cycling on campus an impractical option for students (Utara, 2015). Therefore, personal, social, and physical environment factors influencing students not to cycling.

2.5 Main challenges of cyclists

2.5.1 Weakness of the bicycle facility

In order to attract more cyclists to travel as well as to improve their comfort, convenience, and safety, it is important to provided proper bicycle facilities (Planning et al., 2021). Poor infrastructure conditions were identified as the most significant

obstacle for cyclists (Timpabi et al., 2021). Also in Ohio State University, lack of bicycle facilities shows the number of students cycling is decrease (Akar et al., 2013). According to preliminary findings, only a few of students ride bicycles to commute within the campus, this is due to lack of bicycles and supporting infrastructure. Furthermore, cyclists are forced to travel long distances from one location to another due to a lack of alternate routes that can shorten the journey time between destinations. Additionally, a lack of bicycle parking spots as well as inappropriate parking sites are two other main concerns that deter students from riding their bicycles to campus (Planning et al., 2021).

It was discovered that students were forced to lock their bicycles to the poles of streetlamps, trees, and railings in order to keep their bicycles safe because there were no bicycle locking facilities available. Furthermore, students were seen placing their bicycles at a motorbike parking lot where there was no security for the bicycles (Planning et al., 2021). Based on previous study, lack of cycling infrastructure is the main barrier that discourages the adoption of bicycles as a modal alternative for commuting (de Sousa et al., 2014).

2.5.2 Safety aspects

When it comes to cycling, one of the most important factors to consider is safety. When areas of the physical environment appear unsafe, people are less likely to use bicycles and will choose other safer modes of transportation. (Utara, 2015). Fear of motorised transport prevents potential cyclists, recreational cyclists, and occasional cyclists from adopting bicycles as a form of transportation (Wardlaw, 2014). This will pose a risk to cyclists or others, especially the presence of motor vehicles that make cycling activities unsafe. In most cases, a person's perception of safety is based on his or her own past experiences as well as the experiences of others (Planning et al., 2021).

Surface conditions, driver attitudes toward speeding, and drivers' attitudes toward vulnerable road users are all factors to consider. Due of this situation, it is important to improve road safety, reduce the dominance of vehicles, and create safer conditions for vulnerable road users, as well as a more interesting bicycle route.Theft is the second most important factor limiting the development of cycling, according to all bicycle use surveys, and it is the most important factor after concerns about road safety (Planning et al., 2021). Cyclists will be concerned about their own safety and the safety

of their bikes. Furthermore, there are a variety of explanations for the disparities in cycle accident rates and cyclists' perceptions of road safety that have been proposed. In 2013, there were 19,438 bicycle accidents in the United Kingdom (Utara, 2015).

It is still many deaths, even though fatalities of cyclists reduced by 8 percent in 2013 to 109 persons (Crown, 2015). In 2013, there were 48,000 injured cyclists in the United States, while 743 cyclists were killed in incidents (Highway Traffic Safety Administration & Department of Transportation, 2013). The maintenance of bike lanes has a positive effect on biker safety. Because of sand, broken glass, branches, potholes, and other hard surfaces, bikers took alternative routes such as highways on their journey (Utara, 2015).

Gaps between pavement blocks and patches contributed to bicycle wheel trapping, causing cyclists to lose control. Crash rates at intersections have risen as bike lane safety has deteriorated. Since there are no stop signs at intersections on roads, cyclists must rely on their ability to see other road users to avoid being hit. Another factor contributing to accidents at intersections is the blind spot created by motorised transportation (Utara, 2015).

In terms of safety, it was found that the speed of the cars can affect the safety of other non-motorized transportation users, like cyclists and pedestrians. When motorised vehicles travel at a high rate of speed, the possibility of an accident involving cyclists increases. Even though the maximum speed limit for motorised vehicles on the campus is 30 kilometres per hour, there were still motorists who did not follow to the speed limit on the campus in the past (Planning et al., 2021).

Additionally, it was exposed that certain drivers were found to be travelling in the opposite direction of the one-way traffic flow on the university's campus. Motorized vehicles and cyclists may be involved in crashes because of this behaviour, compromising the safety of both use. There were also no clear road signs provided in the study area to remind motorists of the shared travel lane with cyclists, which could have been challenging (Planning et al., 2021). Based on the review it shows that safety aspect is one of the main challenges for cyclist to use bicycle.

2.5.3 Characteristic of the roads

Figure 2.3 as illustrated below shows the characteristic of the roads that faced by cyclist during cycling. This characteristic includes gradients of the road, pavement type and condition, roadway width and type of parking on the road.
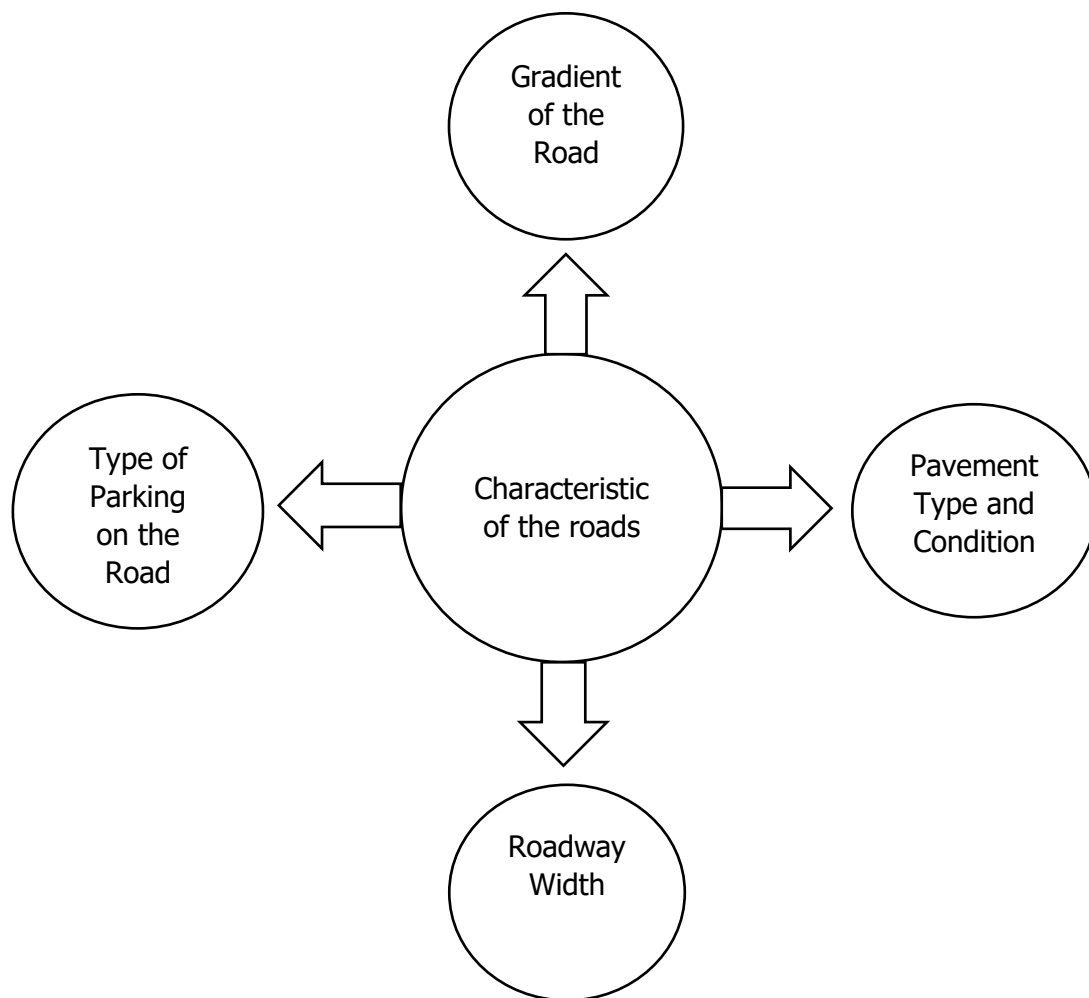
Figure 2.3 : Characteristic of the Roads

Source   : (Segadilha & Sanches, 2014)

Roadway width can influence to the cyclists. According to a previous study, most cyclists desire to pedal on two-lane streets rather than on four-lane. According to these writers, on larger roads, drivers are more likely to pay attention to other vehicles than they are to cyclists, putting them at greater risk of being involved in an accident. The

researchers discovered, on the other hand, that most cyclists plan their trips by guiding them to main streets with multiple traffic lanes. The reason for this is that users are more familiar with the larger roads, which makes planning their journeys easier for them (Segadilha & Sanches, 2014).

The type and condition of pavement is also one of the challenges faced by bicycle users. It is possible that cyclists will encounter significant difficulties on the road because of poor pavement conditions. This is because riding on surfaces that are not suitable for cycling does not ensure the rider's personal safety on the road. As of this, cyclists are forced to take alternate routes. According to the findings of another study, cyclists avoid riding on unpaved roads and prefer to ride on roads with paved and smooth surfaces instead. According to the findings of the study, the type and condition of the pavement are more important for experienced cyclists. Pavement maintenance conditions can have an impact on cyclists' perceptions of road quality, particularly if the pavement's surface conditions are poor (Segadilha & Sanches, 2014).

The presence of uphill stretches makes it difficult to choose a route because it increases the amount of effort required to pedal uphill. Cycling routes with steep inclines are frequently avoided by cyclists. A cyclist's ability to tolerate long uphill stretches is directly related to his or her riding style. The preference for flat roads was found to be greater among non-experienced drivers, according to these researchers. Climbing steep hillsides is a preferred mode of transportation for more experienced cyclists because it requires a higher level of physical exertion than flat roads. It was discovered that bicyclists prefer routes with moderate slope rather than routes with steep slope (Segadilha & Sanches, 2014).

Three categories of slope were used, including flat terrain, some moderate slopes, and steep slope. According to the results of a study conducted by Broach in Portland, one of the characteristics considered most important for cyclist's route selection was the slope. Cycling enthusiasts were willing to travel 37 percent longer distances on a flat route in order to avoid steeper slopes of more than 2 percent, according to the study's findings. In their study, Winters asserted that there is no consensus on the threshold above which a slope is considered unsuitable for cycling, but that this limit was determined to be 10 percent in their case (Segadilha & Sanches, 2014).

When it comes to cyclists' routes, only Stinson and Bath cited the importance of parking type. According to the first authors, cyclists prevent riding on roads with parallel parking because, in general, they are concerned about the probability of hitting with a parked car's door that has suddenly opened. The research conducted by Sener only states that parking is an element that has a direct impact on cyclists' route selection decisions (Segadilha & Sanches, 2014).

2.5.4 Traffic Characteristics

In accordance with the literature, high volumes of traffic have a negative impact on the choice of a road for cycling. When it comes to route selection, traffic volume is a very important factor. Researchers Aultman-Hall and Winters concluded that bicycle riders prefer roads with low traffic volume. It should be noted, however, that the level of annoyance with the vehicle flow is inversely proportional to the level of rider satisfaction. When it comes to traffic, experienced cyclists aren't bothered by the volume and speed of vehicles sharing the road with them (Segadilha & Sanches, 2014).

However, according to Casello, it is the behaviour of drivers, rather than the flow of vehicles, that causes the most concern for cyclists. Several studies have highlighted the relationship between the perceived risk of accidents and the perceived speed and volume of motor vehicle traffic. Harvey stated that cyclists are prepared to move longer distances if they believe they are in a safer environment. He discovered that even experienced riders choose routes that decrease their exposure to vehicular traffic, according to Broach's research. Importantly, perceptions of road safety are more important than the actual total of accidents that occur on the road (Segadilha & Sanches, 2014).

2.5.5 Drivers' attitudes towards cyclists

Using bicycles as a mode of transportation has several advantages in terms of economy, environmental protection, and social. The use of bicycles is a sustainable means of transportation that can decrease congestion and pollution in the city, moreover it has relatively low infrastructure costs, and is related with developments in physical and mental health among the public (Fruhen et al., 2019). Cycling rates, on the other hand, are extremely low in some countries. For instance, only 8% of EU

citizens state that cycling is their most preferred mode of transportation daily (Fruhen et al., 2019). This is due to the driver's negative attitude towards cyclists.

The existence of hostile motorist actions in the form of aggressive treatment toward cyclists can also contribute to the unwillingness to ride a bike. For instance, in a analysis of Australian cyclists, the vast majority of those who responded stated that they had experienced some form of harassment from motorists (Fruhen et al., 2019). Cycling is viewed negatively by not only motorcyclists but also by car drivers. According to studies, a significant number of car drivers have a bad attitude toward cyclists. They believe themselves to be various and different from cyclists, and they consider cyclists to be a minority or outgroup of their own making. Furthermore, a significant number of drivers believe that cyclists should not be allowed on the roads at all, and it has been demonstrated that driver knowledge is associated with such attitudes (Fruhen et al., 2019).

2.6   Efficient approach to promote cycling activities

2.6.1 Bike sharing programmes

Bike sharing is a great way to get people interested in cycling because it provides fun and safe bikes for people to ride. Bike-sharing programmes allow individuals to utilise bicycles on an "as-needed" basis without incurring the fees and responsibility that come with owning and maintaining one. These programmes enable people who would not otherwise be able to ride bicycles to take advantage of the benefits of riding, whether they are visitors or residents. Bicycle sharing programmes can also serve as an alternative to increased bicycle use by sending a strong visual message to the public that bicycles belong on the city's streets. Bike sharing may be viewed as a potent "cycling marketing campaign" on the streets by people who utilise public transportation, according to recent research.

In addition, several studies have found that cycling has grown in cities that have established bike sharing programmes, with the authors emphasising that these findings represent the combined influence of improvements to cycling infrastructure as well as the implementation of bike sharing programmes. Cycling may be viewed as a safe and

regular means of transportation, some argue, and the introduction of bike sharing programmes may help to fix this perception. Many governments have encouraged the use of shared bicycle systems to accelerate the development of sustainable transportation (Z. Chen et al., 2020).   International environmental protection organisations have called for the development of vehicles that are environmentally sustainable, such as bicycles and low-energy electric vehicles, with the goal of lowering urban pollution indexes and increasing traffic safety (Y. Chen et al., 2022).

To accomplish these goals, cities can also offer subsidies to private owners of bicycles and low-energy automobiles, or they can encourage sharing economy resolutions such as bike-sharing and ride sharing schemes through a variety of schemes, which are growing increasingly popular with younger clients (Y. Chen et al., 2022). Bike sharing results in a considerable reduction in CO_2 emissions, as well as a reduction in the usage of fossil fuels, while also providing people with a convenient form of transportation (Zhang et al., 2015). A bike-sharing system is essential for lowering pollution levels and reducing car use, as well as delivering people with a healthy mode of transportation and assisting the movement toward the use of alternate energy sources (Y. Chen et al., 2022).

Sharing bicycle is one of the modes of transportation that people can use to make their journey more convenient. This method has the potential to reduce transportation congestion while also decreasing environmental pollutants (Y. Chen et al., 2022). Many academics have investigated and examined bicycle sharing schemes in various cities (Scott & Ciuro, 2019). They found that a bicycle sharing station near the university will be able to draw in more users as a result of their research (Y. Chen et al., 2022).

2.6.2 Awareness towards electric bicycles

Since most residents prefer a faster mode of transportation than traditional bicycles, it is important to raise awareness about e-bike and their potential to meet the transportation needs of the public. Electric bicycles that are quicker but still involve some physical effort can be a great alternative to motorcyclists (Timpabi et al., 2021). Many cities throughout the world have seen an increase in the popularity of e-bikes, which have become an important element of their transportation infrastructure. An electric bicycle is a type of electric vehicle that is based on a traditional bicycle but combines an electric motor to support in its movement. Electric bicycles gained

popularity in the 20th century as a cost-effective and simple solution to urban transportation issues, as well as having environmental benefits (Qu et al., 2021). The electric bicycle, which is a new type of private transportation, has led to a new way of moving around cities, both for countries with a large populations and for countries that concern about the environment (Qu et al., 2021).

Electric bicycles allow cyclists to travel at constant and increased speeds while exerting less physical effort, allowing them to cover greater distances in less time. Since of their high energy efficiency when compared to conventional motorised transportation, electric bicycles have the potential to be effective in reducing traffic congestion, reducing associated environmental problems, and increasing the physical activity levels of their users (Plazier et al., 2017).

Electric bicycles are not only more suitable for driving on a variety of terrains, such as hilly, flat, and mixed terrains, but they are also more useful in terms of cost, ease of use, repairs, and maintenance than traditional bicycles (Norhisham et al., 2019). As a result, bicyclists will find it easier to move from one location to another, and they will be more likely to use bicycles as a mode of transportation in the future. The benefits of electric bicycles in term of cost, it will provide an environmentally friendly and cost-effective mode of transportation. In university, if it is used by staff, campus police, mail service officers, and facility and maintenance staff, it will also benefit from cost savings on gas and vehicle maintenance (Samsuddin et al., 2016).

Due of their low cost, convenience, and adaptability, electric bicycles (e-bikes) have become the chosen mode of transportation for some residents of China's (Ma et al., 2019). There have been reports of human force and heart rate reductions and variations due to the use of these small electric vehicles. There was also a reduction in travel time for e-bikes, but not for e-motorcycles. E-bikes have been reported to have the fastest travel time in congested traffic which is less than 5 kilometres (Machedon-Pisu & Borza, 2020). This shows that electric bicycles are very suitable to be used as a mode of transportation to create sustainable transportation.

2.6.3 Provide conducive environment for cycling

Provide conducive environment for cycling is one of the practical ways to improve cycling activities. Objective of cycle track was to increase the comfort of the cyclists

who used it. Cyclist and cars were separated more frequently on the road for the purpose of road safety because bicycles are normally safe on bike paths alongside roadways. Bicycle pathways can be classified into three types. First is a bicycle path as shown in Figure 2.4. A bicycle path is defined as a path that is segregated from motorised automotive traffic by an open area or a wall (Planning et al., 2021).

