

# Winter cycling in Eskilstuna municipality: motivators and barriers experienced by commuters

Wenjing Wang

Supervisor: Karin Edberg  
Examiner: Thomas Keating

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## Abstract

Many cities focus on cycling due to the multiple advantages including individual, societal, and economic advantages. Eskilstuna municipality in Sweden is one of the cases that aim to develop cycling, but the question is if the municipality has managed in developing winter cycling because of the special winter weather characteristics, cold, windy, snowy, and dark. This study focuses on the experiences of commuters when commuting in winter in Eskilstuna municipality. The goal of this study is to identify and analyze the motivators and barriers that influence winter cycle commuting, and the research result can contribute to improving the cycling rate in Eskilstuna municipality. The researcher examined the issues in Eskilstuna municipality through qualitative analysis from the focus group interview and interview and document analysis. Factors such as prioritized cycle lanes, the construction of new cycle lanes, preference for wellbeing, social influence (such as cycling culture and cycle-friendly atmosphere), the good function of the cycle (including the cycle, the tire, the cycle lights), good private economy situation were identified as motivators to cycling to work in winter. By contrast, issues that are related to lack of infrastructure maintenance and lack of cycle lanes, the darkness, the snow, limitation in practices of the policy, and cleanness as a social norm were identified as barriers. However, some factors were identified as irrelevant factors such as low temperature, showing room, parking space, and scenery.

Keywords: barrier, commuting, cycle, motivator, winter

# 1. Introduction

## 1.1 Introduction

Nowadays, the topic of cycling draws a lot of attention. Various studies have shown the importance of cycling and the positive effects that cycling brings to individuals and society as an alternative transportation mode. From the individual perspective, cycling is recommended as a potentially powerful way to meet the levels of physical activity (Oja et al., 2011; Ayres, 2014). From a societal perspective, as is said by Heinen and Handy (2012), cycling is beneficial in many aspects, such as protecting environments, reducing greenhouse gases, and controlling climate change. Cycling is an emission-free transportation (Gotschi, 2011), so cycling contributes to reducing the use of fossil fuel (Higgins, 2005). From an economic aspect, cycling is a great way to reduce economic costs. As is said above, cycle commuting is a great way to increase physical activity. Health issues and obesity that are caused by physical inactivity do not only cause a huge cost to individuals but also lead to costs to the society (Teschke et al., 2012).

It is surprising that despite the benefits that are mentioned above, cycling is still not growing (Rosen, Cox and Horton, 2007). According to Transport Analysis (2015), when compared with mid 1900s, the cycling use of Swedish people has declined from 2.8 million to 1.9 million trips per day. At the same time, the population has increased 8% than 1990s, which means that the number of cycle trips per capita has decreased by 38 percent. Many municipalities target to develop cycling because of the benefits. One example of those municipalities is the Eskilstuna municipality in the Sörmland region in Sweden. The researcher is in collaboration with the Sörmland region's FASIS project. The FASIS (Fysisk Aktivitet i Samhällsplanering i Sörmland) means Physical Activity in Community Planning in Sörmland. Eskilstuna municipality aims to develop cycling, but the cycling growth is not satisfactory because the number of cyclists at the center entrances has decreased by 25%, from 20,000 cyclists to 14,500 cyclists since 1980 (Eskilstuna, 2013b).

The researcher focused this paper on winter cycle commuting in Eskilstuna municipality. The focuses are "commuting" and "winter". The reason is that if the cycle "commuting" improved, the general proportion of cycling will be increased. First, when compared with cycling for other purposes, such as cycling for recreation, cycling for commuting has more frequency because cycle commuting is related to daily activity. If cycle commuting is improved, then the total rate of cycling will be increased. Additionally, cycling commuting is beneficial in many aspects. Cycling as a transport for commuters has the benefits of cycling, and it is even more important because of the frequency and regularity of commuting. Cycle commuting can be more beneficial to reducing congestion than cycling for other purposes (Heinen, van Wee and Maat, 2010). Second, the researcher decided to investigate cycle commuting in "winter", because winter cycling drops rapidly when compared to summer cycling. In the winter days, the number of cyclists in winter is one-third of the number of cyclists in summer (Öberg et al., 1996, cited in Eskilstuna, 2013b, p.6). Hence, it seems that if the winter cycling rate can be improved, then it would contribute to general cycling on a large scale. According to Timeanddate (2022), during the coldest month, February, the lowest temperature of Eskilstuna is -7 °C and the average wind speed is 12 km/h. The cold temperature, slippery roads, the darkness, and the wind can all create problems for cyclists in winter. When compared to summer cycling, less favorable weather conditions, such as low temperature, strong winds, and precipitation can lead to a decrease in winter cycling frequency (Emmerson et al., 1998; Ljungberg, 1987, cited in Bergström and Magnusson, 2003, p.650). In winter, the need for travel is mainly met by a car, and only a minor proportion is met by public transport (Eskilstuna, 2013b). Thus, it would be interesting to know if the winter cycling rate drops because Eskilstuna

municipality has this traditional Nordic winter weather, cold weather, darkness, snow, and wind, and how this special weather characteristic affects winter cycle commuting.

Besides these challenges, there are benefits of cycling as discussed above, such as increased physical activity, reducing greenhouse gases, environmental protection, and economic benefits. People choose to cycle because cycling is cheap, convenient, has good exercise, and is an enjoyable transportation (Unwin, 1995). However, the truth is that there are some commuters who do not cycle in winter. Thus, it would be important to analyze the reasons why cyclists don't cycle in winter with the benefits that winter cycling commuting has, and what are the barriers that the cyclists met in terms of winter cycle commuting. If motivators can be figured out, Eskilstuna municipality can develop winter cycling commuting referring to these motivators. The barriers can be avoided and improved in the planning for winter cycle commuting. Identifying and analyzing the motivators and barriers of winter cycle commuting can contribute to offering suggestions to Eskilstuna municipality and even other cities that are also in the cold areas of the world.

Qualitative analysis was used in this study because this research is about knowing the experiences of cyclists in Eskilstuna municipality regarding winter cycling. Qualitative research is useful for providing contextual and personal explanations, and it can generate new insights into people's experiences (Hay and Cope, 2021). To get the material, the researcher used document analysis and at the same time two types of interviews were carried out, which were "interview", and "focus group interview". Besides, the researcher used the concepts in Cox (2019) as the theoretical framework to explain the factors that can affect cycling behavior.

Finally, this study aims to identify and analyze the motivators and barriers of winter cycling for cycle commuters in Eskilstuna municipality. The study investigates citizens' experiences of winter cycle commuting, and the reasons why or why not they cycle to work in winter. By identifying and analyzing the motivators and barriers, this study can offer suggestions to the Eskilstuna municipality to develop and increase winter cycle commuting in the future.

The research questions are:

1. What influences winter cycle commuting in Eskilstuna municipality?  
What are the motivators and barriers to cycling to work in winter in Eskilstuna?
2. How has the Eskilstuna municipality planned for winter cycling?  
How can winter cycling in Eskilstuna municipality be increased in the future?

## 1.2 Thesis Structure

This study is structured into five chapters. Chapter 1 constitutes the introduction and background of the case study and introduces the research problems, aim, and research questions. Chapter 2 states theoretical concepts and previous studies related to winter cycle commuting for this study. Chapter 3 demonstrates the methods and methodologies that were used in this study. Chapter 4 explores the findings of the study and discusses the results which are then analyzed in the context of the theoretical framework that is mentioned in Chapter 2. Chapter 5 concludes the study, makes recommendations for future research and proposes suggestions in terms of winter cycle planning for Eskilstuna municipality.



## 2. Literature Review

This section presents the arguments of previous studies and ideas from previous research about the factors that are related to cycling to work that can affect winter cycle commuting. The theoretical concepts in Cox (2019) are used in this study, and the ideas from previous studies are exhibited in combination with the concepts of Cox (2019). These theoretical concepts and the previous studies were used to analyze the motivators and the barriers that were identified during the interviews.

As is stated in Cox (2019), cycling is considered both the physical act of riding a bike and part of a network of objects and activities which make the act possible. The concepts from Cox (2019) are used to explain the factors that affect cycle behavior from a sociological perspective. According to Cox (2019), sociologies of cycling connect individuals and their riding to the broader contexts of societies. We need to involve sociological analysis to focus on cycling in all its countless varieties (Cox, 2019, p.11). To be more concise, cycling is a performance that can be undertaken alone or with others. No matter how it is performed, alone or with others, it is always connected with other persons or spaces. Cycling is an activity that requires not only a machine and rider but also places where cyclists ride. Hence, even while cycling performance is carried out alone, it is a social activity (Cox, 2019, p.12).

Cox (2019, p.27) introduces the definition of *Vélobility*, which emphasizes on observing the relationship between the various variables required to maintain cycling mobility. When combining the cycle-rider with the spaces where the combination is performed, it can be found that the environments and spaces of cycling are important to those performances. Moreover, *Vélobility* is related to the aggregation of rider, machine, space, and the systematic relations of society, economy, and policy where the relations are performed (Cox, 2019, p.27). Therefore, this section discusses the factors that affect cycling behavior by using *Vélobility* as a theoretical concept from the perspective of rider, machine, space, and the systematic relations of society, economy, and policy according to Cox (2019). Besides, other previous research studies will be discussed under each factor.