Figure 2.4 : Example of Bicycle Path

Source   : (Planning et al., 2021)

The second is a bike lane that runs alongside the road as shown Figure 2.5. It is a segment of the roadway that has been designated for exclusive use by bikes using pavement markings or signage on the roadway (Planning et al., 2021).

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Figure 2.5   : Example of a Bicycle Lane

Source   : (Planning et al., 2021)

The third type of roadway is a shared roadway that is open to both bicycles and motor vehicles for transportation as shown in Figure 2.6. When constructing bicycle pathways, it is necessary to consider a variety of aspects that are linked with bike path design. Included are safety, security, a pathfinding system, the continuity of the bike path, an appealing riding route with good flow, a universal design, and a bike path that is accessible to all users (Planning et al., 2021).

Figure 2.6   : Example of shared roadway

Source   : (Planning et al., 2021)

To encourage the usage of bicycles, it is necessary to provide secure, convenient, and attractive bicycle parking facilities. Universities and colleges include a variety of departments, and students are regularly move from one campus to another and between distant buildings all day (Planning et al., 2021). The installation of bicycle stalls near the entrances of buildings is essential. Bicycles, on the other hand, can be parked practically anywhere, and they are often parked in unexpected locations. When it comes to encouraging riding, the perspectives of cyclists are important since they will determine what should be done and what they require (Planning et al., 2021).

This is because creating a large bicycle parking structure comes first out of necessity. It is not necessary to provide more facilities if individuals do not intend to use it. So, it is critical to evaluate where there is a demand for bicycle parking. As a result, it is strategically practical to begin placing bicycle parking in the most likely location and monitoring the extent to which it is utilised (Planning et al., 2021). In a similar manner, bicycle parking is an important component of a bicycle strategy since it ensures the safety of bicycle users when they arrive at their destinations. It is recommended by the Association of Pedestrian and Cycling Professionals (APBP) that bicycle parking be located within 50 feet or 30 seconds of the building's entrance, according to Aultman.

2.6.4 Policies to promote cycling

Figure 2.7 below shows the chart of increasing bike mode shares in large cities of Europe and the Americas from 1990 to 2015.
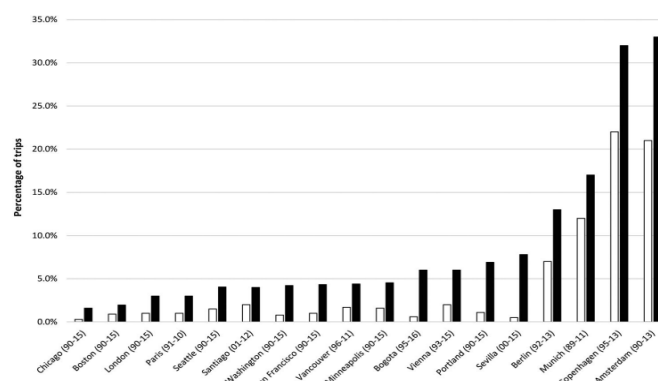

Figure 2.7   : Increasing Bike Mode Shares in Large Cities of Europe and the Americas, 1990 – 2015.

Source   : (Pucher & Buehler, 2017)

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In cities all over the world, mounting scientific evidence shows that providing physically separated, protected cycling facilities on major roads with high volumes of fast-moving vehicular traffic is a critical step toward improving public safety. Both Bogota and Sevilla, which installed integrated networks of over 300 km of protected cycle tracks in a matter of years, experienced the largest and fastest increases in cycling levels, as shown in Figure 2.7. This resulted increasing of bicycling in both cities (Pucher & Buehler, 2017). Many studies have discovered that such protected facilities are especially important for women, children, and the elderly, but they are also important for anyone who is fearful of taking risks or feels vulnerable while cycling on roads with motor vehicles, based to the findings (Pucher & Buehler, 2017).

The growth, improvement, and integration of such protected cycling facilities have been shown to be effective methods of increasing cycling levels, improving cycling safety, and encouraging more women, children, and seniors to ride bicycles. Cycle superhighways are a recent development that appears to be promising (Pucher & Buehler, 2017). The facility of separate bike paths parallel to major roads, with minimal road crossings, and, in some cases, a green wave of synchronised traffic signals at intersections timed to allow for faster cycling, improves the speed and safety of long-distance bicycling. Cycle superhighways are becoming more popular and essential to provide long-distance bike commutes in metropolitan areas, not just in North America and Australia but in Europe as well. Cycling superhighways are already in place in several European cities, and many more are in planning (Pucher & Buehler, 2017).

Comprehensive traffic calming measures on residential streets have the potential to significantly increase cycling and walking in residential neighbourhood. Traffic-calmed streets have allowed speed limits of 30 kilometres per hour or less, which are compulsory through roadway redesign that includes fewer traffic lanes, curves, speed humps, raised intersections and crosswalks, and diverters for cars and trucks to discourage through motor vehicle traffic while still providing suitable passages and shortcuts for cyclists and pedestrians. Numerous studies show the significant increase in safety associated with traffic-calmed neighbourhood streets, particularly for children (Pucher & Buehler, 2017). Traffic calming was established in the Netherlands, which remains the leader in Europe, with more than 75 percent of its urban roads restricted to speeds of 30 km/h or less. Even in the absence of special cycling infrastructure such as bike lanes or paths, traffic-calmed streets typically have so little traffic moving at

such slow speeds that they can be used safely and conveniently as cycling routes (Pucher & Buehler, 2017).

City traffic calming has been proven to be effective in Dutch, German, Swiss, and Austrian. Except for a few isolated neighbourhoods, cities in most other European countries have resisted traffic-calming measu. This is especially true in countries such as the United States, Canada, and Australia (Pucher & Buehler, 2017). Comprehensive traffic calming of residential neighbourhoods is important in more cities and countries, not only to promote cycling but also in improving traffic safety, reducing noise and congestion on local streets, divert through traffic away from residential neighbourhoods, and improve the overall attractiveness and liability of urban communities (Pucher & Buehler, 2017) .

2.6.5 Route Guidance and Information

The creation of a network of direct bicycle paths that connect important starting points and destinations can help to increase the number of people who ride bicycles. Information about cycle routes, such as their number or colour, as well as distances between two points, can be displayed either on maps or on roadside traffic signs to ensure that cyclists can easily locate and follow the routes. As will be seen in the following section, these measures have the potential to attract more cyclists while also contributing to their safety.

Cycling infrastructure, such as traffic and information signs, is given high priority in Norway. According to the Ministry of Transportation and Communications, there should be more signs directing cyclists to their destinations and indicating the distance between cities. However, it is the responsibility of the Public Roads Administration, not the Ministry, to ensure that this priority is followed up on. Traffic signs in cities and urban areas are primarily the responsibility of the police department. The Swiss Federal Government is publishing guidelines for bicycle routes, and it is up to the cantons to put these guidelines into action. Information about large-scale bicycle roads in Japan is available on the Ministry of Land, Infrastructure, and Transport's web site, which includes maps and photographs of the routes.

2.7   Sustainable transportation

Sustainability in the transportation system continues to be the most significant challenge facing not only transportation professionals, researchers, and decision-makers, but also urban planners and environmentalists (Hassan & Lee, 2015). The efficiency and effectiveness of transportation systems affects all the environment, society, and economy. The way our transportation system operates has an impact on almost every aspect of our society. Unfortunately, current trends in transportation systems around the world are unsustainable, and this is agreed upon by many parties. Due of population growth, there has been an increase in car ownership, which has had an impact on transportation (Illahi & Mir, 2020).

As a result of the growing in the number of cars on the road worldwide from 54.9 million in 2000 to 78.7 million in 2019, the ever-increasing consumption of non-renewable resources, the high demand for transportation infrastructure, and increasing safety concerns, transportation systems around the world have been increasingly subject by vehicles and have become less environmentally friendly (Illahi & Mir, 2020). Measurement of the sustainability of transportation systems is important for ensuring that transportation systems can be environmentally acceptable, economically viable, and socially equitable (Illahi & Mir, 2020). In order to explain the criteria for sustainable transportation, it is necessary to first establish a general understanding of the terms "sustainable transportation" and "sustainability. " (Kraus & Proff, 2021).

2.7.1 Concepts of sustainable transportation

Brundtland report stated that sustainability is the conservation of human life in the future. The lack of practical applicability of this definition encouraged the development of additional operational definitions. The majority of these classify the concept into three categories which are economic, social, and environmental (Kraus & Proff, 2021). Social, economic, and environmental responsibilities all intersect in these areas. There must be a balance between the three dimensions for sustainability to be achieved. Sustainability is defined as the balance of criteria concerning economy, social elements, and the environment. Within this study, sustainability is understood in terms of the social dimension, for instance the preconditions for a society to be considered sustainable (Kraus & Proff, 2021).

Banister developed the most well-known concept to improve the sustainability of transportation operations. The following are the concepts he listed, which have been complemented by statements from other relevant authors:

Table 2.1: Concepts of Sustainable Transportation

No.	Concepts	Source
1.	In order to foster a modal shift, it is necessary to limit car usage while simultaneously promoting other ecologically friendly modes of transportation such as bicycles and public transportation. Improvements in cycling and walking infrastructure, promotion of multimodality, and the imposition of increased costs for the use of roadways all help to encourage shifting.	(Molin et al., 2016)
2.	It is necessary to decrease the number of trips made as well as the distance travelled on each trip to reduce travel costs. The measures to reduce traffic congestion are interlinked with urban planning.	(Kraus & Proff, 2021)
3.	Enhanced levels of efficiency for transportation systems. By proposing shared vehicle ownership as well as low-emission vehicles, it can make a significant improvement.	(Kraus & Proff, 2021)
4.	Digitalization is changing the way in which transport services are offered to passengers, with multimodal offers and multimodalities for passenger transportation. This means that consumers can choose from a range of mobility options to encourage a modal shift away from using cars as primary mode of transportation.	(Næss, 2020)

The concept of sustainable improvement was created as a solution to long-term problems related with the climate change and environment. Nowadays, the debate

about sustainable city development is focused on the concept of making compact cities to provide them with a more balanced development. In the case of passenger transportation, social needs are the most important factors affecting the indicators of sustainable transport. According to Goldmana and Gorhamb, argue that to be efficient, a sustainable transport policy must avoid falling into the same trap as the regular transport policy, which is to ignore the greater systems in which transportation activities are situated. A sustainable transportation system is primarily concerned with planning, politics, and the technologies that are employed (Ogryzek et al., 2020) .

Its primary goal is to guarantee the efficient transportation of goods while also providing finest transportation services. Furthermore, sustainable transport evolution is based on city planning that eliminates the need for automobiles and makes urban areas more friendly to pedestrians and cyclists, among other things (Ogryzek et al., 2020). Bike-sharing systems are becoming increasingly popular in large cities, as they are one of the most environmentally friendly modes of transportation available in the urban environment (Pucher & Buehler, 2017). They are considered as a low-cost, efficient, and healthy mode of transportation in densely populated urban area. Furthermore, public transportation should be the primary mode of transportation in those cities. A paradigm has been developed by Professor David Banister of the University of Oxford, in which shows sustainable transportation procedures that should be achieved in urban planning (Ogryzek et al., 2020) .

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2.7.2 Principles of sustainable transportation

Figure 2.8 shows the principles of sustainable transportation. The principles includes technological innovation, distance reduction, reduce travel needs and transport policy shift.
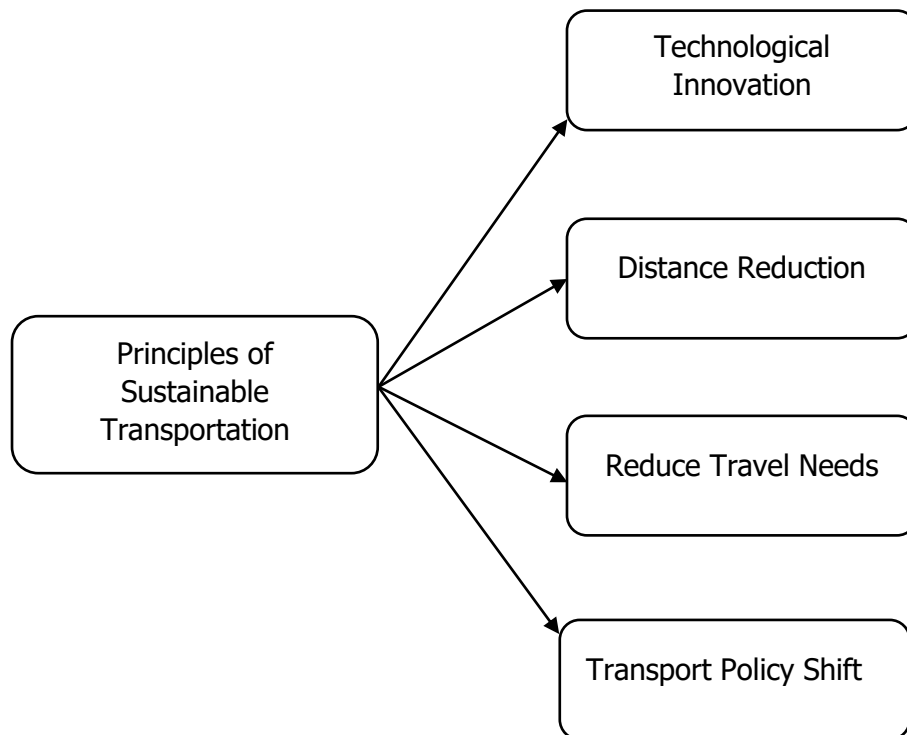
Figure 2.8   : Principles of Sustainable Transportation

Source   : (Ogryzek et al., 2020)

The first sustainable transportation principle, which is reduced travel need, states that travel must be replaced by technological solutions that decrease these requirements to a minimum. In this rule, Banister highlights the significance of the connection between transportation and ICT (information and communications technology), particularly the rising significance of online shopping. Next sustainable transport principle requires a shift in strategy as shown in Figure 2.7, which indicates that car use should be decreased in preference of walking and cycling (Ogryzek et al., 2020). An increasing number of people across the United States are attempting to enhance the sustainability of their transportation systems by shifting routine vehicle trips to walking and cycling (Schneider, 2013).

Additionally, Banister suggests a new road hierarchy in which pedestrians and cyclists are at the top of the sustainable transport pyramid, followed by public transportation in the middle, and car users at the bottom. This goal can be achieved by slowing down the city's traffic and establishing a separate area dedicated to public transportation. Furthermore, road payments must be applied, for instance, a toll for entering the city centre. Besides, the modification of the definition of a roadway is also a part of this principle, which states that a street is more than just a parking lot. A green module-filled space that is also used by people which are cyclists and pedestrians, and public transportation vehicles should be perceived as a positive attribute (Ogryzek et al., 2020).

This maxim promotes the use of the street in a creative manner at various times of the day. Over the course of a weekend, some roads may be changed into street markets or into entertainment zones. Those concepts inspire people to reconsider their perceptions of transportation, and they should be combined with a properly designed strategy for making the most of available space (Ogryzek et al., 2020). The bicycle is a popular mode of transportation because it is both environmentally friendly and cost-effective to maintain and repair (Ogryzek et al., 2020). Bikes also have other beneficial effects, such as being regarded as a means of maintaining one's health and physical fitness (Zhang et al., 2015) .

Table 2.2: Contrasting Approach in Transport Planning

The Conventional Approach (Transport Planning and Engineering)	An Alternative Approach (Sustainable Mobility)
Physical dimensions	Social dimensions
Mobility	Accessibility
Traffic focus, particularly on the car	People focus, either in or on a vehicle or on foot
Large in scale	Local in scale
Street as a road	Street as a space
Motorized transport	All modes of transport often in a hierarchy with pedestrians and cyclists at the top and car users at the bottom
Forecasting traffic	Visioning on cities
Modelling approaches	Scenario development and modelling
Economic evaluation	Multicriteria analysis to take amount of environmental and social concerns
Travel as a derived demand	Travel as a values activity as well as a derived demand
Demand based	Management based
Speeding up traffic	Slowing movement down
Travel time minimization	Reasonable travel times and travel time reliability
Segregation of people and traffic	Integration of people and traffic

Source : (Ogryzek et al., 2020)

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The third sustainable transportation principle is the reduction of travel distance. With this development, the city expects to increase mobility within city districts, which may result in a shift in the use of transportation modes toward those that are more environmentally friendly, such as walking and cycling. Travel distance also can be reduced through shared ride-hailing. According to (Tirachini & Gomez-Lobo, 2020), by shared ride-hailing, it can decrease the travel distance. Housing, commerce, recreation, and education should be integrated into district planning so that residents can take advantage of a variety of services in one location, thereby reducing travel time. It is recommended that, in accordance with the principles of sustainable space development, "green urban islands" without automobile traffic be established and that these islands be linked to one another to allow for safe pedestrian and bicycle traffic (Ogryzek et al., 2020).

The fourth sustainability rule states that, new transportation technologies must be applied. This statement is similar as mentioned by (Zawieska & Pieriegud, 2018), Future sustainable transportation can be achieved by the application of new transportation technology and services like autonomous vehicles or mobility-as-a-service (MaaS) solutions, along with demographic shifts. In the industrial sector, transportation is one of the few that continues to increase emissions, accounting for 26% of global CO_2 emission. The significance of technology in transportation cannot be overstated, as it has a direct impact on the efficiency of the system. Alternative fuels and renewable energy sources, as well as cutting-edge engine design and construction, would be the most environmentally friendly option for all modes of transportation. The development of green cities is a top importance in the noble quest for sustainability. New approaches should also focus on reducing traffic-related noise and ensuring quick and easy access to all parts of the city. It is essential that all future automobiles be low impact. It is also a combination of efficiency and drivers' behaviour change toward more rational driving, eco-driving, and adhering to the speed limit (Ogryzek et al., 2020).