### 2.1 The Rider

Cox (2019, p.133) expresses that in cycling terms, the rider is related to the rational rider and ritual rider. The rational rider is for practical means of travel. Ritual behaviors are, on the other hand, performances that are intended to convey something beyond their actions. The ritual rider must transform the mundane journey into a ritual event to make sense. For example, considering cycling as a practice of sustainability. Another example that Cox (2019, p.134) gives is that some riders consider travel to work as an externality of the wage labor but not paid by the employer, which is a cost for the riders. This can explain why some cyclists are reluctant to cycle to work because when cycling to work it becomes associated with an extension of the workplace and duties of labor. Under this condition, the riders are regarded as rational riders, because they are considering the practical issues, such as the wage, the workplace, and the labor. However, some riders consider travel to work as a means for self-advancement, as a body-training regime for health fitness (Cox, 2019, p.134). In this way, the cycle commute is not regarded as a cost, but a gain of some personal kind. Hereby, by conveying the meaning of body training to cycling to work, the performance of the journey is moved into a ritual behavior.

To the riders, previous studies mentioned the health benefits that cycling brings to people. There are health benefits of cycling, such as increasing physical activity, and improving health, both physical health and mental health. To begin with, cycling is a good way to increase physical activity. Cycling plays an important role in boosting physical activity levels, and cycling is appropriate for people of all ages, gender, and backgrounds (Tin Tin et al., 2012). The physical activity that is performed by cycle commuters is considered moderate physical

activity (Donaire-Gonzalez et al., 2015). Moreover, physical activity can contribute to health benefits and reduce health problems. According to a study about the impacts of the potential increase in cycle commuting in Stockholm, the increased amount of physical activity was estimated to have significant health benefits (Sommar et al., 2021). The considerable distance of cycle commuting suggests that it has good benefits on a variety of health outcomes, such as physical fitness, maximal capacity for exercises, reduction in weight, as well as increasing nutritional absorption through food (Schantz, Salier Eriksson and Rosdahl, 2020). Heinen, van Wee and Maat (2010) mention that cycle commuting is beneficial to public health by reducing the proportion of overweight. According to the study by Oja et al (2011), commuting by bicycle for a few kilometers on a single trip can significantly improve the cardiorespiratory performance of low-fitness adults. The risk of cancer is also reduced with the increase in cycling (Oja et al., 2011). In addition, ample health benefits were also estimated to result from less exposure to air pollution (Sommar et al., 2021). Besides physical health, cycle commuting is also beneficial to mental health. Regular activity at least once a week is related to reducing sleep disorders (Sherrill et al. 1998, cited in Prati, 2018, p.369).

## 2.2 The Machine

The cycle as a machine can affect the cycling behavior. Cox (2019) demonstrates that the technologies of the cycle create possibilities and determine the types of cycling. For the same physical effort, the different designs can favor different speeds of travel (Cox, 2019, p.69). Each cycle is assembled with a range of components, such as cycle lights, brakes, and cycle tires. Thus, the function of these components may influence the riding and the cyclists. To begin with, the cycle lights are important to protect cyclists. According to the study by Madsen et al. (2013), the use of permanent running cycle lights that are based upon the electro-dynamic induction principle will improve the traffic safety of the cyclists significantly because of the improvement of visibility. Besides, the performance of the cycle brakes is crucial to protect the cyclists' safety. The variation of the front and the rear brake force distribution should be considered to enhance the safety of the cyclists (Lie and Sung, 2010). Lie and Sung (2010) also state that it is important that the exact brake curve must be as close as possible to the road condition. In terms of the tires, the measured rolling resistance of the cycles is related to the subjective feeling of the comfort of cycling (Fenre and Klein-Paste, 2021a). And the rolling resistance is significantly affected by the properties of the tires (Fenre and Klein-Paste, 2021b).

## 2.3 Space

Cycling practices are composed of the spaces that are consumed and created when using the machine. The environments are associated with physical locations: the roads, paths, tracks, and terrains where cycling takes place (Cox, 2019, p.81). Cox (2019) uses route and ride to explain the cycling process. Routes and rides explain cycling space from a different perspective. According to the author, routes mean the distance from A to B. And the route between A and B is more or less direct. However, a ride encompasses more than just a route because rides are further shaped by the space around where the riders see and feel, such as environmental factors, weather, and temperature (Cox, 2019, p.84).

### 2.3.1 Scenery

The everyday ride transforms into an environmental performance of the body, the place where sensory can regulate the individual mind and the surroundings (Cox, 2019, p.131). Hence, other senses' input, such as the sound, and the smell in response to the changes terrain or surface, expands the abundance of the experience of a ride (Cox, 2019, p.84). Thus, the scenery is considered an element that can influence cycling. According to previous research, the scenery

is one of the most important motivations that can trigger cyclists' tendency of cycling (Winters et al., 2011). If the settings along the cycling routes are attractive, it is crucial for cyclists, such as greenery and place-making (Hull and O'Holleran, 2014).

### **2.3.2 Infrastructure**

Besides the scenery, the infrastructure that is along the route is also one of the elements that make up the space. To start, the roads, paths, and tracks are talked about by other authors. The roads, paths, and tracks where cyclists are traveling belong to infrastructure. If there are more cycling infrastructures, the rate of bicycle commuting will increase (Dill and Carr, 2003). People may be discouraged from cycling if a route lacks bicycle facilities (Heinen, van Wee and Maat, 2010). Thus, cycling behavior is related to the infrastructure from the following aspects. First, a good quality bicycle lane can attract cyclists. High-quality bicycle lanes secure cyclists' safety when cycling, and they can also reduce the safety problems that are caused by some environmental factors, such as harsh weather. If the bicycle lane is more comfortable, more cyclists will be attracted. For example, as is said in Hull and O'Holleran (2014), the materials used by the Dutch were more resilient and comfortable to cycle on. Providing bicycle lanes can boost the number of women who ride bicycles. The infrastructure of cycle paths can positively affect women's cycling (Higuera-Mendieta *et al.*, 2021). Because women express more discomfort in mixed traffic, to ensure the comfort of female cyclists, cycling infrastructure, such as cycling paths that are separated from other road traffic should be constructed (Prati, 2018). The second important infrastructure that is related to cycling is the continuity of bicycle infrastructures. For example, it is significant to have separate lanes or marked sections on the roads where a bicycle facility presents throughout the route. Bollards/vegetation can provide a visual deterrent from driving and parking in bicycle lanes (Hull and O'Holleran, 2014). Cyclists prefer continuous bicycle facilities to the ones that are interrupted (Stinson and Bhat, 2003). Without a doubt, a wide cycle path with few junctions and discontinuities, as well as a precise route layout with markings and good signage that is mixed with visibility of both the cyclists and cars functions well in appealing to new cyclists (Hull and O'Holleran, 2014).

Moreover, besides the infrastructures, other studies mention that the facilities for cyclists such as showering and changing room, and parking places are also important to cyclists. Showering and changing room facilities, and cycle parking places can make cycle commuting more feasible (Heinen, Maat and van Wee, 2013). Parking was regarded as an important facility by previous studies because of the convenience that parking brings to the commuters. As claimed by Noland and Kunreuther (1995), parking facilities at the workplace plays a significant role in developing cycling commuting.

### **2.3.3 Low Temperature**

Temperature is a significant element that influences the likelihood of cycling commuting according to Flynn *et al.* (2012). To begin with, the low temperature can affect people's tendency of cycling negatively, and when the temperature is below 15 °C, the number of people who cycle decreases (Saneinejad, Roorda and Kennedy, 2012). In some cases, low temperature is considered a limitation of cycle use during the winter months (Spencer *et al.*, 2013). It has been proved by previous studies that the tendency of using cycling as a mode of transportation to work is lowest during the winter season in the areas where the climate is cold (Stinson and Bhat, 2004). However, other studies show that temperature is one of the most important factors that decrease the number of cyclists who cycle to work in summer but not in winter (Bergström and Magnusson, 2003).

### **2.3.4 Darkness**

When discussing winter cycle commuting, it is important to discuss the experiences of cyclists, which are determined by the environment through which he or she is cycling. The darkness is a problem that hinders people from cycling. Climate conditions, as well as the time of year and day, such as lightness and darkness, have a significant impact on cycling experience (Rosen, Cox and Horton, 2007). When it comes to the most critical aspects that influence cycle commuting motivation, darkness is a notable component (Bergström and Magnusson, 2003; Nankervis, 1999). Generally, a bad experience of cycling is connected with darkness (Gatersleben and Appleton, 2007). The combination of darkness and precipitation can limit cycle commuting (Spencer *et al.*, 2013). To deal with the problems that is brought by darkness, good light conditions are crucial to cycling. The study of light conditions demonstrates that lighting infrastructure along the cycling path is beneficial to cyclists (Spencer *et al.*, 2013). What's more, in darker cycle lanes high-quality illumination is necessary to be provided (Hull and O'Holleran, 2014).