Sustainability in transportation refers to maintaining the current order of traffic participants. Pedestrians should be given the highest priority because they are the most vulnerable and vulnerable group. Cyclists are the second group, followed by the public transportation system. Incorporating bicycles into a comprehensive planning framework may lead to new modes of transportation in urban areas (Gössling, 2013).

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Car owners are at the bottom of the list because they are the most common cause of traffic jams and street closures as shown in Figure 2.9 (Ogryzek et al., 2020)

PEDESTRIANS

CYCLISTS

PUBLIC TRANSPORT

CARS
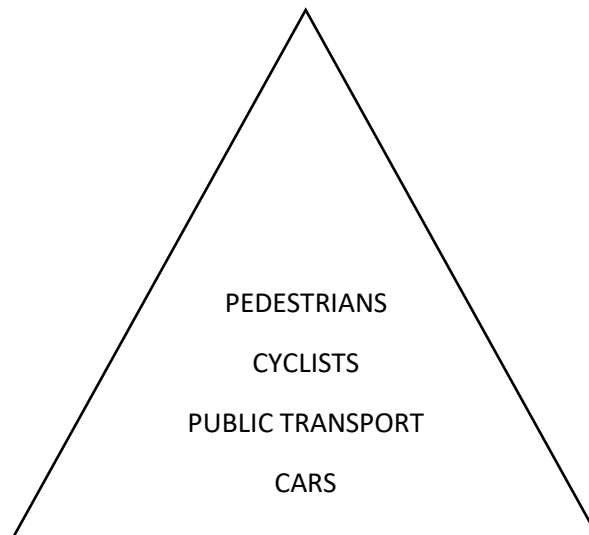
Figure 2.9 : Sustainable Transport Pyramid.

Source   : (Ogryzek et al., 2020)

The above-mentioned sustainable transportation rules are the key to making the shift in thinking about spatial planning that is appealing to residents. Because of this, people should be involved in the creation and decision-making processes of transportation planning (Ogryzek et al., 2020). To successfully implement any reform, it is important to remember that social acceptance is a fundamental value. This can be achieved with the help of GIS technology (Ogryzek et al., 2020).

2.8   Impacts of bicycle utilization towards sustainable transportation

To gain a better understanding of the significance of cycling as a sustainable mode of transportation, a brief definition must be provided. The European Commission's state that "Sustainable Development means meeting the requirements of present generations without exposing the ability of future generations to know their own needs" is a widely used definition. With the understanding that mobility is the basis for

people to know their needs by enabling them to carry out activities related to these requirements in a variety of locations, it follows that transportation is essential to fulfil the needs of people. Taking into consideration that the concept of sustainability also necessitates a balance between the social dimension of mobility and the economic and ecological aspects, cycling is a very sustainable mode of transportation because it allows people to travel in an affordable, healthy, safe, resource-efficient, and environmentally friendly manner as shown in Figure 2.10. As a result, cycling plays an important role in the long-term development of cities and metropolitan areas (Pospischil & Mailer, 2014).
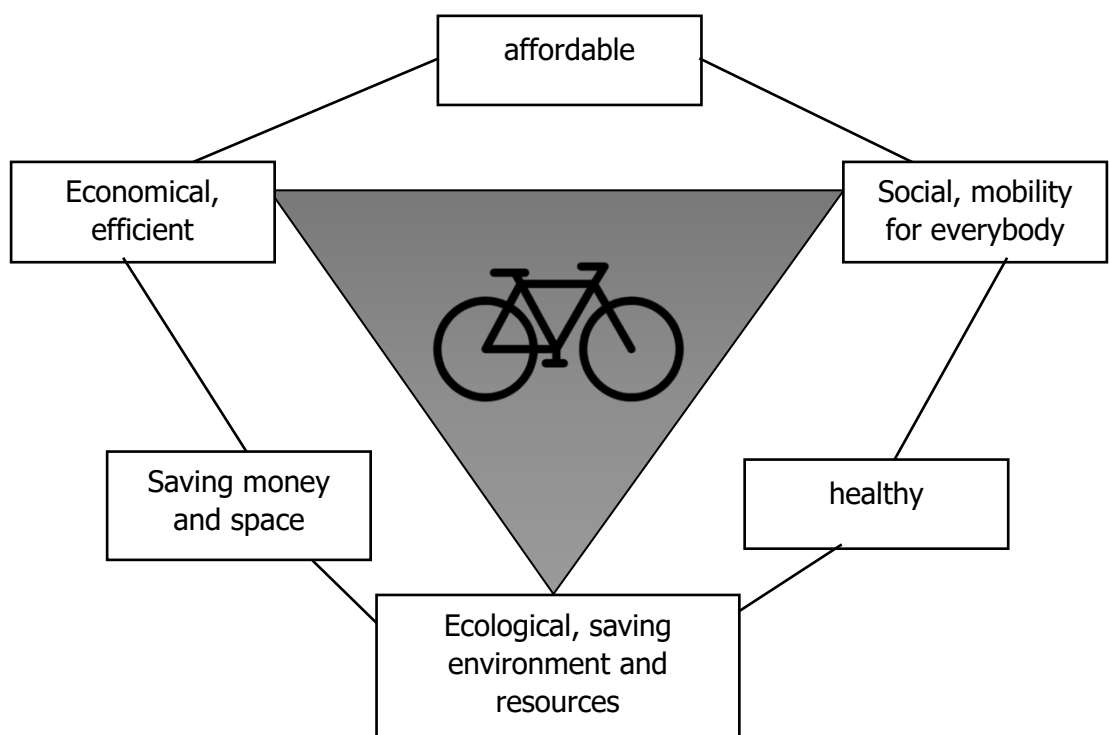
Figure 2.10   : Cycling as a Sustainable Mean of Transport.

Source   : (Pospischil & Mailer, 2014)

When evaluating the health benefits of cycling, it is critical to consider the risks associated with riding a bicycle. Cyclists have a high active safety, which means they cause a low risk to the safety of others, but a low passive safety, which means they are highly vulnerable, and the safety of a cyclist is dependent on the awareness of other road users of their presence on the road they are riding on. As shown in Figure 2.8, when comparing the growth in Innsbruck's population from 2002 to 2011 with the increase in daily cycling journeys from 2002 to 2011, it can be concluded that, even

though the city's population increased by 6% and the increase in daily cycling journeys increased by 13% to 2011 23%, there has been a decrease in the number of accidents (Pospischil & Mailer, 2014).

These accidents are less possible when there are more cyclists on the road. This is due to more cyclists in the traffic make them more visible to other road users, which makes them less expected to get into an accident. Cyclists help make transportation more environmentally friendly by saving space and resource. The amount of space needed to transport one person by bicycle is only a ninth of the amount of space required on average per person to transport one person in a private car (Pospischil & Mailer, 2014).

The amount of space required for cycle parking is also significantly less than the amount of space required for car parking, which is a significant benefit when most vehicles are parked for 23 hours a day and parking near utilities such as train stations or shopping centres is limited. When compared to a road in the central city, a cycle path involves less than half the width and is more environmentally friendly while also being more acceptable in terms of urban design and appearance (Pospischil & Mailer, 2014).
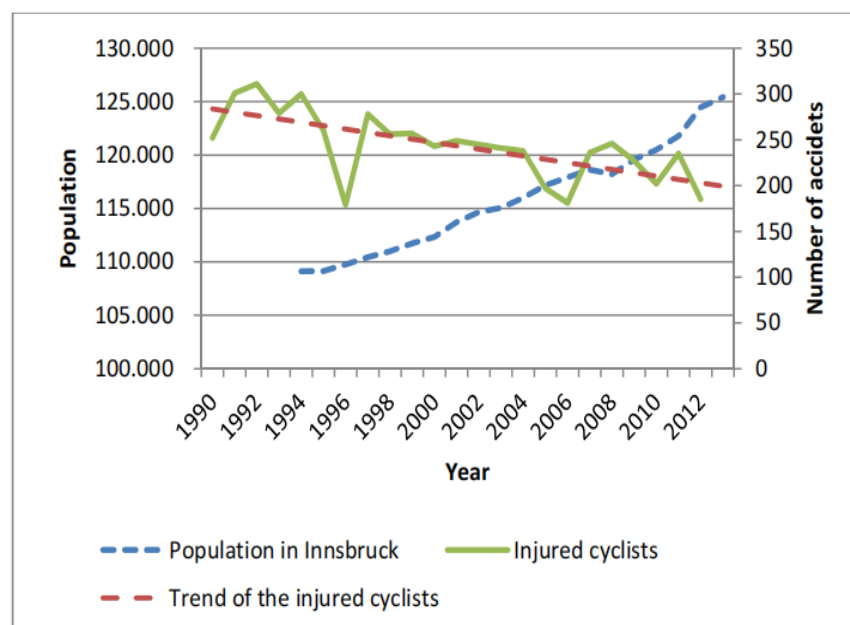
Figure 2.11   : Population in Innsbruck and Accidents Including Cyclists.

Source   : (Pospischil & Mailer, 2014)

2.9 Previous Studies Related to the Bicycle Utilization Influencing Factors and Impacts Towards Sustainable Transportation

Several types of research have been conducted to investigate how bicycle use has influenced factors and impacts towards sustainable transportation. Table 2.3 shows a summary of previous studies related to the influence of factors and the impact of bicycle use on sustainable transportation.

Table 2.3: Previous Research on Bicycle Utilization Influencing Factors and Impacts Towards Sustainable Transportation

No.	Research Title & Source	Description
1.	Bicycle ownership and utilization in Tamale Metropolis; influencing factors and impacts to sustainable transport (Timpabi et al., 2021)	This study is focused to identify bicycle ownership and ridership and gain insights into how demographics, perceptions and experiences of respondents influenced the status of cycling in Tamale Metropolis. Based on findings in this study, its show that affordability, health benefits and avoidance of congestion, in the order of significance are the three most important reasons why cyclists choose bicycles over other modes.
2.	The factors shaping car drivers' attitudes towards cyclist and their impact on Behaviour (Fruhen et al., 2019)	Based on finding in this study, it suggest that an important avenue for changing car driver attitudes towards cyclists is to take account of their attitudes towards automobility by campaigns designed to promote the benefits of cycling are inadvertently threatening people's attachment to cars, thereby increasing hostility towards cyclists.
3.	Perception of barriers for the use of bicycles	The purpose of the study reported in this article was to assess the perceptions of a group of

		people regarding hurdles that may prevent them from using bicycles to commute to and from work. The barriers that have been identify include lack of cycling infrastructure, lack of safety, distance to be travelled, physical fitness, slopes and climate.
	(de Sousa et al., 2014)	
4.	A cross sectional survey of attitudes, behaviours, barriers, and motivators to cycling in university students (Swiers et al., 2017)	The purpose of this research is to investigate the factors that encourage and discourage university students from cycling. Based on the finding in this study shows, the people perception towards cycling is cycling can reduce levels of pollution and congestion. Respondents also faced a barrier such as weather and safety. The motivator for the cyclist includes cycling improving fitness and maintaining or losing weight.
5 .	How can universities in emerging economies support a more thriving cycling culture? (Mateo-Babiano et al., 2020)	The study's primary goal is to assess whether universities can effectively encourage the adoption of more environmentally friendly means of transportation. Based on the finding, this study was able to examine how one university set in a developing city context opens up potential opportunities to encourage more active travel, and through the implementation of a bikeshare program, may be able to support sustainable mobility in higher education institutions.
6.	Diffusion of public bicycle systems: Investigating influences of users' perceived risk and switching intention (Wang et al., 2021)	Specifically, the goal of this study is to determine how diffusion processes affect prospective users' perceptions of danger associated with public bicycle use, as well as their intentions to switch to public bicycles as a method of transportation. Based on this finding, governments have begun to crack down on violations such as riding on sidewalks and improper bicycle parking, further exacerbating the challenges for cyclists.

Based on previous studies, there have been no studies related to the use of bicycles that influence the factors and effects on sustainable transportation in UMS. Thus, this study demonstrates novelty and contributes to new knowledge. In addition, the findings can help future researchers to see a clearer view in deciding the best ways to improve cycling activities for their research purpose.

CHAPTER 3

METHODOLOGY

3.1 Introduction

This chapter is intended to provide an overview of the research methodology used in the study of bicycle utilization in UMS, influencing factors and impacts towards sustainable transportation. Every component of conducting this research was thoroughly described in this chapter, from the approach analysis for research design to respondent selection, sample size calculations, and study location selection. There were also questionnaire surveys as data collection methods, as well as different types of statistical analysis and tests, that were used in this research.

3.2   Flow Chart of Methodology
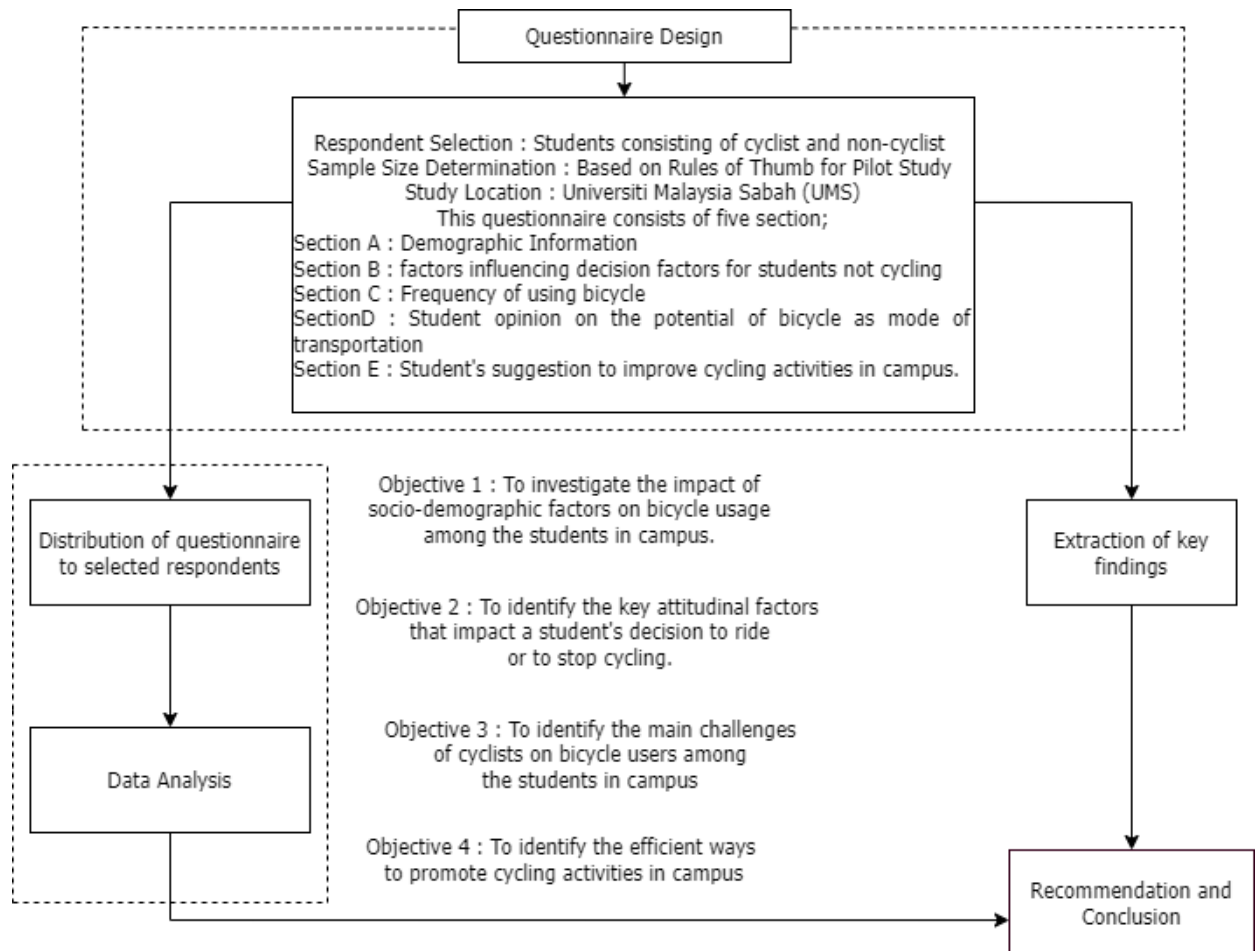
Figure 3.1 : Flow Chart of the Methodology

3.3   Design of Questionnaire

3.3.1 Respondent selection

The preferable type of respondents for completing the questionnaires was centred on the students in campus. The target respondents are students consisting of cyclists and non-cyclists of all ages and genders. Questionnaire's survey has been distributed to random users for the questions to be reviewed.

3.3.2 Sample Size Determination

To achieve high-quality results, it is necessary to conduct well-designed research studies that include relevant experimental design and precise performance. This study was conducted by using pilot study in analysing its feasibility prior in performing the main study which also known as the full study or large-scale main trial which can be very beneficial for this purpose. One of the goals of conducting a pilot study is to improve the overall quality of research, which can be accomplished in most aspects of the research process (Malmqvist et al., 2019). Questionnaire surveys were included in this pilot study. By using sample size rules of thumb to estimate the sample size for the pilot trial is the simplest method to utilise (Whitehead et al., 2016). There are several recommended sample sizes by rules of thumb presented in Table 3.1.