### **2.3.5 Wind**

Wind can produce challenges for cyclists. Wind speed can affect cyclists negatively, and wind can deter the cycle speed and comfortableness. Increased wind speed limits cycle commuting (Flynn *et al.*, 2012). When compared with pedestrians, wind speed negatively influences cyclists about twice as much (Saneinejad, Roorda and Kennedy, 2012). Even though the wind is sometimes seen as a minor element that can limit cycling, however, when compounded with other factors, such as precipitation, it can become a more deterrent factor that prohibits cycle commuting (Spencer *et al.*, 2013).

### **2.3.6 Snow**

Snow creates challenges for cyclists when cycling to work. Snow can cause risks to cyclists in various ways because of the slippery road caused by snow and ice, and the uncomfortableness of irregular surfaces if the road maintenance doesn't clean the snow in time. Because of the slippery road conditions caused by the snow, cycle trip percentage can decline dramatically during the winter months in many of the cold areas of the world (Fenre and Klein-Paste, 2021). There are mainly three reasons why snow can prevent cycling in winter. First, it is common that the road surface to be covered by snow and ice. The existence of ice and snow results in reduced friction, leading to a slippery road surface (Fenre and Klein-Paste, 2021). According to the study about characteristics of commuters' single-bicycle crashes, a slippery road surface in winter resulting from the snow can cause single-bicycle crashes (Utriainen, 2020). Second, snow and icy roads make it uncomfortable for cyclists to ride on, which leads to the result that cyclists avoid roads with irregular surfaces because those surfaces can affect the cycling experience negatively (Bíl *et al.*, 2015, cited in Fenre and Klein-Paste, 2021). Snow depth can affect cycle commuting negatively, and that can explain why people do not cycle in the winter months (Flynn *et al.*, 2012). Third, snow and ice on the roads is the factor that can create the possibility of bumps and ruts (Fenre and Klein-Paste, 2021).

## **2.4 Society**

Cycling can be beneficial to society in several ways. To begin with, cycling is a great way to create social cohesion. Cycling is lower cost transportation when comparing to other transportation mode, and by encouraging cycling, the disparities between advantaged groups and disadvantaged groups can be reduced. Thus, it can narrow the differences in job access between non-drivers and drivers (Litman, 2021), which is a great way to increase social cohesion. Moreover, human health can be improved by changing motorized transportation to

cycle commuting. The increase of active transport, such as cycling, could contribute to meeting the targets of controlling greenhouse-gas emissions (Woodcock *et al.*, 2007). Cycle commuting can make a greater contribution to decreasing traffic congestion than cycling for other purposes, such as cycling for sporting and cycling for leisure (Heinen, van Wee and Maat, 2010). Additionally, cycle commuting can facilitate in improving the environment and economic benefits which include the reduction of traffic congestion, air pollution, noise pollution, as well as the consumption fossil fuel (de Nazelle *et al.*, 2011; Macmillan *et al.*, 2014; Xia *et al.*, 2013, cited in Prati, 2018, p.369). When related back to health, climate change, physical inactivity, and urban air pollution can also cause adverse health effects (Woodcock *et al.*, 2007).

In terms of the factors related to society that influence cycling, the researcher discusses these factors from three dimensions, social norm, culture, and cycle-friendly atmosphere. The term “culture” refers to a certain group of people’s way of life, particularly their general customs at a particular time (Cambridge Dictionary), so cycling culture means treating cycling as a general custom. However, as an informal social control, a social norm is controlled and influenced by a society or a smaller group of people (Heinen, van Wee and Maat, 2010). When talking about “general customs” in the definition of “culture” and “a society” in defining “social norm”, it seems that culture and social norm are similar. However, considering from another perspective, culture and a social norm can also be different because when compared with culture, a social norm emphasizes relatively smaller groups of people. By contrast, culture is related to the general customs, meaning that it is related to relatively larger groups of people. Last, atmosphere refers to the character, feeling, or mood of a place or situation (Cambridge Dictionary). Thus, a cycle-friendly atmosphere can be a situation that is created to make people have the mood of cycling.

#### **2.4.1 Culture**

Williams (1989) states that culture is ordinary, and every human society has its own shape, its own purposes, and its own meanings. The growing society is made and remade by every individual mind. Besides, the making of the mind is the slow learning of shapes, purposes, and meaning. For example, the human mind can be made by communication, and observation (Williams, 1989). Thus, the individual mind of cycling can be affected by the communication of cycling and the observation of other people cycling. The cycling culture of a location can affect cyclists’ decision to cycle. Pucher, Komanoff and Schimek (1999) state that culture does affect cycling. Their study shows that cycling is considered a common activity in the Netherlands and Denmark for young and old, rich, and poor people. By contrast, in America, cycling is only for recreation, and the cycle commuters are men.

#### **2.4.2 Social Norm**

The meaning of the elective choice to ride is related to the context and social norm around cycling in any given location (Cox, 2019). According to the study of Heinen, van Wee and Maat (2010) social norms play an important role in affecting cycling. The research of Heinen and Handy (2012) shows that in certain situations, people perceive a negative norm of cycling and do not consider those situations appropriate to cycle. For example, a lack of understanding from co-workers will deter their cycling choices. However, cyclists put social pressure on other commuters who do not cycle to work, and they cannot understand those people who live near to work but do not cycle. Attitudes and the perception of the social norms in the social surroundings are probably to be influenced by national or regional culture (Heinen and Handy, 2012).

### 2.3.2 Cycle-Friendly Atmosphere

It is important to establish a cycle-friendly atmosphere in order to encourage cycling (Dill and Voros, 2007). Heinen and Handy (2012) concluded that setting a role model who is a highly respected person can promote more positive attitudes and norms on cycling. What's more, a positive and emotionally appealing message should be sent to improve the public image of cycling in the advertisement and public awareness campaigns. The way of sharing the image with the society is crucial because the public image of cycling is an important factor (Pucher, Komanoff and Schimek 1999).

## 2.5 Policy

The accolade of “cycling city” is used as a promotional tool for cycling and there is a key focus on academic research that aims to collaborate with municipal authorities in their advocacy of more cycling-friendly cities (Oldenziel et al. 2016, cited in Cox, 2019, p.178). The advocacy of cycling is related with policymaking and policymakers (Cox, 2019, p.182). As is said in Cox (2019), to achieve the essential improvements in cycling advocacy, the policy formation process is necessary. Thus, to advocate cycling, it is important to discuss the policy that can affect cycling behavior. Significant increases in cycling require an integrated package of varied, complementary initiatives, such as infrastructure provision and cycle programs, as well as supportive land use planning and limitations on car use (Pucher, Dill and Handy, 2010). In their study, Pucher, Dill and Handy (2010) also suggested that policy is vital in promoting cycling, and not only cycling policies, but transportation policies in general, housing and land use laws, as well as car pricing regulations, can help achieve a significant increase in cycling.

## 2.6 Economy

From an economic aspect, cycling is a great way to reduce economic costs when the sickness resulting from physical inactivity is controlled, and when less fuel is used because of using vehicles. As is said above, cycle commuting is a great way to increase physical activity. Health issues and obesity induced by physical inactivity do not only cost individuals a huge amount of money but also lead to costs to the society (Teschke *et al.*, 2012). In 2001, the economic costs that were spent on physical inactivity and obesity in Canada were estimated to be \$ 5.3 billion and \$ 4.3 billion (Katzmarzyk and Janssen, 2004). According to a study on costs and benefits of cycling in Poland, investments in bicycling in the range of \$138 to \$605 million will save \$388 to \$594 million in health care expenditures, \$143 to \$218 million in fuel costs, and \$7 to \$ 12 billion in the worth of statistical lives of by 2040 (Gotschi, 2011), which is a large cost saving when compared to the investment on bicycles. If the problem of physical inactivity can be handled by cycling, then the economic costs would be saved.

However, the economy also can influence cycling. The economy may affect people's mentality and perception of cycling. The elective of riding depends on local economic structures (Cox, 2019). In the economically least affluent societies, cycles are seen as obsolete and these societies desire the car, however, in the most affluent societies, the attitude toward cycling is in the other direction (Newman 1999, p.189, cited in Rosen, Cox and Horton, 2007, p.4). The result can be explained by the phenomenon that in societies where there are few cars, people are encouraged to drive. However, people are encouraged to cycle in societies where there are many cars (Cox and Horton, 2007, p.4).

### 3. Context, Methods, and Methodology

This study used interviews and document analysis. By carrying out interviews, the researcher could get insights about traffic planners' ideas from Eskilstuna municipality, the experiences of cyclists in Eskilstuna municipality regarding winter cycle commuting, and what could be developed to enhance winter cycle commuting in future planning from the commuters' perspectives. By analyzing the document, the researcher got what had been planned by Eskilstuna municipality and figured out what needed to be improved according to the cyclists' appearance. Therefore, analyzing the results from the interviews and the documents, the researcher was able to investigate the motivators and barriers of winter cycling for commuters and offer suggestions to the Eskilstuna municipality in developing winter cycle commuting.

#### 3.1 Context of Study

This study is conducted to research winter cycle commuting, and the case that is chosen is Eskilstuna municipality in Sweden. Eskilstuna municipality has the target of developing cycling. Eskilstuna (2021) states that the Eskilstuna municipality focuses on cycling because cycling is cheap and environmentally friendly transport and cycling is positive for health. To develop cycling, the Eskilstuna municipality has updated plans and constructed new cycle lanes, that provide opportunities for people to cycle. Eskilstuna (2013b) states that two-thirds of the population live in Eskilstuna municipality within 5km from the Fristadstorget, which means the distances are barely longer than a person can imagine cycling to different destination points. It is relatively quick to get around by bike and on distances under five kilometers, the bike can compete with the car (Eskilstuna, 2012, p.17). What's more, according to Eskilstuna (2013b) Eskilstuna municipality had 160km long pedestrian and bicycle work and only a 50 km network in 1980. However, in 2013, even though the Eskilstuna municipality focuses on cycling, the number of cyclists reduced in Eskilstuna municipality when compared to 1980 (Eskilstuna, 2013b). Thus, it would be interesting to know the factors that might affect the cycling rate with the fact that Eskilstuna municipality targets developing cycling. Eskilstuna (2012) also states that cycling is not increasing at the desired pace, and there is a negative long-term trend.

Eskilstuna municipality has established policies about cycling. It is important to know if the policies related to winter cycling are in line with the cyclists' preferences to identify the motivators and the barriers according to the cyclists' experiences. At the same time, it is also important to find out what policies can be developed considering winter cycle commuting. The good cycle policy is recognized by CykelFrämjandet (2021a), the researcher found that Eskilstuna municipality has the highest points (högsta poäng) (8.5 points out of 10) in cycle policy (cykelpolitik) among all the three municipalities, Nyköpings municipality, Katrineholm municipality, Eskilstuna municipality, in Sörmland region that have participated in this 2021 Municipal Velometer, meaning that Eskilstuna municipality has better cycling policies when comparing with other municipalities. Especially, regarding winter cycling, there are detailed plans in the Eskilstuna municipality traffic plan in encouraging winter cycling. To begin with, the municipality has detailed plans for dealing with the snow. As is said in Eskilstuna (2013a, p.14), to prioritize cyclists in winter, the important lanes to the city center and larger workplaces must be cleared of snow with the highest standard level. Besides, carrying out winter road maintenance makes it possible to cycle in the winter seasons (Eskilstuna, 2013b, p.7). However, the average source of infrastructure in Eskilstuna municipality is below average (CykelFrämjandet, 2019), which means that additional resources for cycle infrastructure can be invested to develop cycling.

According to this study, even though Eskilstuna municipality has plans for winter cycling, non-winter commuters do exist. Multiple reasons can affect the winter cycle commuting. For example, the special weather creates challenges for winter cycling. There are more challenges

using cycling as a form of transportation than driving cars and taking buses, because of the exposition to the special winter weather. Increasing winter cycle commuting plays a key role in increasing the cycling rates in Eskilstuna municipality because of the characteristics of the higher frequency of cycle commuting than cycling for other purposes.

### 3.2 Data Collection

According to Savin-Baden and Major (2013), data collection can come from different sources involving interview transcripts and documents by describing, listening, and interpreting. This study was conducted mainly on two sources of data, interview transcripts, and documents from the Eskilstuna municipality. This study conducted two focus group interviews (n=4) and two interviews (n=2) during March and April 2022. The two focus group interviews and one interview with the cyclists in Eskilstuna municipality were conducted to understand citizens' experiences with winter cycle commuting. Additionally, one interview with the traffic planner was carried out to identify the targets of the Eskilstuna municipality and the challenges the municipality met. What's more, the researcher gathered the documents provided by the FASIS project about cycling plans in Eskilstuna municipality.

### 3.3 Samples

The first step was to find out the "target population" (Jensen and Shumway, 2010). There were two kinds of "target population" in this research. The first "target population" was the traffic planner in Eskilstuna municipality. The traffic planner could discuss winter cycling from the Eskilstuna municipality's perspective. For example, what the Eskilstuna municipality had done to increase winter cycle commuting, what still needed to be improved, what challenges the Eskilstuna municipality had met, and how the municipality acts to enhance winter cycle commuting. The second "target population" was the cyclists who worked in Eskilstuna municipality, since this study was going to research the experiences of cyclists toward winter cycle commuting. To get a relatively broad perspective, both winter cycle commuters and non-winter cycle commuters were interviewed to identify the motivators and barriers that commuters meet. In this study, winter cycle commuters mean commuters who cycle to work all year round. Non-winter cycle commuters refer to the commuters who don't cycle to work in winter, from December to February, but cycle to work for the rest of the year.

After defining the "target population", the researcher identified the sampling unit which contains a "respondent" who can supply information that is needed for this research (Jensen and Shumway, 2010). There are three sampling units in this study, Eskilstuna municipality, Tietoevry, and Cykelfrämjandet. These three sampling units contained the respondent that this study needed. The first sampling unit is Eskilstuna municipality. The researcher is in collaboration with the FASIS project. FASIS project helped the researcher get in touch with the Eskilstuna municipality and the traffic planner to carry out the interview. The second sampling unit is a company called Tietoevry. Since the study is about winter cycle commuters, the researcher decided to choose a company as a sampling unit to find participants for the interview. Then, the researcher found a technology company called Tietoevry. The branch of Tietoevry in Eskilstuna municipality is called EVRY which mainly focuses on healthcare software. It is only 600 m from the city center Fristadstorget, where the most companies locate. Because of the physical location, the commuters in Tietoevry Eskilstuna might represent some of the other commuters' ideas of winter cycling commuting. Meanwhile, the main field of this company is related to healthcare, which is related to this research, because cycling is related to physical health. The researcher found a contact person in this company. This contact person helped gathered the participants including the winter cycle commuter and the non-winter cycle commuters by sending out information about this study to her coworkers. The third sampling



unit is Cykelfrämjandet Sörmland, which is a non-profit organization that arranges excursions and tries to improve cycling conditions in Sörmland. Cykelfrämjandet Sörmland can provide the target population who are both cyclists and commuters to this research. However, participants that were gathered by Cykelfrämjandet had their own jobs. Member 1 in focus group 1 is from the Swedish energy agency, and member two in focus group 1 is a train driver in Eskilstuna municipality. Gathering participants from an interest organization had both benefits and risks. Regarding the benefits, the participants from Cykelfrämjandet were cyclists, and it was easier for the researcher to get participants because Cykelfrämjandet could help send out information to the club members of Cykelfrämjandet. However, there was also a risk of gathering participants this way. The reason was that cyclists in Cykelfrämjandet might have a strong interest in cycling. Thus, when asking about their experiences with winter cycling, they might not provide enough information because they liked cycling, and they cycled to work no matter what the motivators and barriers were, which could narrow the interview results.

### 3.4 Methodology

Since this study research on investigating the experiences of cyclists in Eskilstuna municipality regarding winter cycling, qualitative analysis matches this study. Qualitative research can contribute to this study mainly from four aspects. Qualitative research has the ability to generate new insights into people's experiences, and emotions, as well as the relationships between the meaning and the human-environment (Hay and Cope, 2021). In this study, new insights will be gathered from the participants in Eskilstuna municipality according to their reflections. Meanwhile, by comparing the interview results to the previous studies, this study can identify the correlations between the previous studies and the experiences of cyclists from the aspect of winter cycling. Qualitative data can help explain or comprehend why things happen in the way they do (Farthing, 2016). In this research, the qualitative data can explain why participants cycle to work all year round, and why they do not cycle to work in winter but during the rest time of the year. The qualitative data from the interviews will provide the researcher with the reasons why the participants choose winter cycle commuting or not. Because of the time limitation of this research, the researcher didn't choose quantitative research. Thus, qualitative research is suitable for this study because qualitative research can investigate how people make sense of their thoughts and experiences (Savin-Baden and Major, 2013, p.11) and doesn't require large scale data collection.

### 3.5 Methods

In terms of interviews, the researcher used two types of interviews, which are "interview" and "focus group interview". These two forms of interviews are defined according to Savin-Baden and Major (2013).