Table 3.1: Recommended Sample Size by Rules of Thumb for Pilot Study

Author	Recommended Pilot Trial Sample Size
Julious	24
Kieser and Wassmer	20 – 40
Brownie	30
Sim and Lewis	≥ 55
Teare et al.	70

Source : (Whitehead et al., 2016)

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The sample size selected for this research is the maximum sample size of 70 as provided in the table above. As recommended by Teare, a pilot trial sample size of 70 people should be used in order to decrease the imprecision around an approximation of the standard deviation (Whitehead et al., 2016). It also made a significant contribution to the improvement of precision and the reduction of bias. As a result, the sample size was chosen because it had the desirable characteristics for a pilot study for the data collection through questionnaires.

3.3.3 Study Location

A paper-based panel survey was carried out on the campus of University Malaysia Sabah. University Malaysia Sabah comprises a small number of communities that are separated by a short distance between two adjacent locations. To achieve the goals outlined in Chapter 1, most of this study's attention is directed toward students. Review and distribution of questionnaires to students who ride bicycles or do not ride bicycles. Figure 3.2 below shows the routes of University Malaysia Sabah.

Figure 3.2 : Universiti Malaysia Sabah (UMS) Routes

3.4   Data Collection Procedure

3.4.1 Literature Review

The information and details about bicycle utilisation in UMS, as well as influencing factors and impacts on sustainable transportation, have been gathered through a variety of academic and industry literature reviews to develop a thorough understanding of the report, which can be found both online and in print. The most detailed understanding of the study is gained using search engines such as Google Scholar, Science Direct, and ResearchGate, which are part of an online education platform. The information is gathered from online media about easily accessible and accurate journal articles, online journals, and related documentation. The focus of the literature search is primarily on bicycle utilisation and its influence on sustainable transportation. This research focuses on the use of bicycles by individuals in a specific context, and it is conducted primarily on a global and local scale.

The terms during the searching process of this study are varied. For example, the main term which is 'bicycle utilization', can also be identified as 'bicycle usage', 'bicycle users' and 'cyclist' too. However, the term bicycle remains included and unchanged. Table 3.5.1 shows the main search criteria for this study.

Table 3.2: Main Search Terms for Each Database

Database	Keywords searched
Google Scholar	Bicycle + utilization
Science Direct	Bicycle + utilization
Scopus	Bicycle + utilization
Springer	Bicycle + utilization
Elsevier	Bicycle + utilization
Research Gate	Bicycle + utilization
MDPI	Bicycle + utilization
IOP	Bicycle + utilization
ISI	Bicycle + utilization

3.4.2 Questionnaire Survey

Questionnaires were generally performed to investigate the factors influencing bicycle use among students and its impact on sustainable transportation. A total of 377 respondents among University Malaysia Sabah students were chosen and the focus group of these respondents were students living on campus. Student backgrounds are different, comprising students from several courses from different faculties. As the purpose of this research was to analyse the factors and impacts of bicycle use on sustainable transportation at University Malaysia Sabah, five sections of the questionnaire were constructed.

This questionnaire method's main approach was a closed-ended and online-based as the primary data collecting tool. The online questionnaires were consisted of five sections with respective sets of questions. Section A consisted of five questions which were about the demographic information. Section B was regarding the factors influencing decision factors for students not cycling. At the same time, Section C was about frequency of using bicycle. Section D was related about student opinion on the potential of bicycle as mode of transportation. Section E was related to the to approach cycling activities in campus. Section B consisted of one question, Section C were consisted of four questions, while Section D consisted of thirteen questions. Next is Section E, where it was related to the student's suggestion to improve cycling activities in campus. Likert-Scale based choices of answers were applied for Sections C, Sections D and Section E. With the current development of technology, the questionnaires were designed in an online platform of Google Doc and disseminated to student respondents within UMS campus by WhatsApp's social media contacts, Facebook, and Twitter.

3.5   Data Analysis

The data obtained in this analysis were calculated statistically by the procedure performed using Microsoft Excel computer-based software and the Statistical Package for Social Science (SPSS).

3.5.1   Descriptive Statistics Frequencies Analysis

It was common practise in this study to conduct descriptive statistical frequency analysis to obtain the distribution of frequencies as well as the sum of percentages for each section of the study across the board. In this research method, it was possible to present the interpretation of data or results in a more convenient and efficient manner than was previously possible. Typically, this type of analysis was used to clarify the most important characteristics of the data in a research project.

The analysis of descriptive statistical frequencies simplifies the interpretation of raw data into simple summaries with simplified graphical analysis, which can then be used as the foundation for virtually any quantitative data analysis. The raw data obtained in summary is made more vividly visible using a virtual presence in the form of different preferred graphs, which allows the frequencies or percentages to be more easily identified, and the maximum and minimum data to be identified more vividly using this analysis.

3.5.2   Chi-Square Test

This study used the Chi-Square test to focus on one of the objectives of the study that was closely related to the title of the study. The Chi-Square test was used in Section A to focus on one of the objectives of the study that was closely related to the title of the study. The purpose of this test was to investigate the relationship between the demographic information provided by the respondents and their bicycle utilisation. This test defined statistical significance as a p-value that varied between 0 and 1 in terms of the degree of statistical significance.

In general, the evidence for rejecting the null hypothesis was more convincing because the p-value derived from the chi-square test was lower than the evidence for accepting it. It was determined that there was no constructive correlation between the two variables involved in this test, indicating that they were independent. The p-value

of less than 0.05 (95% confidence level) indicates that the statistical significance between the variables and the null hypothesis is in serious doubt, as there is only a less than 5 percent chance that the null hypothesis is correct, according to the results. In contrast, if the p-value is greater than 0.05, the null hypothesis indicates that there is a high degree of agreement between the two groups.

CHAPTER 4

RESULTS AND DISCUSSION

4.1 Introduction

This chapter presents the results of statistical analysis using SPSS statistics software and Microsoft Excel. This chapter largely contains the study's findings and discussions, which were gathered using questionnaires. As indicated in Chapter 3, these sets of data are analysed using a variety of statistical tests, and the results of the analysis are further examined with a variety of supporting evidence from previous studies.

4.2   Demographic Respondents

The information related to the profile of respondents who are study in Universiti Malaysia Sabah, Kota Kinabalu city are analysed concurrently. The profile of respondents is interpreted with descriptive statistics frequencies analysis by several questions which are related to the personal and background scope in the form of frequency counts and percentages for comparison purposes. These demographic questions are situated in the initial part of the questionnaire surveys, Section A, is known as a random sample, not restricted to gender, occupation status or other factors. By which, it comprised of the respondent's age, gender, faculty, family income and number of cyclists.

Based on this research, it shows that 91 respondents in this survey are male and 286 are female, accounting for 24.1% and 75.9% respectively. The age distribution of the survey respondents shows that majority of the respondents consisted of the age group 18 – 25 years old with 367 (97.3%) respondents, followed by the age group 26 – 35 years old which was 10 (2.7%) respondents respectively as represents in Figure 4.1. It shows that generally, no respondents from the age group of 36 – 45 years old, 46 – 55 years old as well as 56 – 65 years old. The highest number of respondents are from the age of group 18 – 25 years old indicated that age became one of the main variables in demographic characteristics that affect the willingness of people to complete the online surveys
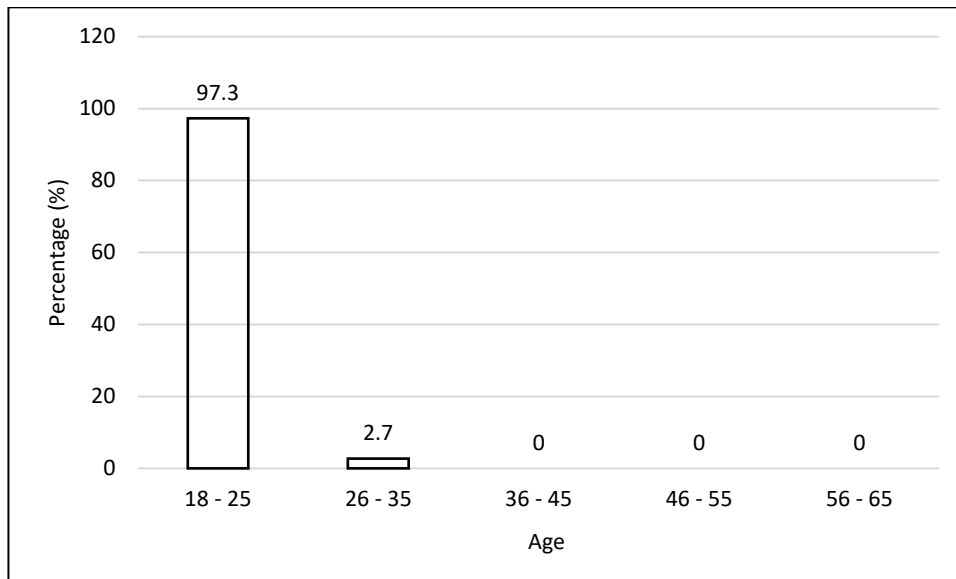
Figure 4.1 : Age of Respondents

Throughout the research, the respondents consisted of various faculties in the Universiti Malaysia Sabah. As for the faculty of respondents in this survey research as shown in Figure 4.2 describes a number of 92 (24.4%) respondents from faculty of engineering, followed by a number of 77 (20.4%) respondents from faculty of science and natural resources, 47 (12.5%) respondents from faculty of medicine and health science, 44 (11.7%) respondents from faculty of business, economic and accountancy, 42 (11.1%) respondents from faculty of computing and informatics, 30 (8%) respondents from faculty of psychology and education and 23 (6.1%) respondents from faculty of humanities, art and heritage . Apart from that, about 12 (3.25) and 10 (2.7%) respondents from faculty forestry tropical and faculty of food science and nutrition. This shows, this survey is distributed to all faculties.
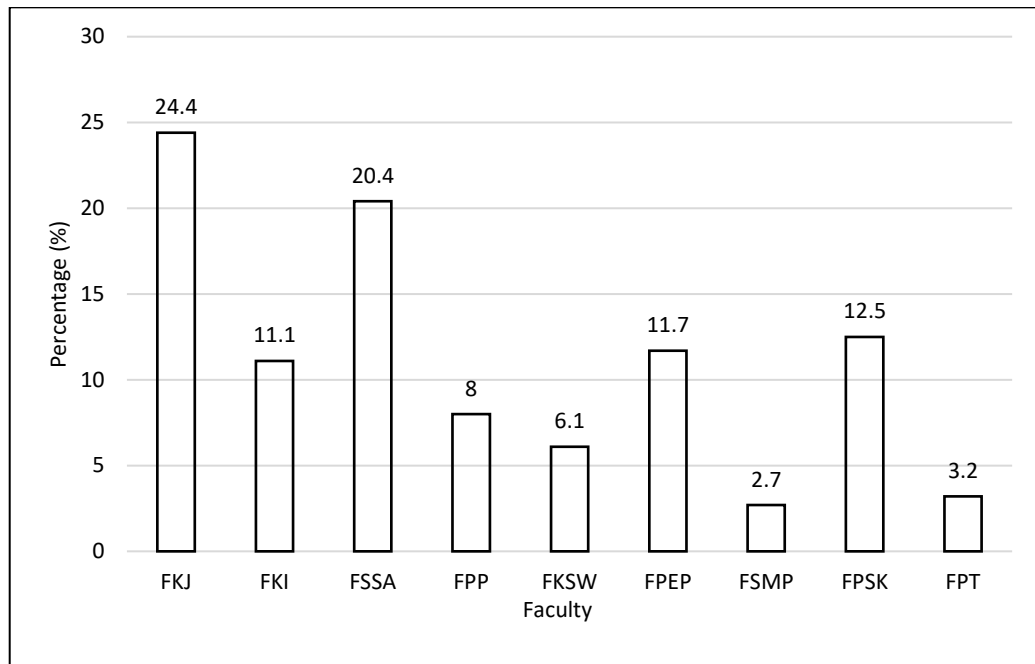
Figure 4.2 : Faculty of Respondents
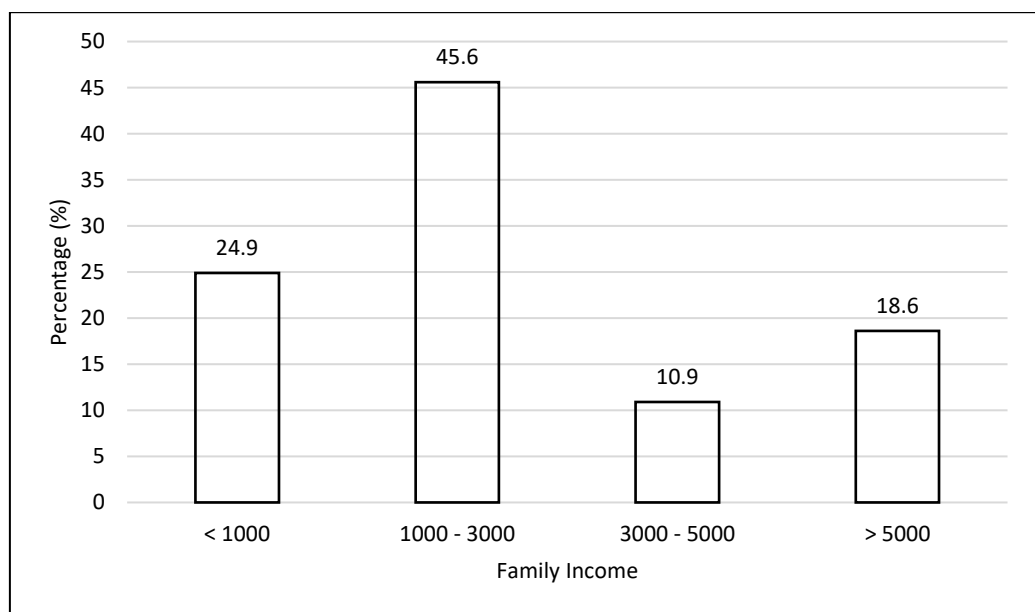
Figure 4.3 : Family Income of Respondents

In terms of family income of respondents, it is observed that 172 (45.6%) of the respondents have average family income RM1000 to RM3000, followed by 94 (24.9%) respondents below RM1000, 70 (18.6%) respondents more than RM5000 and the lowest 41 (10.9%) respondents in average income RM3000 to RM5000 as illustrated in Figure 4.3 above.
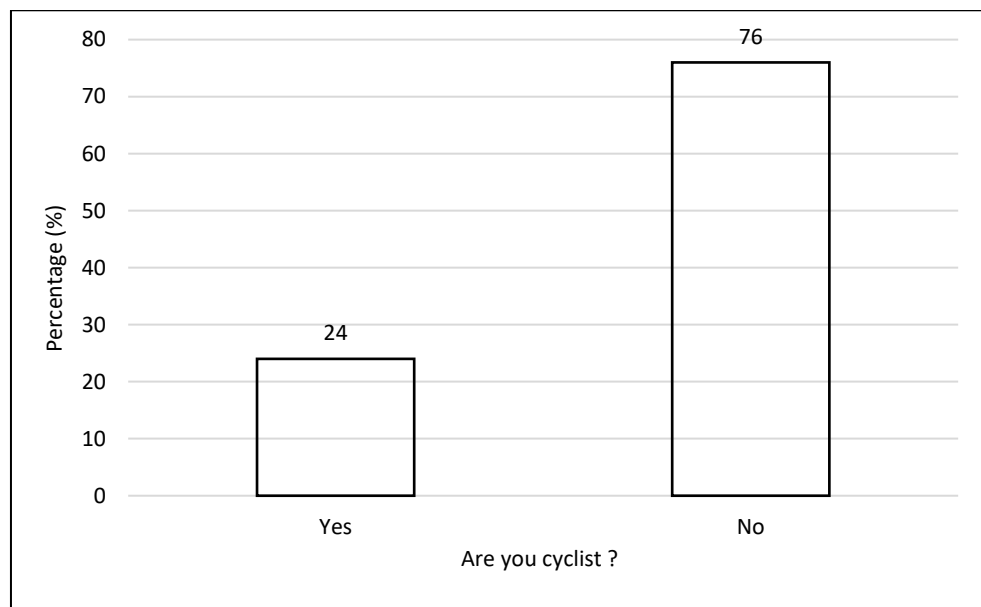
Figure 4.4 : Bicycle Ridership in Universiti Malaysia Sabah

In this research, the respondents are asked about if they are cyclist or not, the indicated respond as prescribed in Figure 4.4 where it displays that about 91 (24%) of the respondents are bicycle users and the remaining respondents 286 (76%) are not using bicycle, however it can be concluded that majority of respondents do not ride bicycles.

4.3 Impact of socio-demographic factors on bicycle usage among the students in campus.

Respondent were mostly student in Universiti Malaysia Sabah, Kota Kinabalu. Most of the samples were females; people between the ages of 18 – 25 years old; students with family income between RM1000 – RM3000. Summary statistic of respondents' demographics are presented in Table 4.1.

Table 4.1: Summary of Statistics On Respondents' Information

| Demographics	Description	Characteristics of Respondents (%)	Bicycle Users (%)
Gender	Female	75.9	16.4
	Male	24.1	7.7
Age	18 - 25	97.3	22.8
	26 - 35	2.7	1.3
	36 - 45	0	0
	46 - 55	0	0
	56 - 65	0	0
Family Income	Less than RM1000	24.9	5.3
	RM1000 - RM3000	45.6	14.3
	RM3000 - RM5000	10.9	1.6
	More than RM5000	18.6	2.9

The most important personal variables influencing bicycle use are gender, age, and income (Effects, 2011). Out of the 100% of respondents who use bicycle from Table 1.7. The majority (16.4%) were females and followed by males (7.7%) respondents. According to the findings of this survey, females are more likely to cycle than males. This influence by family income of the students. For the respondents age group of 18 – 25 years old, the bicycle usage is relatively highest which is 22.8%. Following the citizen of the age group of 26 – 35 years old with bicycle usage of 1.3%. Bicycle riding diminishes with age (Effects, 2011). Mostly, almost majority of the age 18 – 35 years old use a bicycle. They're used bicycle to class, recreational or leisure time and important matter such go to library or other facilities in campus. As a result, the adoption of bicycle use on campus is significant, and this is one of the plans to achieve sustainable transportation.