#### 3.5.1 Focus Group Interview

The definition of a focus group interview will be discussed first. A focus group interview is a type of interview that is nexus of the focus group and group interview (Savin-Baden and Major, 2013, p.375). As is shown in the following figure:

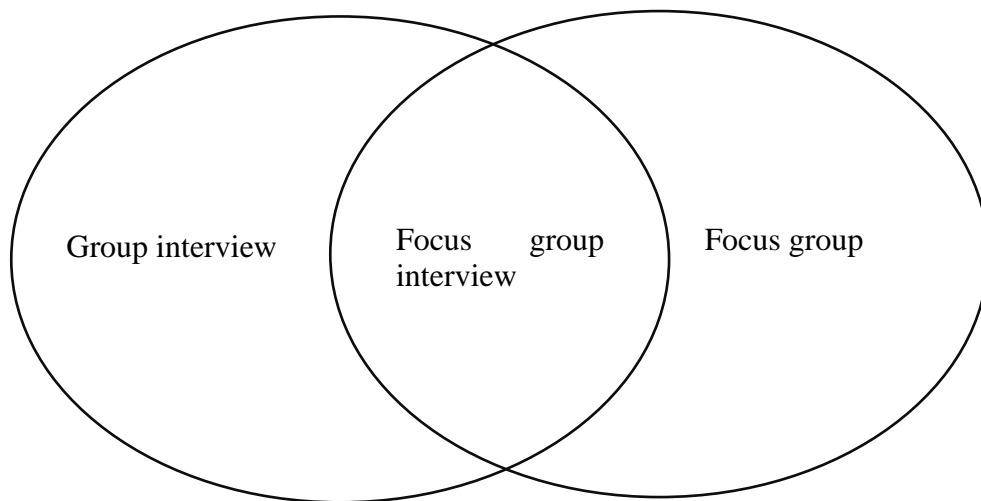


Figure1. from Savin-Baden and Major (2013, p.375)

A group interview refers to when an interviewer asks questions to the group members and the individuals in the group respond in turn (Kitzinger, 1994 cited in Savin-Baden and Major, 2013, p. 375). However, focus groups gather a limited number of individuals and the individuals provide information about a specific topic, issue, or subject through a conversation with each other (Savin-Baden and Major, 2013, p.375). The researcher in this study asked questions to the interviewees and at the same time, individuals discussed their experiences with each other and their ideas about winter cycle commuting. Thus, a focus group interview is a good method for this study, because focus group interview has the advantages of both group interview and focus group.

Since a focus group interview is a combination of both focus group and group interview, it has both the advantages of group interview and focus group. First, group interview allows the researcher to collect data from numerous people at once (Kitzinger, 1995 cited in Savin-Baden and Major, 2013, p. 375). Second, focus groups are effective at generating interactions amongst groups of people. In addition, focus group is appropriate for studies of how issues or experiences are talked about and argued (Secor, 2010, p.199). Secor (2010, p.199) also state focus groups provide opportunities for in-depth, flexible dialogues with the participants, and interchange can be generated by the respondents. A focus group is used to gather information about a certain topic or issue (Cameron, 2021, p.203), and focus groups can help the researcher figure out why people think and act the way they do. For example, the cyclists expressed their ideas about the reasons why they cycle to work or not. Focus groups also allow researchers and participants to collaborate on developing information and understandings (Cameron, 2021, p.205). When discussing the hindrance of cycling to work in winter, participants were active in giving suggestions, such as building a bicycle highway, and the researcher also mentioned the bicycle-only highway that was built in Beijing in 2019, and the participants and the researcher discussed the issues and advantages of the bicycle-only highway. Focus groups can work well to know why cyclists cycle to work or not in winter and new ideas and understandings can be gathered in the interview. To sum up, focus group interview was useful for this research because it combined the benefits of both group interview and focus groups. Thus, the researcher could gather both data from multiple individuals at once, and at the same time, the idea of winter cycle commuting can be achieved through the interactions between the participants. Because focus group interviews allow for the collection of multiple people's perspectives in one session, they tend to yield information more quickly than individual interviews (Savin-Baden and Major, 2013, p.389). Thus, focus group interviews are less expensive and time-intensive than

individual interviews (Savin-Baden and Major, 2013, p.389). Although the sample size has been increased, focus group interviews don't require more time and resources (Savin-Baden and Major, 2013, p.389).

However, there are some disadvantages of the focus group interview. First, in focus group interviews, it is possible that participants discuss what is socially acceptable rather than what is really happening in the environment (Savin-Baden and Major, 2013, p.389). Second, there might be a potentiality that the participants are emotionally charged, and it is probable that the participants in the study will impact one another (Savin-Baden and Major, 2013, p.389). Third, there are also practical issues. Focus group interviews take time, and the number of questions that may be asked is limited due to the number of people that engaged in the interview (Savin-Baden and Major, 2013, p.389). What's important is the willingness of the participants and the dynamics of the conversation determine the quality of the data collected (Savin-Baden and Major, 2013, p.389). Hence, the information gathered may be varied by different situations.

However, there is a limitation in defining the interviews in this study as "focus group interview". According to Savin-Baden and Major (2013, p.388), there are normally at least 4 participants in a focus group interview. However, the researcher gathered 2 participants in each of the focus group interviews. Even though there were only two participants, it was still not one on one interview, so it is deemed relevant to call it a group. As is said in Savin-Baden and Major (2013, p.388), the number of participants that is needed relies on the depth and the responses that are desired. Even though there were only two participants, they had more chances to make communications and connect through conversations, through which relative in-depth information could be gathered.

### **3.5.2 Interview**

As a complement to focus group interviews, individual interviews were also used in this study. According to Savin-Baden and Major (2013, p.357), an interview in qualitative research is a conversation between the interviewer who ask the questions and the participant who responds. Interviews are different from focus group interviews. Although both can provide opportunities for flexible engagements with participants. Interviews can provide complex in-depth information from participants, which focus group interviews can't (Wengraf, 2001, cited in Savin-Baden and Major, 2013, p.358). Interviews are appropriate when a researcher wants to make use of the one-to-one communication form so that the researcher can probe extensively into the participants' experiences (Savin-Baden and Major, 2013, p.358). Meanwhile, interviews are more appropriate when the researcher wants to ask about sensitive topics (Savin-Baden and Major, 2013, p.358). For example, when being asked about the resources that Eskilstuna municipality get from region Sörmland, the traffic planner could express his concerns about the lack of resource since the resources that the municipality used to build cycling infrastructures were from region Sörmland.

Thus, the researcher got the following interviews:

Interview 1 was held with a winter cycle commuter in Tietoevry.

Interview 2 was held with a traffic planner in Eskilstuna municipality.

Focus group interview 1 was held with two of the club members in Cykelfrämjandet who cycled to work all year round.

Focus group interview 2 was carried out with two cyclists who worked in Tietoevry in Eskilstuna municipality and didn't cycle to work in winter but during the rest time of the year.

All the interviews were carried out online. The focus group interview lasted about 45 min. Interviews last about 30 min.

**Table 1.** information about the interview category:

Interview type	Participant type	Participant occupation	Participant
Focus Group 1	Winter cycle commuters	Swedish energy agency	Member 1
		Train driver	Member 2
Focus group 2	Non-winter cycle commuters	Tietoevry	Member 1 Member 2
Interview 1	Winter cycle commuter	Tietoevry	One participant
Interview 2	Traffic planner	Eskilstuna municipality	One participant

Source: gathered from interviews

### 3.5.2 Semi-structured Interview

Both the focus group interview and interview followed a semi-structured format. The questions and issues that were asked in the interview have been judged by the researcher as relevant to the topic. As is stated in Savin-Baden and Major (2013, 359), in a semi-structured interview, the researcher not only asks the predetermined questions but also adds new ones in response to participant comments and reactions. The researcher can shift from the general to the specific to any sensitive concerns or questions, as there is not a specific order of the question (Savin-Baden and Major, 2013, p.359), such as the reasons why the Eskilstuna municipality didn't invest more resources on winter cycling.

### 3.5.3 Online Interview

Both the focus group interview and interview were carried out by video call. Dunn (2021) demonstrates that video-conferencing software can be used to carry out with people who have different locations in real-time. To begin with, they state that it is less expensive in terms of time and resources both environmentally and financially (Dunn, 2021, p.181), which is an advantage for students who have time limitations. What's more, a video call is as good as a face-to-face interview, and many people are inclined in video call, because they feel more comfortable with the video call (Dunn, 2021, p.181). However, the digital interview has disadvantages. Dunn (2021, p.181) mention that video call interviews have challenges resulted from the technology failures, uneven access, as well as the lack of ethnographic context relative to face-to-face interviews. The authors state that failures in technology can delay the start of the interview and cause audio drop-outs. Besides, uneven internet availability poses a significant challenge to the interview's success, particularly for those who live in remote locations. To deal with these potential challenges, the researcher followed the recommendations of Dunn (2021, p.182). To begin with, in terms of ethics, the researcher restated the request for consent forms and reminded the participants that they could open and close the camera according to their preferences. In each interview, the researcher checked with the participants about the check-in moments by checking if the participants can hear the researcher.

### 3.5.4 Document Analysis

Documents here refer to official policy documents, among which development plans are of particular interest to the planning researchers (Farthing, 2016). Documents are useful to this study because of methodological reasons. In this study, the researcher used the documents from Eskilstuna municipality, such as the traffic plans and cycling plans in Eskilstuna municipality.

These plans were used to see how the Eskilstuna municipality had planned for increasing winter cycle commuting. For example, in the interviews, the participants mentioned the cycle lanes, snow clearance, the darkness, and the cycling policies. Then by analyzing the traffic and cycling plans, the researcher could know how the municipality has planned to deal with the snow, darkness, and what has been written about the cycling policies.

However, these steering plans were published in 2012 and 2013, and these plans are a bit old, but they are still valid. According to the traffic planner, there are no newer versions of the steering documents regarding transportation and mobility, and normally, the municipality has an implementation around ten years, which means that even though these plans are old, they are still valid. What's more, the traffic and cycling plan documents were in Swedish, and the researcher translated them into English.

### 3.6 Coding and Analysis

In this study, the researcher coded all the transcriptions from the interviews and the cycling plans from Eskilstuna municipality based on the themes and topics that are related to the previous studies and theoretical framework (Savin-Baden and Major, 2013, p.422). Thus, the coding is mainly based upon the relative factors that can affect cycling including the rider, the cycle, the space that mainly contains weather factors and sensory, the society, the policy, and the economy. Coding is a systematic process where themes words and interpretations are flagged within and across the transcripts from focus groups interviews and interviews (Secor, 2010).

Regarding data analysis, the researcher used constant comparison referring to Savin-Baden and Major (2013, pp.436-437). First, the researcher identified the categories according to the theoretical frameworks in Cox (2019) and the relevant themes under the frameworks that were shown above, including the rider, the machine, the space (the infrastructure, the low temperature, the darkness, the wind), the society, the policy, and the economy. Then, the researcher used both open coding and axial coding followed the coding method from Savin-Baden and Major (2013, p.424). Open coding means that the researcher conceptualizes the related data (Charmaz, 2006, cited in Savin-Baden and Major, 2013, p.422). For example, in open coding, the interview transcription about winter cycle commuting might contain words, such as good, like, and prefer, dangerous, risk, and no influence. Then, the researcher used axial coding to make categories with the open coding results. Axial coding which follows the open coding is a procedure through which the data are put back in new ways (Strauss and Corbin, 1990; 1998, cited in Savin-Baden and Major, 2013, p.424). Then, by axial coding, the positive words, such as good, like, and prefer were coded as motivators, the negative words, such as challenge, dangerous, risk were coded as barriers, and words such as no influence were coded as irrelevant factors. In the end, the researcher used the theoretical frameworks and the previous studies to explain the motivators, barriers, and irrelevant factors. Take darkness for example. When asking if the darkness can affect the tendency of the cycle behavior in winter. Some participants stated that darkness was a challenge for them. The open coding should be that the participants had a negative attitude about the darkness in winter cycling. In axial coding, the result should be interpreted as the darkness being a barrier. In the discussion and analysis part, the researcher analyzed the relationship between the darkness and winter cycle commuting according to the theoretical frame works in Cox (2019) and previous studies.

**Table 2.** Open coding and axial coding

Open coding	Axial coding
Good, like, prefer	Motivator
Challenge, dangerous, risk	Barrier
No influence	Irrelevant

Source: refer to the coding method from Savin-Baden and Major (2013, p.424)

### 3.7 Validity

Validity refers to the researcher's ability to assert the findings' strength and demonstrate that they are "true" (Savin-Baden and Major, 2013, p.473). To guarantee the quality of the research, while conducting the research, the researcher thinks critically and exhibits critical analysis and awareness (Savin-Baden and Major, 2013, p.474). The researcher also employed reflexivity to avoid the position that will limit the quality of the research and the findings were deemed most appropriate (Malterud, 2001b, cited in Savin-Baden and Major, 2013, p.474).

### 3.8 Limitations

There are mainly four limitations of the study. First, the researcher gathered a limited number of participants, which was unavoidable because of the time limitation. The researcher gave the participants more chances to communicate to gather relatively in-depth information and a relatively long interview time, to make sure that more meaningful information could be gathered. What's more, the lack of participants resulted in the fact that the result can not represent the general ideas of the cyclists in Eskilstuna municipality. However, the results can represent the attitudes from the cyclist's perspective, and the opinions of the participants offer valuable implications and are valuable to represent some cyclist's ideas. Moreover, even though this study cannot generalize all the cyclists' ideas and experiences in Eskilstuna municipality, it can function as a complement to the quantitative data research in terms of winter cycle commuting. Quantitative data research has the potential of ignoring individual differences. Therefore, with enough time, the research results can be improved by using the combination of both qualitative research and quantitative research in the future. Second, Farthing (2016, p.196) states how well the research can be affected by how well the researcher is versed in the local language. The researcher is not from Sweden and some of the participants couldn't express themselves well enough in English. After the interview, during the transcription period, when there was some information that was not clear, the researcher wrote emails to the participants to guarantee the quality of the research. Third, one of the limitations mentioned by Farthing (2016) is that the quality of the cross-national research relies on how well the researcher understands and interprets the local planning. The researcher is not from Sweden, which might limit the research quality because the researcher is not familiar with some of the planning cultures in Sweden. Last, there is a limitation about "personal stance" (Savin-Baden and Major, 2013, p.68), which means that the researcher has a position derived from her personal beliefs. Thus, it is unavoidable that when the researcher interpreted the interview results, the researcher's stance and personal conception might potentially affect the interpretation of the data. The researcher used reflexivity to consider her influence and her position during the study to be self-critical and self-conscious analytical scrutiny (Savin-Baden and Major, 2013, p.76).

### 3.9 Ethical Considerations

Good research should take ethics seriously because when it comes to talking to people, it may present risks for the participants (Secor, 2010, p.203). To guarantee confidentiality is crucial, and researchers have the responsibility to respect the subjects (Secor, 2010, p.203).

Ethical issues have been considered in this study and ethical excellence is achieved in the following ways. First, it is crucial that the researcher thinks about informed consent (Savin-Baden and Major, 2013, p.323). During the research, all the participants have signed the consent form so that to guarantee that the privacy of the participants will be protected, and their perspectives will be respected. What's more, communication of adequate information about the study and understanding the information to avoid deception is important to respect the participants (Creswell, 1998; Hammersley and Atkinson, 1995, cited in Savin-Baden and Major, 2013, p.334). The researcher conveyed the information and the aim of the study to the participants at the beginning of each interview to guarantee enough communication of the information. Additionally, Dowling (2021) states that qualitative research often invokes asking questions and it is important that the private details are not released to the public. The researcher protected the participants' private details by ensuring anonymity. For example, the researcher didn't use the name of the participants. Instead, the researcher used Member 1 and Member 2, as is shown in the information of the interview category. To protect the privacy of the traffic planner, the researcher didn't use the traffic planner's real name either. During the interview, the traffic planner mentioned some sensitive issues. For example, the traffic planner mentioned that the region didn't give enough resources to the Eskilstuna municipality.

## 4. Results and Discussion

### 4.1 The Rider

Questions in terms of the rider were discussed by the participants. The interview result was mainly focused on the rational rider including, riding for convenience, riding for self-advancement, and saving money and ritual rider.

First, some participants cycled as rational riders. According to the results, some commuters in this study cycled to work because of the convenience and practicality, and they hadn't thought if they cycled to work for some special purpose or the cycling to work was an extension of their work. For example, they cycled to work so that they didn't need to wait for the bus. As is shown in the quote:

"I think for me, it's more like shoes for me. It's like just something that's there and takes me where I want to go."-Member 1 in focus group 1

The quote shown above can express that the cyclist cycles to work because of practical uses and they are rational riders. The convenience that cycling brought to them functions as a motivator for their cycling behavior.

Second, riding for self-advancement. The interview results revealed that some of the participants cycled to work because of the training and exercising. The two participants in focus group 2 stated that they cycled to work more because of exercise. A positive attitude was shown about the exercise opportunity that cycling brought to the cyclist. Thus, it is easy to see that these people treated cycling as self-advancement. Another participant expressed that cycling to work could save money because she didn't need to pay for the bus tickets.

"Because when I cycle, then I don't need to pay for the bus tickets."-Member 2 in focus group 2

According to the quote, cycling was appreciated as cheap transport and can save money. However, these riding behaviors, riding for convenience, riding for self-advancement and riding to save money are still rational riders, because they cycled to work for practical reasons, and they didn't need to give cycling to work a meaning to continue this behavior. However, the interview with another participant leads us to the third aspect because this participant needed to give riding to work in winter a meaning, such as protecting the environment, to perform the winter cycle commuting behavior. As is shown below:

"I always want to protect the environment that is the biggest reason... I wouldn't do it [cycle] in the winter if it wasn't for the environment." -Member 2 in focus group 1

Thus, by giving mundane cycling a meaning of protecting the environment, cycling behavior can be carried out. Thus, ritual behavior sometimes can positively influence winter cycle commuting.

The multiple results from the interview can be related to previous studies. The study shows that some of the cycle commuters are rational riders, which is in line with the study of Cox (2019). Besides, the convenience that cycling brought was seen as a major motivator for winter cycling, which agrees with the previous study that people choose to cycle because it is convenient (Unwin, 1995). Moreover, the result that cycling is a way to exercise agrees with the previous studies of Cox (2019) and Unwin, (1995) who state that some riders recognize cycling as a means for self-advancement and as a body training to improve health and fitness. Participants treated cycling as an investment of their human capital, such as exercising (Cox, 2019). The exercise that cycling brings is also in line with the previous study that cycle



commuting can improve overall physical activity (Donaire-Gonzalez et al., 2015; Sommar et al., 2021; Schantz, Salier Eriksson and Rosdahl, 2020). In addition, cycling as a cheap transport is related for cycling agrees with the study that people decide to cycle because it is cheap (Unwin, 1995). Changing the mode from rational behavior to ritual behavior may help to improve winter cycle commuting. The cyclist's changing behavior clarifies Cox (2019) in discussing the relationship between the rational rider and the ritual rider. Because Cox (2019) states rational rider is a mundane behavior. However, ritual rider means the rider should give the mundane cycling a specific meaning to convey something that is beyond their own actions. For example, adding the meaning of protecting the environment to winter cycling is important. Obviously, cycling has the potential to protect the environment, which is in line with previous studies that cycling can be beneficial in controlling climate change, reducing pollution, and reducing greenhouse gases (Heinen, van Wee and Maat, 2010).