According to (Pogačar et al., 2020), university students are an important target demographic who could use and promote cycling as a mode of transportation. Since

students are labelled as young and presumably healthy adults, they necessarily have the physical ability to cycle; supposedly, they should have more knowledge, motivation, and awareness on sustainability issues. Concerning family income, bicycle users was found to increase with increasing monthly income, where those with family income ranging from RM1000 – RM3000 represented 14.3% of the population. Student financial resources are also one of the important issues that can contribute to more frequent use of bicycles.

Table 4.2: Summary of Utilization of Bicycle among the Students

Demographics	Description	Frequency of Bicycle Usage among Students (%)			
		Daily	More than 3 Times a week	More than 3 Times a month	Others
Gender	Female	0.0	11.3	69.4	19.4
	Male	0.0	23.1	63.7	0.0

From the Table 4.2, it can be simplified that mostly the female and male students who use bicycles in Universiti Malaysia Sabah frequently use bicycle more than three times a month with 69.4% and 63.7%, respectively. For more than three times a week 11.3% of the respondents are female and 23.1% are male. While 19.4% of female respondents chose other answer options including, they use a bicycle once a year and twice a month. For gender there are much different in term of bicycle usage. Table 4.3 below shows the chi-square test between gender and frequency of bicycle usage.

Table 4.3: Chi-Square Test between Gender and Frequency of Bicycle Usage

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi Square	18.289a	2	.000
Likelihood Ratio	20.868	2	.000
Linear-by-Linear Association	17.579	1	.000
N of Valid Cases	91		

a. 1 cells (16.7%) have expected count less than 5. The minimum expected count is 3.82.

From Table 4.3 the Pearson Chi-Square test gives value of 0.000 which gives p-value ≤ 0.05. This means that gender is very dependent on the frequency of bicycle

usage among students. From the descriptive analysis, the usage of bicycle is mostly from the female user. Mostly male user does not use bicycle very much as they are preferring to use other mode of transportation. Table 4.4 below shows chi-square test between age and frequency of bicycle usage.

Table 4.4: Chi-Square Test between Age and Frequency of Bicycle Usage

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	3.010a	2	.222
Likelihood Ratio	4.668	2	.097
Linear-by-Linear Association	0.145	1	.703
N of Valid Cases	91		

a. 3 cells (50.0%) have expected count less than 5. The minimum expected count is .66.

For the test between age and frequency of bicycle usage, the Pearson Chi-Square is 0.222 which is p-value ≥ 0.05. Thus, the variable is not significant. Which means that, there is no relationship between age and frequency of bicycle usage. Mostly, this questionnaire focusses on students, with an average age between 18 – 35 years old. It can conclude that the users of bicycle are around the middle age and young adults or teenagers. Therefore, this group tend to have more energy to use bicycle. Table 4.5 below shows the chi-square test between family income and frequency of bicycle usage.

Table 4.5: Chi-Square Test between Family Income and Frequency of Bicycle Usage

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	27.825a	6	.000
Likelihood Ratio	30.038	6	.000
Linear-by-Linear Association	6.029	1	.014
N of Valid Cases	91		

a. 7 cells (58.3%) have expected count less than 5. The minimum expected count is .79.

Table 4.5 is the Chi-Square test for family income and frequency of bicycle usage. The data also provide with p-value ≤ 0.05. This means that, there is significant value between family income and frequency of bicycle usage. Mostly, the users of bicycle that having a household income of RM1000 to RM3000 tends to use bicycle

more than people that was having income RM3000 and above. This is due to the family that having households' incomes of RM3000 above can afford other mode of transportation for their use to class or other facilities in campus.

According to the findings of this study, which used a questionnaire to evaluate bicycle use among students at Universiti Malaysia Sabah, there is a significant amount of potential for bicycle use in Universiti Malaysia Sabah because many people still use their own private vehicles or other modes of transportation to travel from one location to another. This is mostly attributable to the extremely high number of people who utilize other mode of transportation. It was observed that the usage of bicycle decrease, with the increase of the household income for the student. Individuals with steady family incomes of between RM 1,000 and RM 3,000 make up most people who use bicycle, accounting for a ratio of 14.3%.

However, students with ages ranging from 18 to 35 years old are the most frequent users of bicycle accounting for 24% of the respondents. Consequently, the majority of users with large capacities are middle age and young adults. There is no significant factor to conclude that age has a major role in the utilization of bicycle usage with a p-value ≥ 0.05. This indicates that age is not a primary consideration when study the factor influencing bicycle use among students due to students are categorized as young adults and has higher frequency of bicycle usage. In regard of mode preference, young adults prefer transit and active transportation options such as walking and biking (Hasnine et al., 2018).

When it comes to usage of bicycle, one's gender is a significant consideration. According to the results of the Chi-Square test, gender is a significant influence in bicycle usage, as evidenced by the fact that the p-value ≤ 0.05. Female tends to use bicycle compared to male. Male is more preferring to use faster mode of transportation and to avoid from adverse weather condition. For this questionnaire, majority of the respondents are female, therefore, it also affects the genders who use bicycles on campus.

4.4　Factors Influencing Decision Factors for Student Not Cycling

Table 4.6: Factors Influencing Decision Factors for Student Not Cycling

Description	Frequency	Percent (%)
What is your reason for not cycling?		
I prefer a faster mode	55	19.2
I can afford other modes	38	13.3
Adverse weather conditions	51	17.8
There are no dedicated lanes for cyclist	47	16.4
Road condition	38	13.3
Others	57	19.9
Total	286	100.0
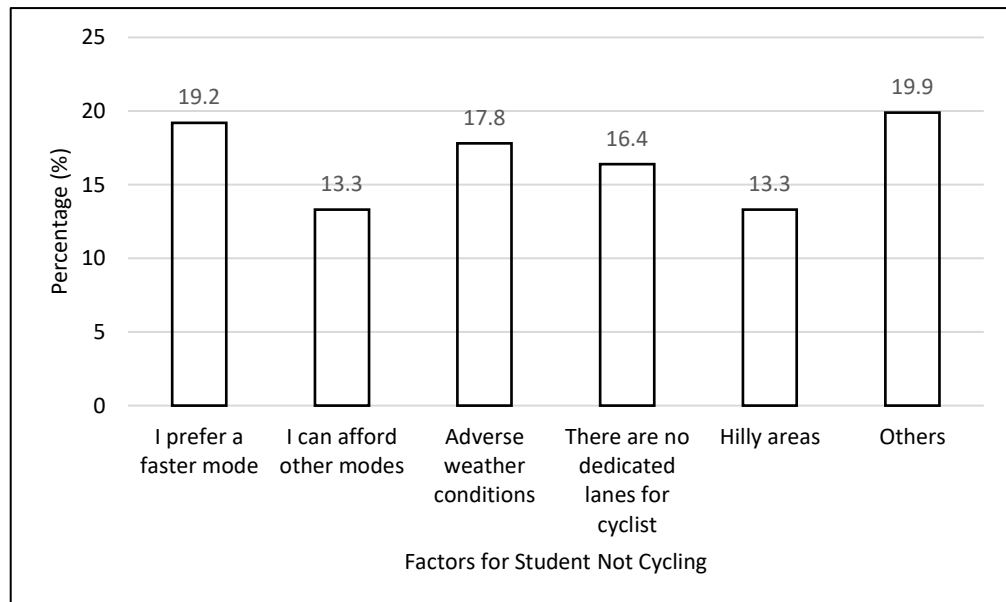
Figure 4.5 : Factors Influencing Decision Factors for Student Not Cycling

Table 4.4 and Figure 4.5 shows the result obtained from the questionnaire about the factors influencing student not cycling in campus. Majority of the respondents have their own reason for not cycling. In the graph in Figure 4.5, it represents as "Others" which consisted of (19.9%) respondents and the highest among the other choices. The respondents have a variety reason for not using a bicycle, they are either "unable to ride a bicycle well", "don't own a bicycle" and "lack the time to go riding". This was followed by prefer a faster mode and adverse weather condition, both at (19.2%) and

(17.8%) respondents. Respondents prefer faster modes compare to conventional bicycle during travelling in long distances and modes that require less physical energy (Timpabi et al., 2021).

Unpredictable weather conditions, especially in Malaysia, are one of the reasons for the lack of bicycle use among individuals. Malaysia has a hot and humid tropical climate with two monsoon seasons between October and February and April to October (Jalalkamali et al., 2012). Temperatures and humidity are high throughout the year. These climatic conditions contribute to the comfort factor of cyclists. Significantly, a greater percentage of those surveyed thought that risks linked with bad weather are the major reasons they avoid bicycling (Abasahl et al., 2018). The findings also shown (16.4%) of the respondents agreed that "no dedicated lane for cyclist" also contributed to student's reason for not using bicycle.

Lack of designated bike lanes could endanger bikers' safety. Cycling safety is increased by adding dedicated lanes for cyclist (Roma, 2020) . Student's can afford other modes and road condition represent equal respondents answered it which is (13.3%) of respondents. Student family finances affect their ability to purchase other vehicles. Mostly, in this study, family income for non-cyclist is above RM3000. This indicates that respondents' demographics have an impact on bicycle use on campus. Poor people ride their bicycles more frequently (Effects, 2011). The utilisation of bicycles on campus is influenced by road conditions. This is due to poor maintenance of car lanes. The road conditions will affect cyclist safety. As mention by (Festa & Forciniti, 2019), the use of bicycles is highly affected by the road's safety and traffic

4.5   Frequency of Using Bicycle for Cyclist

In this research, the respondents are asked about how often they used bicycle, the indicated respond as prescribed in Figure 4.6 where it displayed that about (63%) of the respondents only use bicycle more than three times a month and followed by (23%) of the respondents are using bicycle more than three times a week. Meanwhile, no respondents engaging with bicycle usage daily. The rest of the respondents which fall under others (14%) came up with a different script of answers, however, it can be

concluded that cyclist rarely utilize bicycle usage, where some of them only engage with bicycle usage one or two times in a few years.
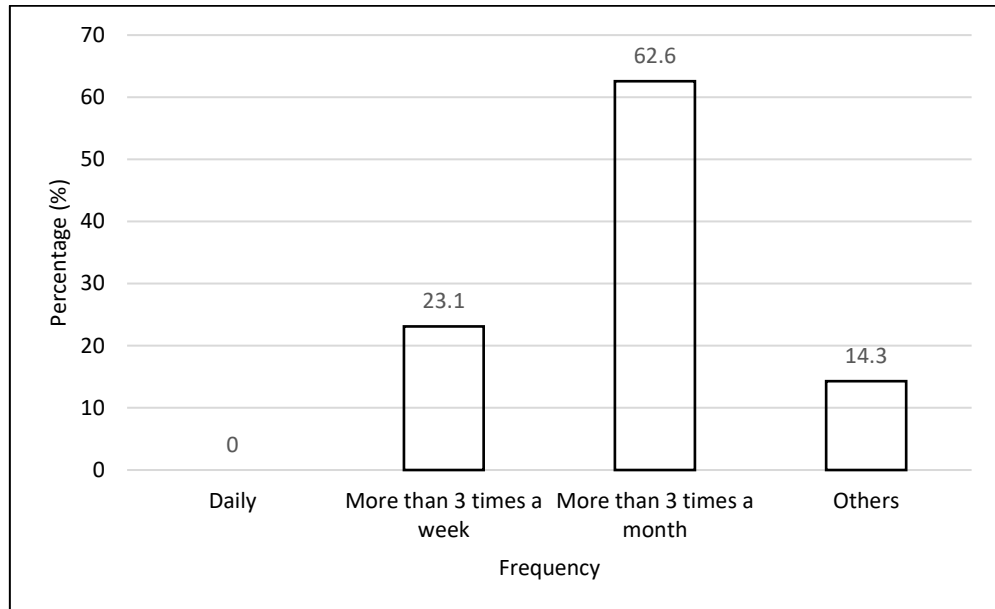

Figure 4.6 : Frequency of Using Bicycle

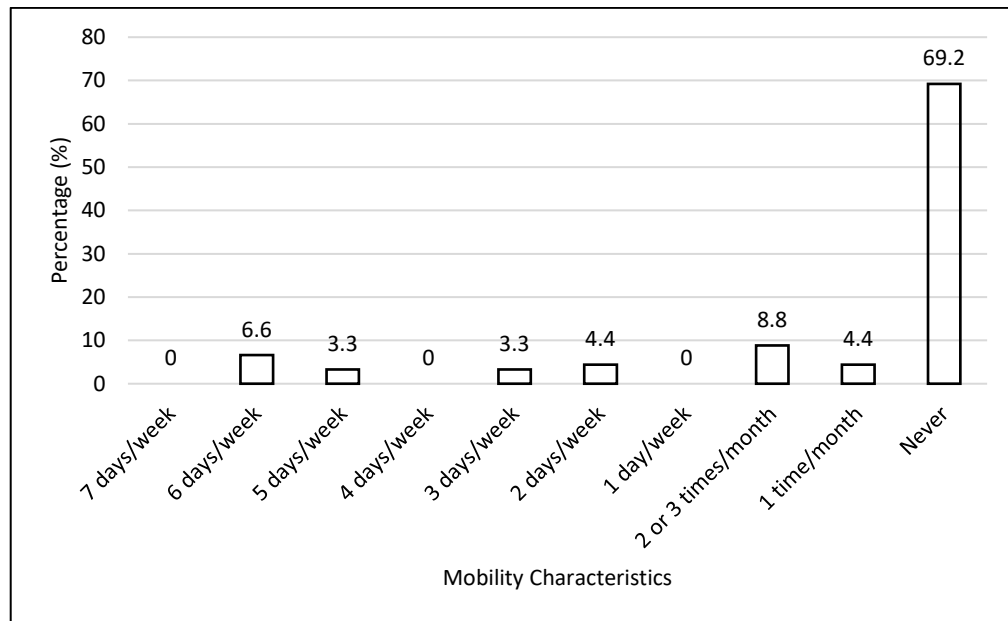### 4.5.1 Mobility Characteristics by Using of Bicycle

Figure 4.7 : Mobility Characteristics by Using Bicycle for a Class

Figure 4.7 shows that about (69%) respondents never use bicycle to go to the class, whereas about (18%) respondents will use bicycle weekly for the same purpose. The remaining respondents who utilise bicycle for class purpose at least once or 2/3 times in a month are (13%). According to the findings of this study, the utilisation of bicycles to commute to class is still lacking.

As for go to important matter such as library or other facilities in campus, the number of respondents who have not using bicycle decrease to (40.7%) of the respondents as shown in Figure 4.8. Apart from that, the number of respondents who use bicycle weekly for important matter increase to (22%) respondents. The rest of the respondents who use bicycle at a minimum frequency which are a few times in a month, equivalent to (13%) with respondents use bicycle to go to class. Rather than using bicycles to go to class, students prefer to use bicycles for other purposes such as to the library or other places on campus.
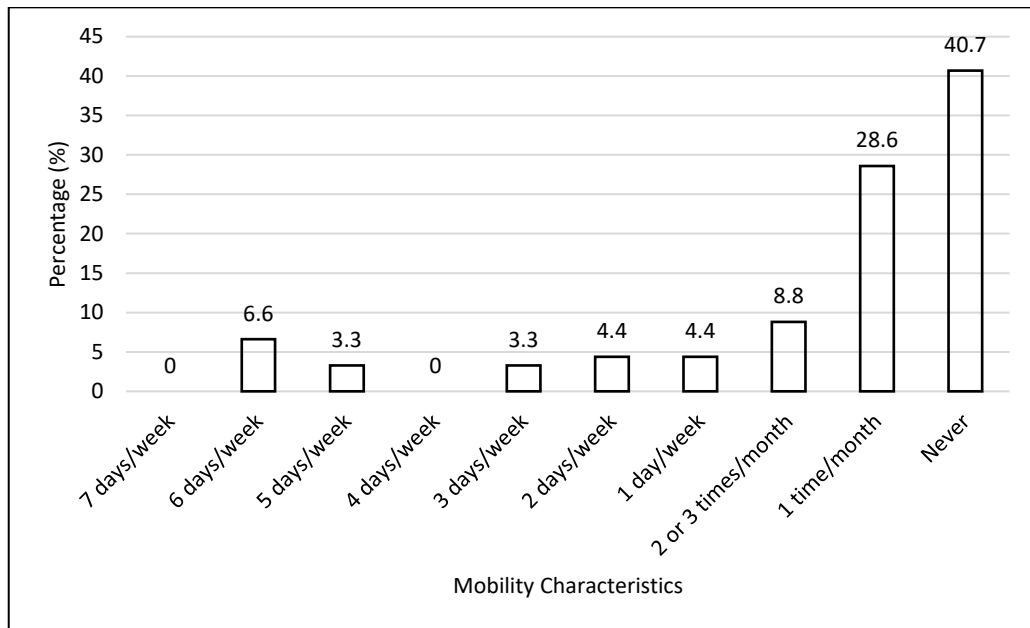
Figure 4.8 : Mobility Characteristics by Using Bicycle for an Important
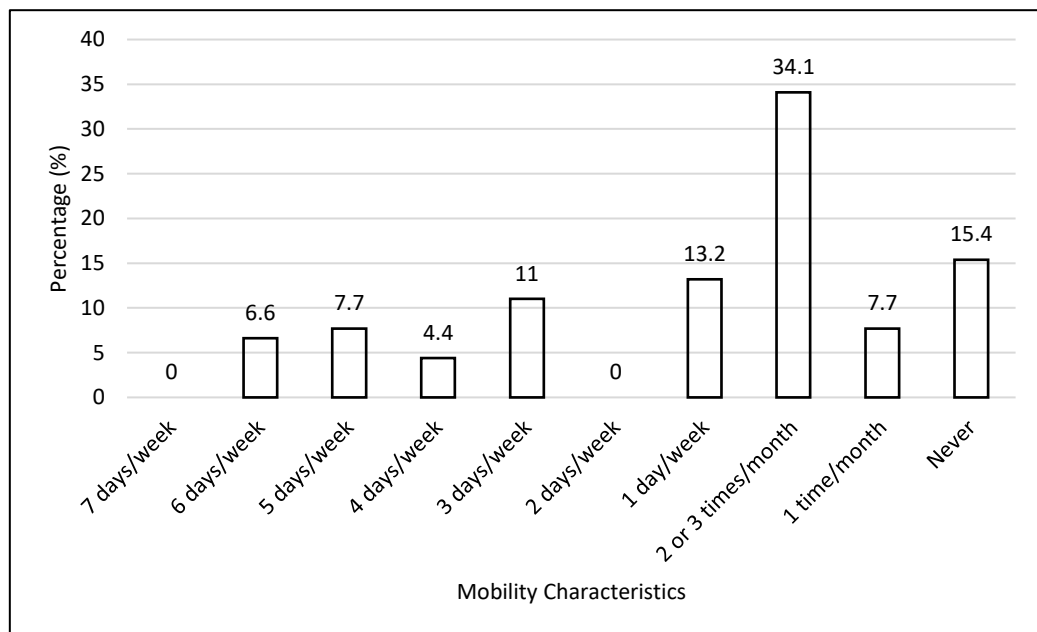
Matter

Figure 4.9 : Mobility Characteristics by Using Bicycle for

Recreational/Sport Activities

This case study is also going through observation on how often people attend outdoor activities like social, recreational, and sport using bicycle. As provided in Figure 4.9, there are about (15.4%) of the respondents never adopt bicycle for activities such

as visiting friends at other residential colleges, recreational or sports. Followed by (43%) of the respondents who will use bicycle for the same purpose weekly. The rest of the respondents use bicycle at least once or few times a month, with a total of (42%). It's found that, students use bicycles more often for recreational purposes than any other business.

4.5.2 Travel Mode Preference by Using Bicycle

To explore the diversification of individual's mode choice decisions about travel behaviours by using bicycle, these questionnaire surveys are constructed in Likert-scale format to observe mode choice preferred by the respondents in daily activities consist of three primary trips which are trip to class, trip to important matter such as library or other facilities in campus and trip to outdoor activity like social/recreational/sport. As presented in Figure 4.10, about 26 (29%) and 40 (44%) respondents strongly disagreed and disagreed in using bicycle to class. Whereas the respondents who selected neutral are 12 (13%) in amount, and the remaining respondents are agreed with the amount of 13 (14%), respectively.
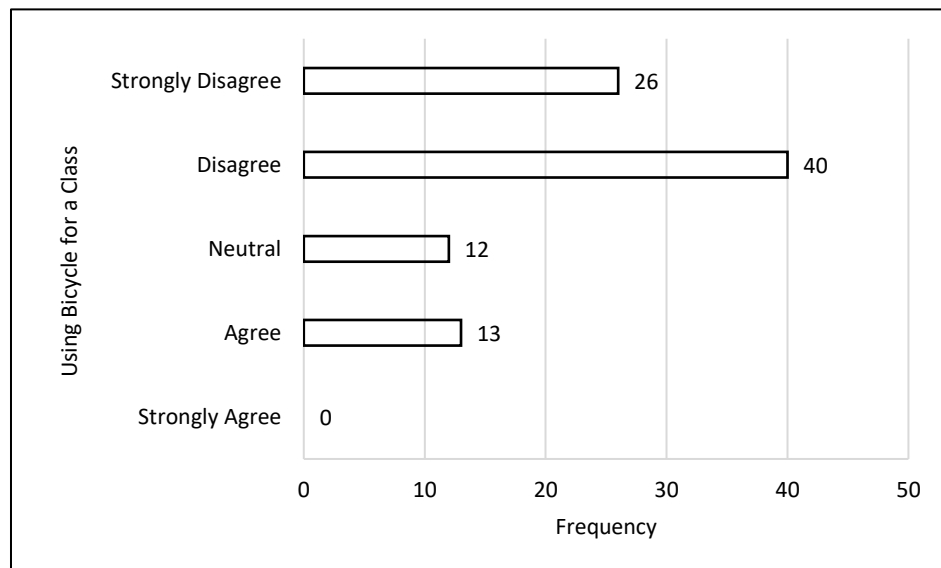
Figure 4.10: Travel Mode Preference by Using Bicycle for a Class

In terms of travel mode choice for an important matter such as go to library or other facilities in campus, the obtained data are provided in Figure 4.11, where 19 (21%) strongly disagreed using bicycle to go for an important matter, followed by 28

(31%) who disagreed. About 27 (30%) of the respondents are neutral with the statement, and the rest of the respondents voted agreed and strongly agreed with an amount of 13 (14%) and 4 (4%), respectively.
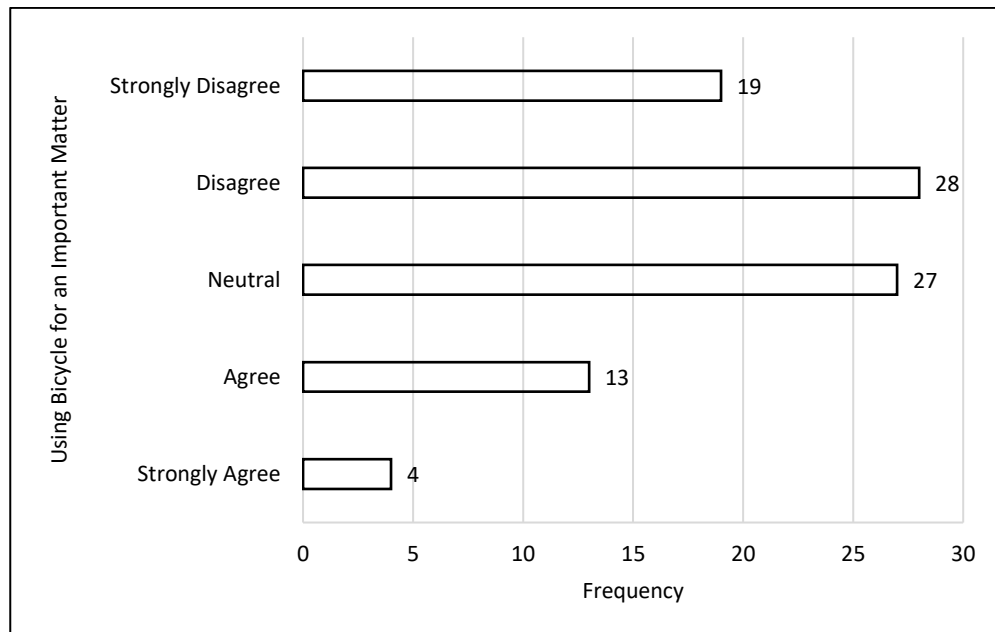
Figure 4.11: Travel Mode Preference by Using Bicycle for an

Important Matter
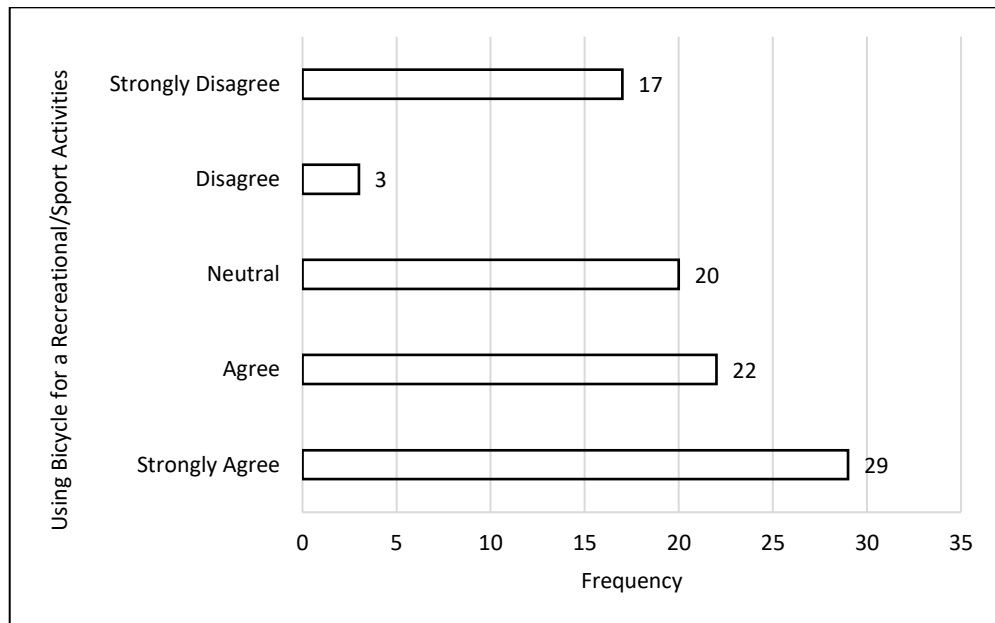
Figure 4.12: Travel Mode Preference by Using Bicycle for a Recreational/Sport Activities

Finally, the respondents are asked about their preferences to use bicycle to participate in recreational/sport activities including friend visits, joining sports, cultural and social events. As shown in Figure 4.12, the number of respondents who are strongly disagreed with the statement is 17 (19%), followed by 3 (3%) of the respondents have disagreed. About 20 (22%) of the respondents were neutral with the statement, whereas large amount of the respondents selected strongly agree and agree with an amount of 29 (32%) and 22 (24%), accordingly.

65

4.6 Student Opinion on the Potential of Bicycle as Mode of Transportation

Table 4.7: Views of Cyclist

Description	Frequency	Percent (%)
Why do you choose bicycle over other modes? (Cyclist views)		
It is affordable	19	20.9
It is a means of exercise to keep me healthy and fit	51	56.0
It does not pollute the environment	18	19.8
Reduce congestion	3	3.3
What are you challenges as a cyclist? (Cyclist views)		
Poor road surface condition	29	31.9
Careless behaviour and lack of regards of drivers for cyclist	17	18.7
Bad weather condition	45	49.5

4.6.1 Factors Influencing Bicycle Use among Students

Figure 4.13: Factors Influencing Bicycle Use among Students
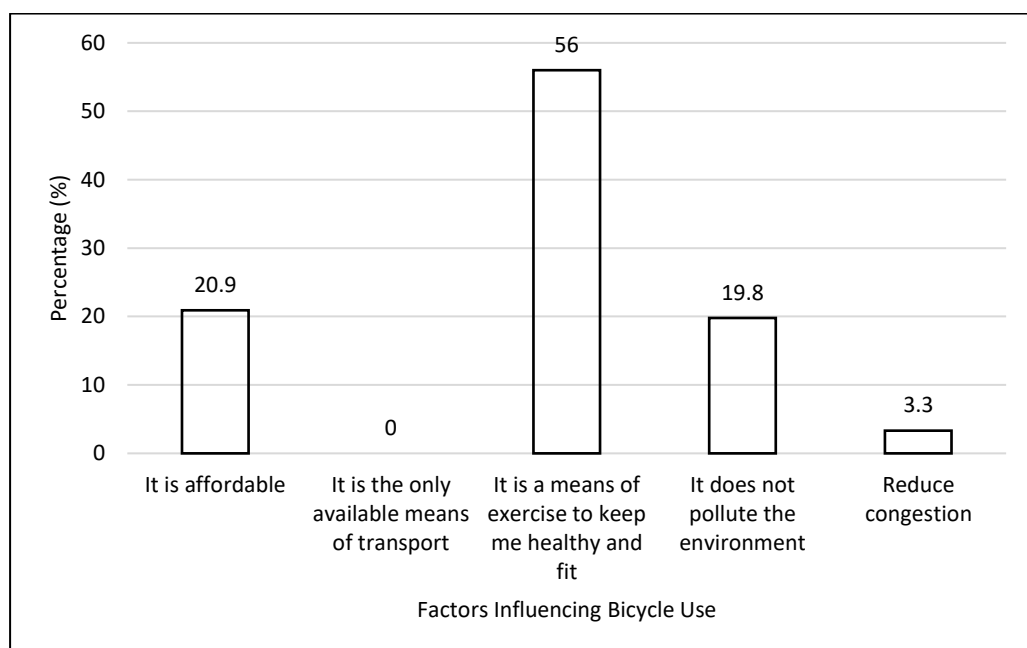
Section D for the questionnaire survey consisted of four different question to assess the respondent's opinion on the potential of bicycle as mode of transportation. The approach in interpreting this was the descriptive statistics frequency analysis. This type of question is asked as it links with one of the objectives mentioned in Chapter 1, which is associated with the factors influencing students to use bicycle and challenges during cycling.

Figure 4.13 shows the factors influencing bicycle use among students. About 51 (56%) of the respondents answer there use bicycle due to cycling is a means of exercise to keep healthy and fit. This is related with mobility characteristic and travel mode preference by using bicycle for a recreational/sport activities whereas the number of respondents who agree with the statement is high. Regular use of bicycles can stimulate and improve the heart, lungs and circulation, thereby reducing the risk of cardiovascular disease. Cycling can also strengthen the heart muscle, lower resting heart rate and reduce blood fat levels. Based on other studies, they agree that bicycles are suitable for health and sustainable means of transportation (Useche et al., 2019). According to Therefore, this factor encourages more students to use bicycles on campus.

Apart from that, 19 (20.9%) number of respondents who answered using bicycle is affordable. Bicycles are one of the most economical transportations. This is due to the cycling can saves money and cheap mode of transport. It allows low-income people to access their workplaces and make social or recreational trips in an effective and affordable manner (Majumdar & Mitra, 2018). There are about 18 (20%) of the respondents use bicycle due to bicycle is an environment friendly.

This is because riding a bicycle uses minimal fossil fuel and is a pollution-free mode of transport. Cycling can also reduce the need to build, service and dispose of cars. Also, riding a bike saves on roadways, thus providing opportunities for less concrete and more plant life on campus. A bicycle is measured to be an environment-friendly and fuel-conserving mode of transport (Roy et al., 2019). Mostly students are aware about the important of using bicycle for environment. This can contribute to sustainable transportation. The rest of the respondents use bicycle to reduce congestion with a total of 3 (3%) of the respondents.

4.6.2 Main Challenges as a Cyclist

Chart showing percentages for challenges as a cyclist:
- Poor road surface condition: 31.9
- Careless behavior and lack of regards of drivers for cyclist: 18.7
- Negative or poor image of the community for cyclist: 0
- Bad weather condition: 49.5
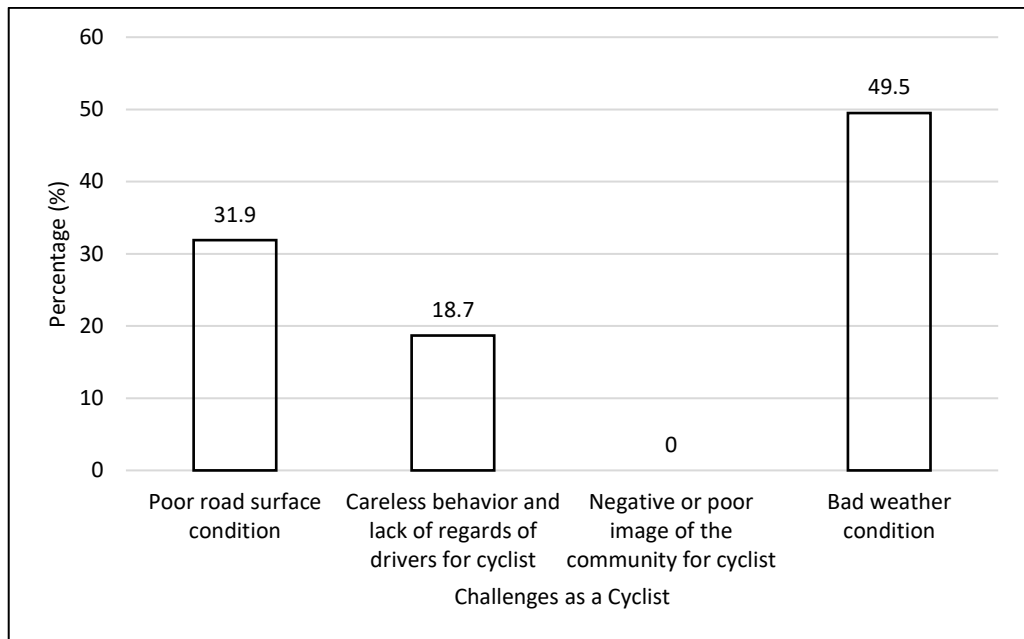
Figure 4.14: Main Challenges as a Cyclist

Another question that has been asked in the questionnaire was the challenges or problems experienced by cyclist when using bicycle in UMS. Figure 4.13 shows that majority of the students, which at 45 (50%) of the respondents agreed that bad weather condition was the main challenges when using bicycle. Bad weather is another barrier that prevents people from cycling (Adell & Hiselius, 2021). Bicycle users at Universiti Malaysia Sabah experience a variety of challenges, including heavy rain and hot weather.

Furthermore, the lack of dedicated routes for bicycle riders on campus will make it difficult for them to utilise bicycles during adverse weather. This situation will expose them in danger and may result in an accident due to wet road conditions during rain. According to (Jalalkamali et al., 2012), the majority of students at UITM Shah Alam believe that the geography of the university, as well as the hot humid weather of Malaysia, are issues that must be overcome in order to improve the cycling condition and encourage students to use bicycle more frequently.