## 4.2 The Machine

The cycle was discussed in the interview with the commuters and the traffic planner. The interview result shows that a good cycle, as a machine, was considered positive, and it was regarded as a motivator to cycle in winter. However, the quality of the tires and the cycle lights related to winter cycle commuting were worried about.

The winter cycle commuter conveyed that cycle was important. For her, the cycle could prevent her from slipping on the snow. This commuter cycled to work all year round and the winter weather characteristics, such as low temperature, and snow didn't seem present challenges to her. She was positive about winter cycle commuting, and she argued that her good bike supported her in winter cycle commuting.

"I cycle to work in the summer and the autumn and spring, why not in the winter. It works fine...I have good clothes. I have a good bike." -Interview 1

Besides the cycle from the cyclists themselves, the Eskilstuna municipality also provided cycles to the people. According to the interview with the traffic planner, 15 people could borrow bikes from the Eskilstuna municipality in winter. These people could use the bikes for free and check the functions of these bikes. Meanwhile, they would give feedback and comments on the bikes and the studded tires according to their experiences. The traffic stated as below:

"We've had some bigger campaigns ...15 individuals can borrow bikes prepared for winter with studded tires...They can test for one or two months. They will answer the survey and tell how it was. We use their quotes and how they feel about it and use as promotion for others" -Interview 2

Besides the traffic planner, nearly all the participants in this study were aware of this campaign of borrowing bikes. Even if the participants hadn't borrowed the bikes from the municipality themselves, they expressed positive attitudes toward this campaign.

"They having a campaign right now when they [cyclists] want to, I think, borrow cycles..."-Member 1 in focus group 2

However, there are some concerns about the cycle as a machine because the cycle also contains components, such as the tires and the cycle lights. During the interview, the concerns about the tires were conveyed by the participants. The quality of the tires could affect the safety of the cyclist during the winter days. For example, the cyclists stated that:

"I got a lot of punctures because of the gravel...I even bought the tires that were supposed to be puncture-free, but they were not puncture-free." -Interview 1

According to the statement of the participant, the function of the tires played an important role when she cycled to work. The bad quality of the punctured tires were barriers that affected her motivation to cycle to work in winter. Thus, we can see from the interview result that the cycle as a machine has the possibility to deter cycle behavior.

Besides the tires, during the interview with the traffic planner, the concerns about the quality of the front and back cycle lights were expressed. In winter, the weather becomes dark earlier. Thus, the equipment such as the front and the back lights are important for the cyclists to be visible enough to the other road users. However, the concern of the traffic planner was that people didn't know which lights were of good quality to be visible enough to the other traffic. He stated as follows:

“So find one [cycle light] that's better, but there is no grading on them...So, it's very tough as a consumer to know which one you should buy.” -Interview 2

The traffic planner's concern showed that the difficulty for commuters to choose the cycle lights might pose a problem for them. The difficulty may prevent them from using the good lights or they would buy the cheaper ones instead because of the price. Both would create safety dangers when cycling in the darkness. Thus, it would be crucial that the cyclists can be notified of the grading and the function of the cycle lights.

This study shows that the cycle is a motivator for the participant. A good bike with good tires that is less affected by the winter weather is important for the winter cycle commuting, because of the potential problems, such as the slippery and the icy roads. The result of this study supports the study of Cox (2019, p.69) that the technologies of the machine produce the potentiality of cycling. A good cycle with technologies, such as puncture-free tires and high-quality front and back lights serves as a motivator to the participant. Moreover, the cyclists were positive about the campaigns of borrowing bikes from the Eskilstuna municipality. Thus, it would be important that the Eskilstuna municipality considers continuing to carry out such campaigns to promote winter cycle commuting.

## 4.3 Space

### 4.3.1 Scenery

Cox (2019) explains that the rides mean how the rider sees and feels about the space around, including the scenery, the weather, and the sensory input along the way. Since sensory input about the weather and the safety-related issues are discussed in other sections, this section mainly focuses on the scenery along the way of cycling to work in winter. The interview results showed that good scenery was preferred, but it was not a determinant factor.

From the interview, the sensory input of the good scenery seemed to be appreciated by the participant.

“I choose my path a bit because of it [the scenery]. If I know I can go that way that's maybe a couple of 100 meters more that's nicer. I usually go that way.” -Member 1 in focus group 1

But it was also expressed by this participant that it was not a determinant factor that influenced winter cycle commuting. As he said, the beautiful view was not as important as safe infrastructure. When compared with the basic concepts of cycle infrastructure, good scenery was like luxury things.

The other participant expressed similar ideas about the scenery. Her statement was that she liked good scenery, but she wouldn't change her cycling behavior just because of the good scenery.

“If I cycle in the sun rise, that’s wonderful. But I don't think today it's going to be a sunrise at 7 o'clock and then I would cycle.”-Interview 1

According to the interview with the participants, it can be concluded that the participants appreciated the beautiful scenery. But beautiful scenery is not a major factor on winter cycle commuting. It might be because that they are commuters and the scenery along the way to work is similar year-round. Thus, the scenery could not make a big difference to cyclists. This study is not in line with Cox (2019) that says the scenery that the rider sees can influence the cycling behavior. This study also disagrees with the previous findings that beautiful scenery is one of the most important factors that can affect cyclists (Winters et al., 2011).

#### **4.3.2 Infrastructure**

In terms of infrastructure, cycle lanes, showering and changing room, and cycling parking place were asked to the participants.

##### **Cycle lane**

Cycle lanes were discussed among both the winter cycle commuters and the non-winter cycle commuter. The interview results showed that cycle lanes were an important aspect that affect cyclists’ motivation for winter cycle commuting. Both motivators and barriers were expressed about the cycle lanes. And the topics were mainly focused on the aspects that are related to the quality and the maintenance of cycle lanes.

In terms of the motivators, there were mainly two aspects that were discussed by the participants in the interview, which were the prioritized cycle lanes and the construction of more cycle lanes. First, the prioritized cycle lanes brought positive experiences to the participants. Even the non-winter cycle commuters expressed a positive attitude about the prioritized cycle lanes. Nearly all the participants knew which route was prioritized by the Eskilstuna municipality and which routes were easier for them to cycle when it snowed. As is shown below:

“Sometimes the cycle lanes are plowed before the streets. They are quite good.” -  
Interview 1

“Some main cycle paths are taken care with taking away snow.” -Member 1 in focus  
group 2

According to the interview results, it is easy to see that participants were satisfied and positive with the prioritized cycle lanes, and the prioritized cycle lanes served as a motivator for both the cycle commuters and the non-cycle commuters in this study. Additionally, for the non-winter cycle commuter, she didn’t cycle to work in winter because of the stronger barrier, which was the darkness, but the prioritized cycle lanes were still a motivator, just not as strong as the barrier.

Second, more cycle lanes that have been reconstructed were considered positive by the participant. The infrastructure that could slow down the traffic was a good way to protect the cyclists when the weather was snowy and when the road was slippery. The quote is as follows:

“They reconstruct the traffic lanes in the city, make the traffic more slow to better protection. There are the road bumps...”-Member 1 in focus group 2

As is shown above, the well-designed cycle lanes were important to the cyclist, and participants considered the well-constructed cycle lands as a motivator for winter cycling. We can see from the cycle plan in Eskilstuna municipality that the municipality has focused on the importance of cycle lanes. For example, the municipality has the target to prioritize the cyclists by improving the space where commuters cycle to work. In this stance, the municipality’s plan

is in line with Cox (2019) about the influence of space on cycle behaviors. Take Torshällavägen for example, as is shown in the quote:

“Torshällavägen

From Idunplan to Schröderstiernas väg, the side surfaces are widened to accommodate the super-cycle road, from Schröderstiernas väg past Slagsta, the super-cycle road is laid in the existing driving area and between Slagsta and Glömsst, the existing gc-road is widened.” (Eskilstuna, 2013b, p.47)

What’s more, the cycle path sweeping was focused during the winter times to guarantee the safety of the cyclists. In addition, in the strategic plans, Eskilstuna municipality mentions the importance of snow removal.