This was followed by poor road surface condition, which represents 29 (32%) of the respondents. One of the difficulties that cyclists experience is poor road surface conditions. There are numerous holes or obstacles, such as tree branches and large rocks, that might cause harm to the tyres or the bicycle itself. The findings also shown 17 (19%) of the respondent agreed that the careless behaviour and lack of regards of drivers for cyclist also contributed to the student's challenges when using bicycle. This is identical with the findings of (Timpabi et al., 2021)'s study in Accra, which identified a lack of safety as a major barrier for cyclists.

4.6.3 Bicycle User Motivation for Cycling

To explore the diversification of the things that motivated individual's to use bicycle, these questionnaire surveys are constructed in Likert-scale format to observe the things that motivated that individual using bicycle in daily activities consist of five primary statement which are travelling this distance on a bicycle takes less time than with other means of transport, for health and fitness, I want to save money, cycling make me happy, and I care about the environment.

As shown in Figure 4.15, about 14 (15%) and 15 (17%) respondents strongly disagreed and disagreed in travelling this distance on a bicycle takes less time that with other means of transport. Whereas the respondents who selected neutral are 35 (38%) in amount, and the remaining respondents are strongly agreed and agreed with the amount of 5 (6%) and 14 (15%), respectively. Majority from this statement, respondents neither agree nor disagree, most of them answered neutral.
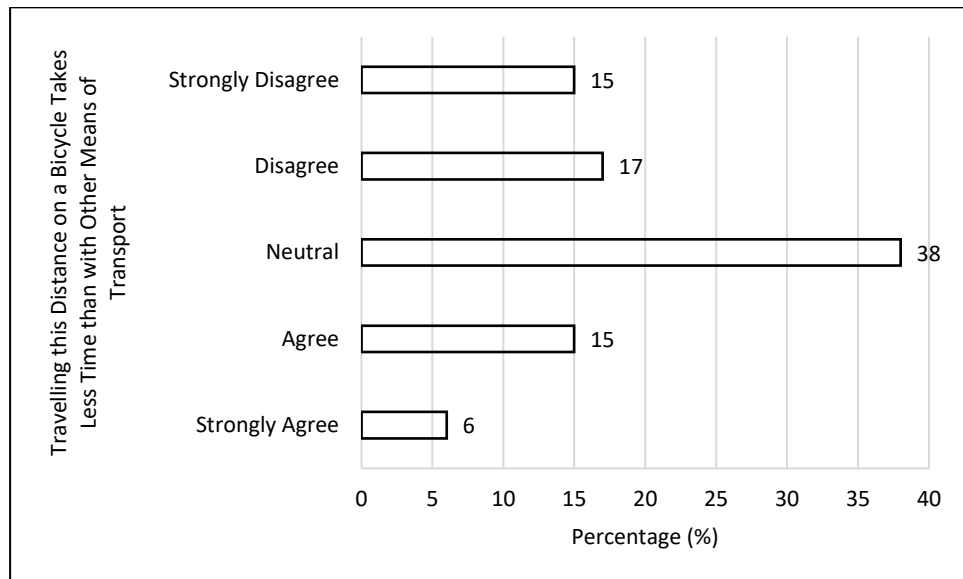
Figure 4.15 : Bicycle User Motivation for Cycling through Travelling this Distance on a Bicycle Takes Less Time than with Other Means of Transport

In terms of motivation for cycling due to for health and fitness, the obtained data are provided in Figure 4.16, where 5 respondents (6%) strongly disagreed with cycling due to health and fitness and there no respondents answered disagree. About 3 (3%) of the respondents are neutral with the statement, and the rest of the respondents voted agreed and strongly agreed with an amount of 17 (19%) and 57 (63%), respectively. From this statement, it can be concluded that health and fitness factors encourage cyclists to use bicycles on campus.

Figure 4.16 : Bicycle User Motivation for Cycling through Health and Fitness
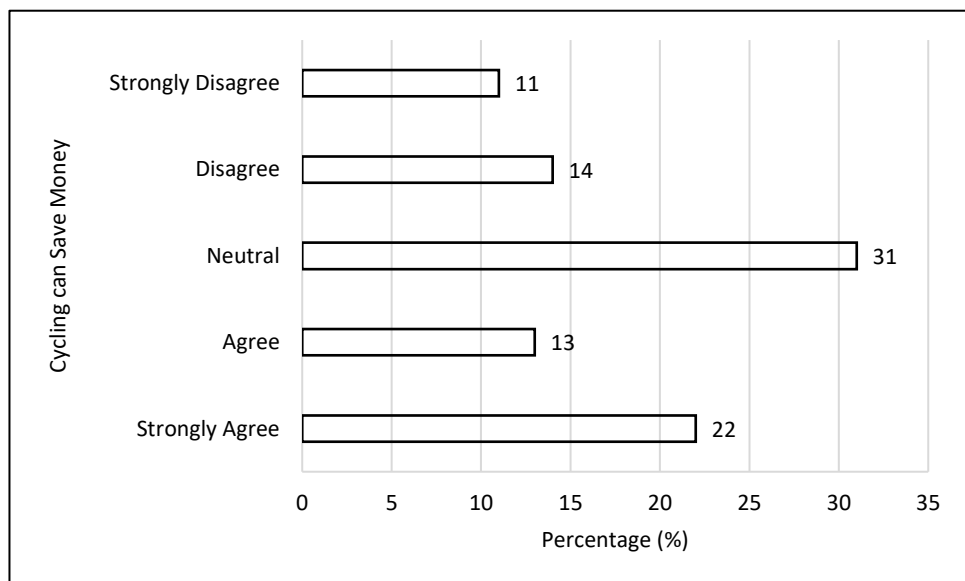
Figure 4.17 : Bicycle User Motivation for Cycling through Cycling can Save Money

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The respondents are asked about their motivation to use bicycle due to want to save money. As shown in Figure 4.17, the number of respondents who are strongly disagreed with the statement is 10 (11%), followed by 13 (14%) of the respondents have disagreed. About 28 (31%) of the respondents were neutral with the statement, whereas the remaining respondents selected strongly agree and agree with an amount of 20 (22%) and 10 (13%), accordingly. Majority of the responden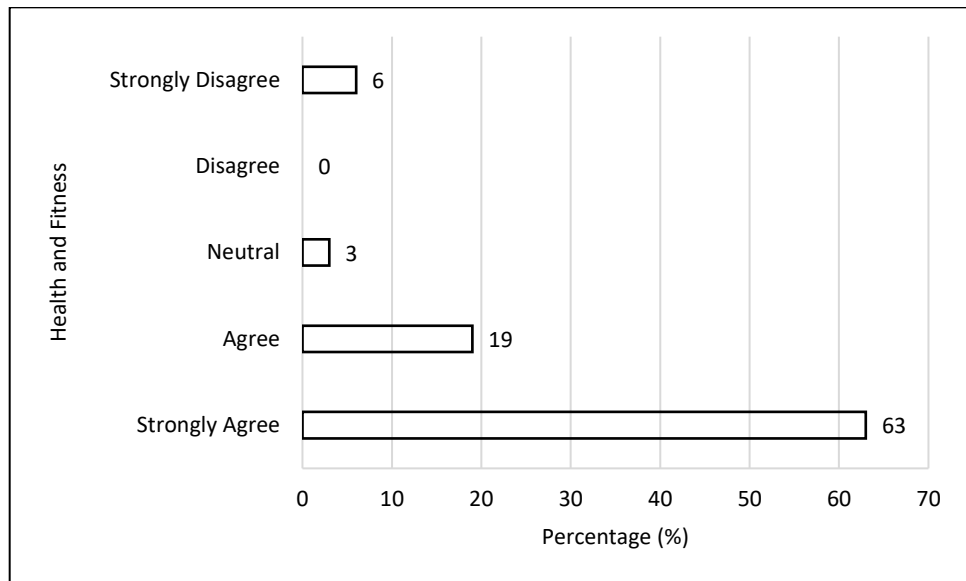ts neither agree nor disagree, most of them answered neutral and second highest respondents are strongly agree with this statement.

Figure 4.18 shows the bicycle user motivation for cycling through cycling can make the respondents happy. From the findings as defined in Figure 4.18, about 3 (3%) and 4 (4%) respondents strongly disagreed and disagreed in by cycling can get respondents happy. Whereas the respondents who selected neutral are 9 (10%) in amount, and the remaining respondents are strongly agreed and agreed with the amount of 42 (46%) and 25 (28%), respectively.
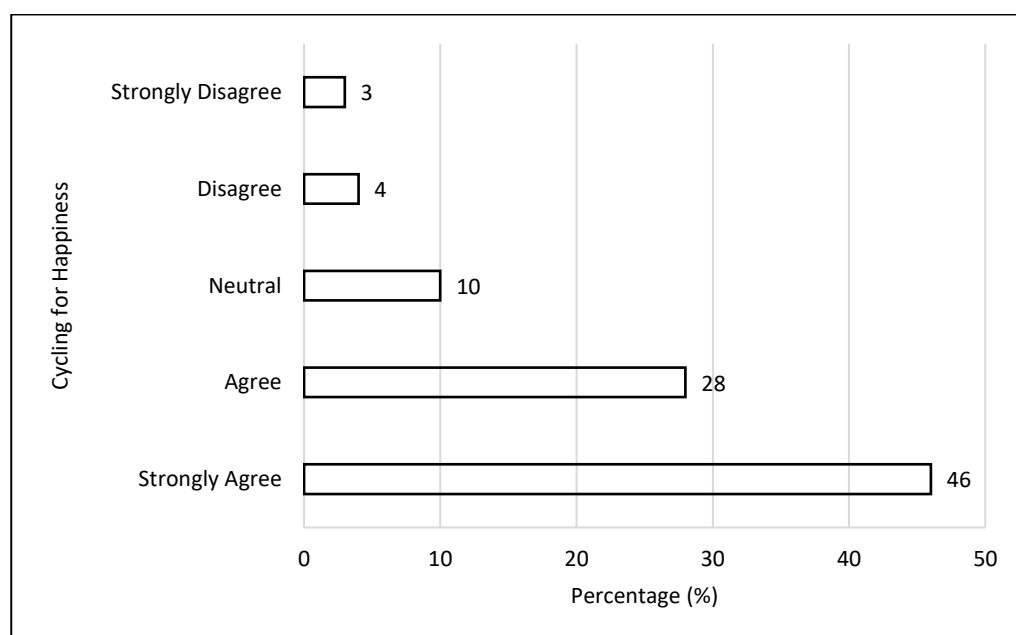
Figure 4.18 : Bicycle User Motivation for Cycling through Cycling for Happiness
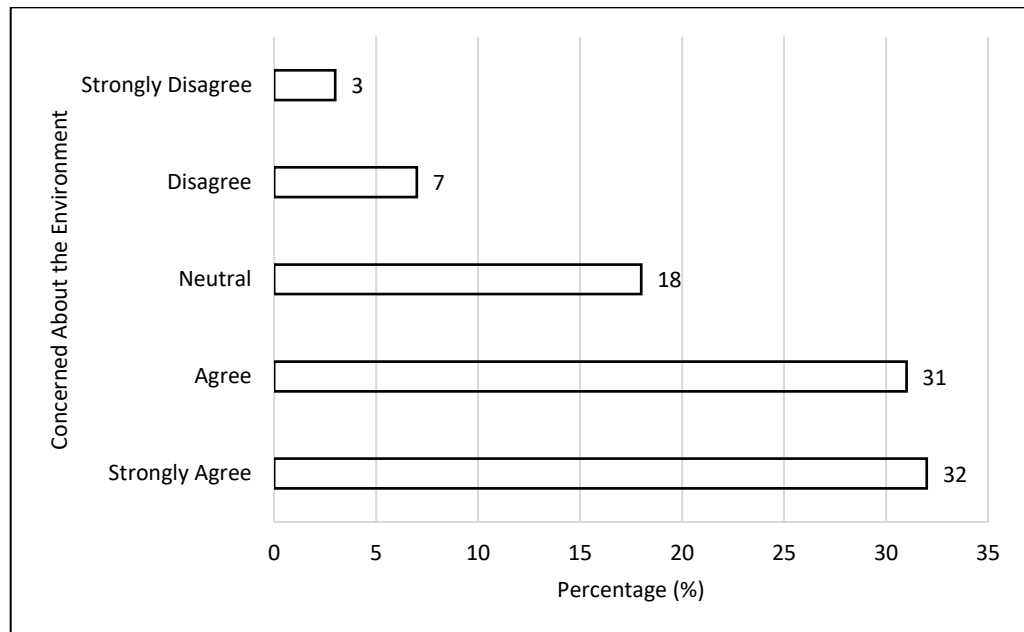
Figure 4.19 : Bicycle User Motivation for Cycling through being Concerned About the Environment

Finally, in terms of bicycle user motivation for cycling through being concerned about the environment as presented in Figure 4.19, it is observed that the number of respondents who are strongly disagreed with the statement is 3 (3%), followed by 6 (7%) of the respondents have disagreed. Whereas the respondents who selected neutral are 16 (18%) in amount, and the remaining respondents are strongly agreed and agreed with the amount of 29 (32%) and 28 (31%), respectively.

4.7 Efficient Ways to Promote Cycling Activities in Campus

Cycling's primary goals are to create environmentally conscious, physically fit, and healthy people, as well as to raise public awareness of sustainable modes of transportation. According to a previous study, university students are one of the appropriate approaches to improve cycling practices due to their small amount of people. However, there will be difficulties in achieving this goal. As a result, studies have been done to propose effective strategies to enhance bicycle use on campus.

Section E in this survey are asked about level of satisfaction to approach cycling activities in campus. These questionnaire surveys are constructed in Likert-scale format to observe level of satisfaction of respondents to approach cycling activities in campus consist of five primary solution which are fostering the use of electric bicycles, provision dedicated lanes for cyclist, provision of adequate and secured parking facilities, creation of public awareness on cycling relevance and the need for giving them priority, and bicycle service centre inside the campus.

This type of question is asked as it links with one of the objectives mentioned in Chapter 1, which is associated with the efficient way to promote cycling activities in campus. As presented in Figure 4.19, about 29 (8%) and 15 (4%) respondents strongly disagreed and disagreed in using bicycle to class. Whereas the respondents who selected neutral are 115 (31%) in amount, and the remaining respondents are strongly agreed and agreed with the amount of 102 (27%) and 116 (31%), respectively.

Figure 4.20: Efficient Ways to Promote Cycling Activities in Campus through Fostering the use of Electric Bicycles

In terms of efficient ways to promote cycling activities in campus through provision dedicated lanes for cyclist, the obtained data are provided in Figure 4.20, where 7 respondents (2%) strongly disagreed with the statement provision dedicated lanes for cyclist can improve cycling activities in campus, followed by 33 (9%) who disagreed. About 80 (21%) of the respondents are neutral with the statement, and the rest of the respondents voted agreed and strongly agreed with an amount of 137 (36%) and 120 (32%), respectively.
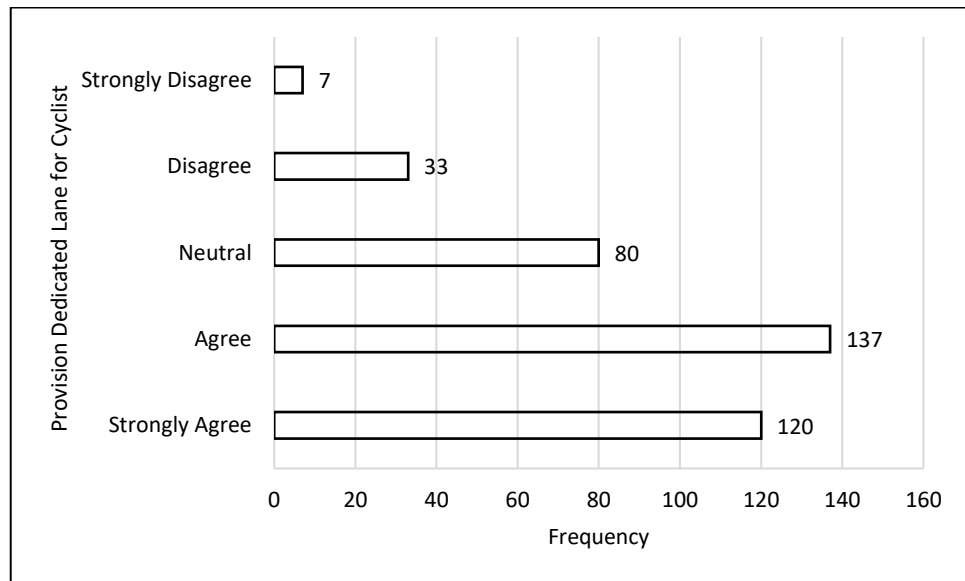
Figure 4.21: Efficient Way to Promote Cycling Activities in Campus through Provision Dedicated Lane for Cyclist
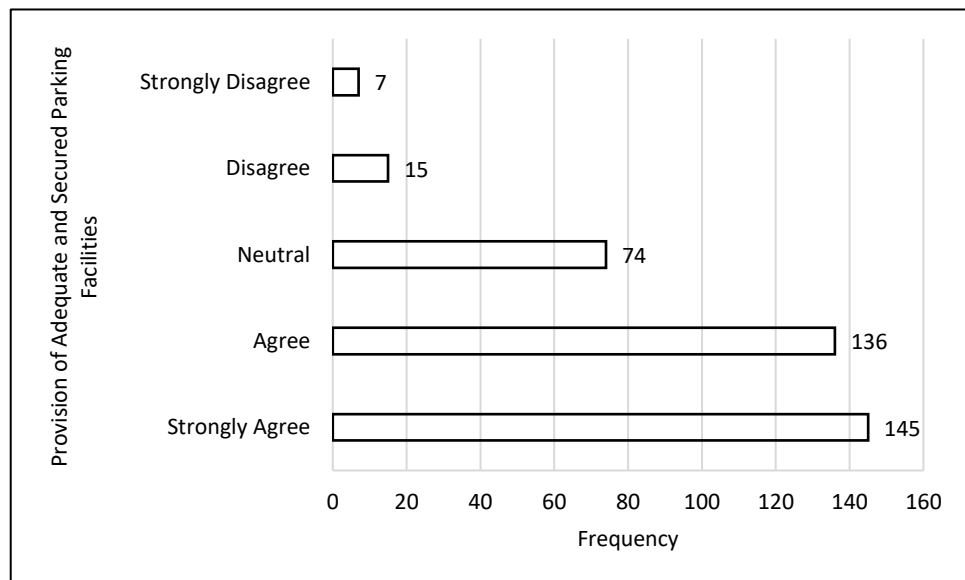
Figure 4.22: Efficient Way to Promote Cycling Activities in Campus through Provision of Adequate and Secured Parking Facilities

The respondents are asked about solutions to encourage bicycle use by providing of adequate and secured parking facilities. As shown in Figure 4.21, the number of respondents who are strongly disagreed with the statement is 7 (2%), followed by 15 (4%) of the respondents have disagreed. About 74 (20%) of the respondents were neutral with the statement, whereas the remaining respondents selected strongly agree and agree with an amount of 145 (38%) and 136 (36%), accordingly. Majority of the respondents strongly agree with this statement.

Figure 4.22 shows the efficient way to promote cycling activities in campus through creation of public awareness on cycling relevance and the need of giving them priority. From the findings as defined in Figure 4.22, about 7 (2%) and 33 (9%) respondents strongly disagreed and disagreed in creation of public awareness on cycling relevance and the need of giving them priority to improve cycling. Whereas the respondents who selected neutral are 80 (21%) in amount, and the remaining respondents are strongly agreed and agreed with the amount of 120 (32%) and 137 (36%), respectively.
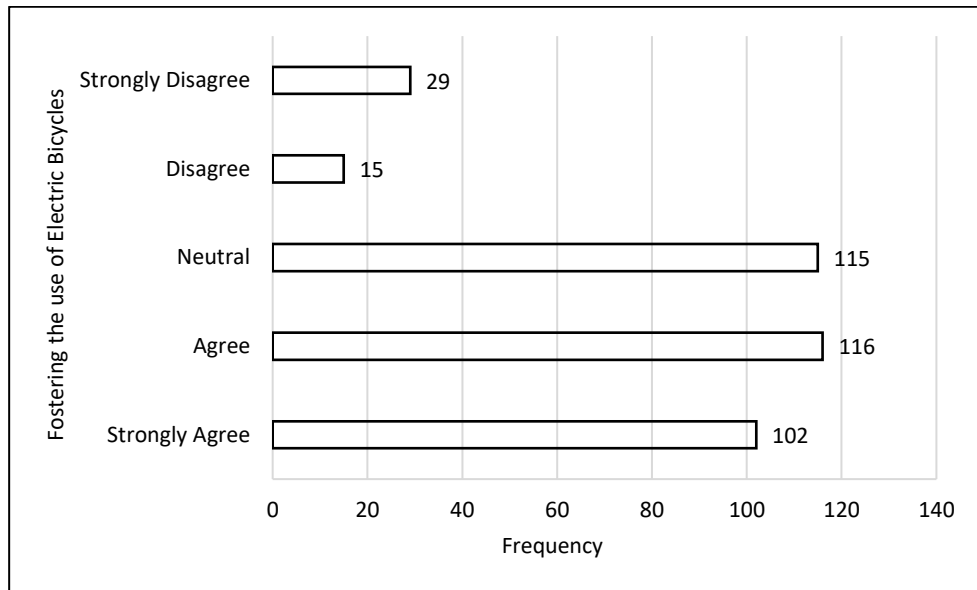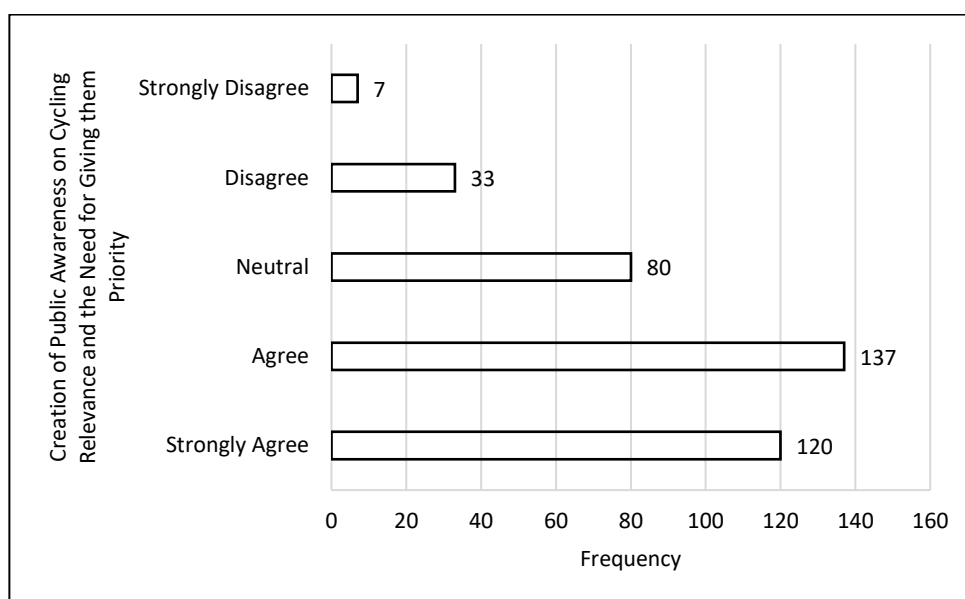

Figure 4.23: Efficient Way to Promote Cycling Activities in Campus through Creation of Public Awareness on Cycling Relevance and the Need for Giving them Priority

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Finally, in terms of to boost bicycle usage through provide bicycle service centre inside the campus as shown in Figure 4.24, it is observed that the number of respondents who are strongly disagreed with the statement is 4 (1%), followed by 3 (1%) of the respondents have disagreed. Whereas the respondents who selected neutral are 80 (21%) in amount, and the remaining respondents are strongly agreed and agreed with the amount of 151 (40%) and 139 (37%), respectively.
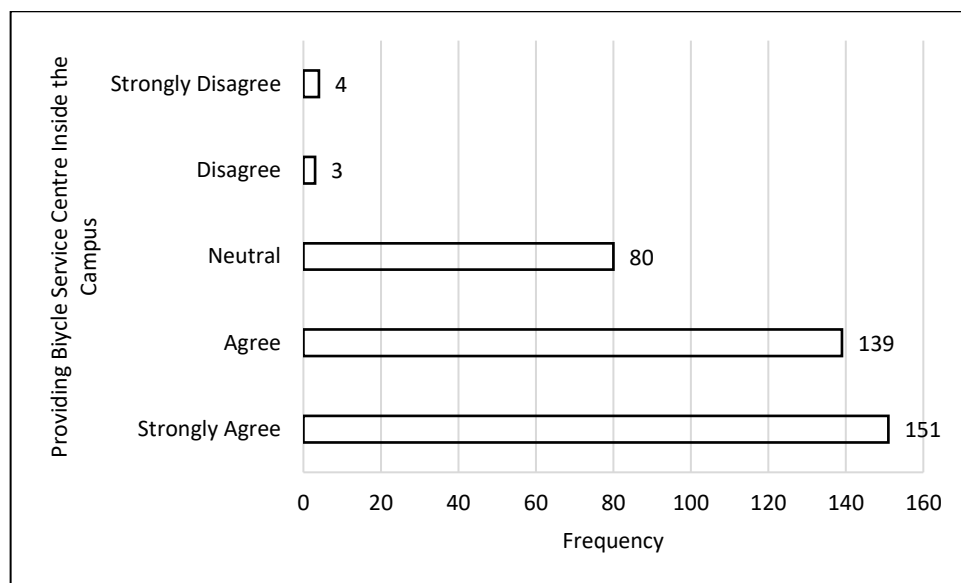
Figure 4.24 : Efficient Way to Promote Cycling Activities in Campus through Providing Biycle Service Centre Inside the Campus

In accordance with the survey results, it can be outlined that majority of the respondents strongly agreed that providing bicycle service centre inside the campus as one of the efficient ways to promote cycling activities. These findings are supported through writing from (Dehghanmongabadi, 2018) where, the article mentioned that provide additional bike services such as repair and accessory shops to improve the quality services of cycling. A student or even a lecturer might form a club or association to manage the campus bicycle service centre. By establishing a bicycle service centre on campus, students will be able to fix their bicycles in the event of damage without having to leave campus. As a result, with this kind of initiative it will encourage more

students to paddle the bicycle to the class and increasing the numbers of use of bicycle among the students.

Figure 4.25: Bike Lockers for Bicycle Parking

Source   : **(Cyclesafe, 2019)**

Providing of adequate and secured parking facilities other solutions to improve cycling activities in campus as the second highest respondents agree with this statement. Adequate and secure parking facilities are essential for cyclist safety. This is to avoid undesirable outcomes such as theft issues. The university can provide bike lockers to bicycle users as shown in Figure 4.25. A bike locker is one of the ideal bike storage choices since it gives a fully enclosed individual place for keeping bikes. Some essential elements of a bike locker should include weather protection, proper attachment of the bicycle, and security against vandalism and interference. Because of the security that provides, bicycle lockers encourage active movement. Cyclists will feel more secure storing their bikes in lockers. When placed outdoors, this provides users with a greater sense of security against theft, vandalism, and the elements. In addition, from the article drafted by (Wilson et al., 2018), adequate bike parking was also identified as a critical component, with institutions providing student parking requirements in a variety of methods, including the usage of bike lockers, cages, and racks.

Creation of public awareness on cycling relevance and the need for giving them priority and by provision dedicated lane for cyclist are another efficient way to promote

cycling activities in campus. These two statements have equal number of respondents answered strongly agreed and agreed. Universities can develop educational programmes to promote safe cycling among students. Cycling culture can be encouraged on campus by establishing bicycle clubs and conducting cycling-related tournaments. Public awareness of the use of bicycles can also be raised by organizing cycling events between students on campus or students from other colleges. As a result from (Nikitas, 2018), bicycling activities have also evolved as a popular means to promote bicycling, with a number of institutions taking part in national bike day. Providing dedicated lanes for cyclists is an important step to encourage more cyclists. Through this method, they feel safer to use the bike to class, other facilities in campus or for recreational purposes. The establishment of this route has the potential to reduce the number of bicycle accidents.

Finally, fostering the use of electric bicycle as an efficient way to promote cycling activities in campus. Past studies have also suggested that the introduction of electric bicycles as a measure encourages cycling (Timpabi et al., 2021). Electric bicycle facilities have been provided on campus, but the quantity of electric bicycles provided is limited and cannot accommodate the number of students on campus. Therefore, the quantity of electric bicycles provided should be sufficient to accommodate the number of students. Electric bicycles should also be placed at each student residential college to facilitate their use. This is since the existing electric bicycle rental centres are located distant from the student residential colleges. This also makes it difficult for students, but it also lowers their desire to ride bicycles on campus. As a result, fostering the use of electric bicycles can be achieved by increasing the quantity of existing electric bicycles and electric bicycles should be provided in every student residential college.

CHAPTER 5

CONCLUSION AND RECOMMENDATIONS

This chapter is the final concluding writing for this study. In this chapter, several conclusions were done based on the result gained from the data collection of statistical analysis and testing in chapter 4. The results were summarized based on the significant findings in accordance with the objective of this study. Limitations and recommendations of this study were also included as to advance future study in related to the topic of this study.

5.1   Conclusions

The aim of this study is to identify factors and impacts of bicycle utilization towards sustainable transportation in UMS. However, there are limitations encountered while performing this study, one of which is that this study is primarily focused on students and the use of bicycles on campus. Nevertheless, the objectives of this study are still achievable. As to summarize this study, several noticeable conclusions were taken into consideration as presented:

1. This study observed there is impact of socio-demographic factors on bicycle usage among the students in campus. Gender and family income affecting the bicycle usage in campus.
2. This study managed to identify factors influencing decision factors for students not cycling which are lack of bicycle skill, prefer to use a faster mode, adverse weather condition, dedicated lanes for cyclist is not provided and the road condition in campus.
3. It was observed that factors that encourage students to ride include using bicycle is affordable, for exercise purpose to keep healthy and fit, environment friendly and to reduce congestion.

4. It was found that among four challenges that faced by cyclist during cycling bad weather condition is the highest challenge, followed by poor road surface condition and careless behaviour and lack of regards of drivers for cyclist.

5. According to measure the satisfaction to approach cycling activities in campus, the respondents were most satisfied by providing bicycle service centre inside the campus as one of the efficient ways to promote cycling activities.

5.2 Limitations

Limitation based on conducting this study have been identified as listed:

1. It was found that this study only focuses on students in Universiti Malaysia Sabah and more focuses on bicycle usage.

2. Additionally, this study was collected respondents data from online questionnaire only.

5.3 Recommendations

By the end of this study, some suggestions were able to be proposed for further study in the near future. These were few recommendations that can be considered as follows:

1. Conduct the future study by focuses on Kota Kinabalu cities with the utilization of bicycle access to as to attained more precise and accurate perception. As for this current study, it comprises all the data collected from Universiti Malaysia Sabah, Kota Kinabalu city only.

2. Future researchers could do studies on various modes of active transportation, such as walking and taking public transportation. Whereas the current study only focuses on the use of bicycles.

3. Questionnaires for future study can be distributed to all communities in UMS because this current study only focuses among students.

4. Methods for collecting respondent data for future research improvement can be done by virtual or face -to -face interviews.

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**Bicycle Utilization In UMS, Influencing Factors and Impacts Towards
Sustainable Transportation**

Instructions

Check (√) the empty boxes.

SECTION A: Demographic Respondent

1. Age

- 18 - 25
- 26 - 35
- 36 - 45
- 46 – 55
- 56 - 65

2. Gender

- Female
- Male

3. Faculty

- FKJ
- FKI
- FSSA
- FPP
- FKSW
- FPEP
- FSMP
- FPSK
- FPT

4. Family Income

- < 1000

- 1000 - 3000
- 3000 - 5000
- > 5000

5. Are you cyclist ?
- Yes
- No

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SECTION B: Factors Influencing Decision Factors for Students Not Cycling

1. What is your reason for not cycling?
   - I prefer a faster mode
   - I can afford other modes
   - Adverse weather conditions
   - There are no dedicated lanes for cyclist
   - Others

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SECTION C: Frequency of Using Bicycle

1. How often do you use bicycle?
- Daily
- More than 3 times a week
- More than 3 times a month
- Others

2. Cycling Distance
- Less than 1km
- 1 - 2 km
- 3 - 4 km
- 4 - 5 km
- 5 - 7 km
- More than 7 km

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Question 3

Tick (/) the answer to describe how often do you cycling to do the essentials work.

Mobility Characteristics	7 days/ week	6 days/ week	5 days/ week	4 days/ week	3 days/ week	2 days/ week	1 day/ week	2 or 3 times/ month	1 time/ month	Never
How often do you go to class by cycling?										
How often do you go for an important matter such goes to library/other facilities in campus by cycling?										
How often do you go for a recreational/leisure by cycling?										

Question 4

Tick (/) the answer to describe your travel mode preference from the range of **1** to **5**

1 = Strongly Disagree, **2** = Disagree, **3** = Neutral, **4** = Agree, **5** = Strongly Agree

Travel Mode Preference	1	2	3	4	5
I normally cycling to class					
I normally cycling to go for an important matter such as goes to library/other facilities in campus					
I normally cycling to go for a recreational/sports					

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SECTION D: Student Opinion on the Potential Of Bicycle as Mode Of Transportation

1. Why do you choose bicycles over other modes?
- It is affordable
- It is the only available means of transport
- It is a means of exercise to keep me healthy and fit
- It does not pollute the environment
- Others

2. What are your challenges as a cyclist?
- Poor road surface condition
- Careless behavior and lack of regards of drivers for cyclist
- Negative or poor image of the community for cyclist
- Bad weather condition
- Others

Question 3

Tick (/) the answer to describe your motivation to cycling from the range of **1** to **5**

1 = Strongly Disagree, **2** = Disagree, **3** = Neutral, **4** = Agree, **5** = Strongly Agree

Motivation to Cycling	1	2	3	4	5
Travelling this distance on a bicycle takes less time than with other means of transport					
For health and fitness					
I want to save money (I do not have to pay for a fuel)					
Cycling makes me happy					
I care about the environment					

Question 4

Tick (/) the answer to describe your barriers using usual route to class and assess how traversable it is by bicycle? from the range of **1** to **5**

1 = Strongly Disagree, **2** = Disagree, **3** = Neutral, **4** = Agree, **5** = Strongly Agree

Motivation to Cycling	1	2	3	4	5
Bicycle road infrastructure is sufficient to reach destinations safely.					
Faculty infrastructure is sufficient to safely park the bicycle.					
Car drivers are mindful for cyclists					
The route is convenient for cycling.					
It would feel safe to walk down the street with a bicycle.					
The distance is too long to travel on a bicycle.					

SECTION E: Level of Satisfaction to Improve Cycling Activities in Campus

Please rate the following perception to improve cycling activities in campus

1 = Strongly Disagree, **2** = Disagree, **3** = Neutral, **4** = Agree, **5** = Strongly Agree

Improvement	1	2	3	4	5
Provision of electric bicycles (faster bicycles)					
Provision dedicated lanes for cyclists					
Provision of adequate and secured parking facilities					
Creation of public awareness on cycling relevance and the need for giving them priority					
Bicycle service centre inside the campus area					

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