“Bicycle paths must be given priority and that snow removal work must begin no later than when it has snowed five centimeters. Snow removal must be completed within 10 hours after it has stopped snowing.” (Eskilstuna, 2013b, p.39)

“During the period April-November, pedestrian and bicycle paths are swept once a month. On several pedestrian and cycle paths in the central parts of Eskilstuna, sweeping is intensified during this period to every two weeks.” (Eskilstuna, 2013b, p.38)

However, with the attention paid to dealing with potential issues that resulted from the winter weather, especially the snow on the cycle lane, there were still negative attitudes toward the cycle lane. Thus, it seems that there is a gap between what has been planned to protect the cyclist and the experiences of the cyclists in terms of winter cycle commuting. In this study, the commuters expressed negative attitudes, which mainly focused on issues related to snow maintenance, such as the refrozen snow on the cycle lanes, the lack of snow maintenance, and snow plowing problems, the challenges related to the gravel, and the lack of continuous cycle lanes.

First, what the cyclists cared about was the refrozen and the melting snow after the snow was cleared. The problems were that there was new snow the next day after the cycle lanes were cleaned. One winter cycle commuter expressed that the lack of maintenance after the snow was cleaned was concerned as a problem. As is shown below:

“It's common that they only get rid of the snow when it just has fallen but after that, there's no maintenance...The water comes down from when the snow melts...and overnight will freeze again.” -Member 2 in focus group 1

Thus, in accordance with the interview results, the lack of maintenance after the snow cleaning was a negative aspect, and it was a barrier for the cyclist to cycle to work in winter considering the slippery cycle lanes and safety problems.

Besides, even though the snow on the prioritized or main road was plowed, the snow on the roads that were near the participant's home is not plowed. The most important reason for one participant who didn't cycle to work in winter was that there is no maintenance on the first 500 meters route after it snowed, which was a significant factor that prevented her from cycling to work in winter. She expressed that even though the main cycle lanes were well taken care of, some other cycle lanes weren't maintained at all. The quote is as follows:

“I often cycle in the summertime, but not in the wintertime, because I'm afraid of slippery ice and snow...500 meters or so from my house to when I start. So [When] I come from home to office, then the first 500 meters. So there [the road condition] is very bad.”- Member 2 in focus group 2

Lack of snow maintenance can also cause cycle ruts, which created challenges for the cyclist. As is said below:

“When you have to go through the icy parts where other cyclists went before and left the [cycle ruts]” -Member 2 in focus group 1

As is described in the quote, the lack of maintenance was a negative aspect that could prevent cyclists from cycling to work in winter. Hence, the lack of maintenance was a big barrier for the non-winter cycle commuter.

In addition, the snow plowing was argued as a negative aspect by one participant. The snow plowing was not enough, because the exit of the cycle lanes was not plowed. The lack of plowing of the cycle lanes was a challenge for the participant and it was recognized as a barrier by the participant. As is shown in the following:

“They don’t plow our exits, but they plow the car way”-Member 2 in focus group 1

Another participant also showed a negative attitude toward the plowing. The snow plowing on the cycle lanes allowed for safer cycling in winter, but the snow plowing didn’t benefit the cyclists well. When there was snow plowing, the snow was piled in the middle of the cycle lane. The participant must get off the bike to walk to the cycle lane. The participants consider this as a barrier for her.

“I can’t pass because the snow is interrupting or preventing you [me] from moving forward... I have to get off the bike.”-Interview 1

Thus, it can be seen from the result that even though snow plowing was a good method to guarantee safety, it was still treated as a barrier for the cyclist because of the inconvenience that the snow plowing brought.

Second, even though the municipality maintained the road by using gravel, the gravel created problems for the cycles, because one participant said that her bicycle got punctured several times one winter. Even though the tendency of this participant to winter cycling was not affected by the gravel, concerns about the puncture of the tires were still obviously stated. As is stated below:

“They have this gravel. And that’s a gravel... And I got lots of punctures...I think it’s because of the gravel” -Interview 1

This quote claimed that the winter cycle commuter worried about the problems that were caused by the gravel method of dealing with the slippery. The gravels were negatively commented on. Thus, the gravel method was considered a barrier to the cyclist.

Third, the sudden disappearance of cycle lanes when the cycle lanes met with the car roads was a hindrance for the cyclists, and it was a factor that was negatively argued in the interview. As is shown in the following quote:

“In Eskilstuna, at the station, you come from the roundabouts, and you make it turn up, suddenly the bicycle lane just goes out into the car.”-Member 2 in focus group 1

According to what is discussed above, the lack of continuity of the cycle lanes is a barrier for the participant. The sudden disappearance is not a phenomenon that only happens in winter, but when it comes to winter cycling, the sudden disappearance of cycle lanes created problems for the cyclists.

To conclude this section, the results in this study agree with the argument of Cox (2019) that the space, which is manifested as infrastructure, could influence the cycling behavior. The main motivator appreciated by the cyclists was the good quality of the cycle lanes, which is in line with the previous study that a good quality bicycle lane can attract cyclists (Higuera-Mendieta et al., 2021). What's more, this result fits with the previous study that the continuity of the cycle lanes is important for the cyclists to choose to cycle (Stinson and Bhat, 2003). By contrast, even though the Eskilstuna municipality claims to focus on the maintenance of cycle lanes to prioritize the cyclists, the snow maintenance, the gravel, the plowing, and the sudden disappearance of the cycle lanes were identified as barriers. It is reasonable that the participant cared about the safety problems because the previous study stated that icy and snowy conditions can cause crashes. Consistent with the previous studies, snow can result in slippery roads and the friction will be reduced (Fenre and Klein-Paste, 2021). The issues caused by the cycle ruts on the cycle lane can create dangers is in line with the findings of Fenre and Klein-Paste (2021). And the irregular surface is the reason that deters cyclists from cycling in winter. The interview result agrees with the result that snow plowing is a factor that can affect cycle behavior (Spencer et al., 2013). The results are also in line with the previous studies which express cycle lanes that have direct routes connecting are important to the cyclists (Hull and O'Holleran, 2014). In addition, the result in this study is consistent with the previous study that using gravel can cause punctures and creates a safety hazard to the cyclists (Bergström, 2003). In terms of dealing with the refrozen cycle lanes and the lack of maintenance that were considered barriers, Bergström and Magnusson (2003) suggest that it would be important to clear snow and ice frequently and continuously instead of leaving some parts. The authors also mention the importance of preventing the refrozen tracks which is important to protect people's health.

### **Showering Room and Changing Room**

Questions about the influence of showering and changing rooms on winter cycle commuting were asked to both the winter cycle commuters and the non-winter cycle commuters because the previous studies state that showering and changing room are important to cycling (Heinen, Maat and van Wee, 2013). The interview results showed that all the participants did not consider it as a factor that would affect their preference for cycling or not, even though there were such facilities in some of the participants' working places. As is shown in the quote:

“I don't use them [the shower places].”-Interview 1

What's more, even though there were no changing rooms, the participants didn't complain about it, and they demonstrated that the shower and changing room were not a motivator or a barrier. And even though there were shower rooms, the participant didn't regard it as a motivator for winter cycle commuting.

“We have a shower at work to me, but I don't use that. But no special room for clothes...I think it is ok as it is.”-Member 1 in focus group 2

The result of this study shows that the showering room and the changing room don't affect the decision on winter cycle commuting. Even though there were shower rooms and changing rooms, they didn't express a positive attitude. However, they also didn't state negative attitudes if there were no such facilities. Hence, according to the interview results, shower rooms and changing rooms are neither motivations nor barriers for these participants. This result doesn't agree with Cox (2019) that the showering place and the changing room, as a physical space can affect the decision of cycling behavior. The result in this study is in contrast with the previous study that shower place is important to positively affect the cycling (Tin Tin et al., 2010; Buehler, 2012, Nkurunziza et al. 2012).

### **Cycle Parking Place**

When asking about the influence of parking place, some participants responded that there were no parking places in their working places because their office was close to the university where they could park their cycles. The participants also stated that there were no roofs or shelters in the parking place and the parking place was outdoor. However, the result of the interview showed that neither the winter cycle commuters nor non-winter cycle commuters complained that there were no parking places. They didn't consider cycle parking places as a factor that affected their preference for winter cycle commuting. As is expressed by member 1 and member 2 in focus group 2, without parking place was not an issue and it would not affect their choices of cycling in winter.

Following the quote, the parking place was not an element that could determine the cyclists' behavior in winter cycling. No specific negative attitude was shown. Therefore, the parking place is neither a motivator nor a barrier.

To conclude the influence of parking places on the cycle behavior, the result of this section is in contrast with the study by Noland and Kunreuther (1995) which shows that parking facilities are important to developing cycling. The result also contrasts with the idea that the lack of parking negatively affects cycle behavior Nkurunziza et al. (2012). What's more, the interview result showed that parking space as a physical infrastructure, as an element of space, couldn't influence winter cycling commuting, which doesn't follow the study of Cox (2019) who state that space where people cycle is related to cycling behavior.

### **4.3.3 Low Temperature**

Among all the interviews, the influence of temperature on winter cycling was asked about both the winter cycle commuters and the non-winter cycle commuters. The results show that neither the winter cycle commuters nor the non-winter cycle commuters cared about the low temperature. The low temperature is traditional weather in winter, and it is an issue for some people, but the participants in this interview didn't think their choice of cycling to work could be hindered by low temperature.

The non-winter cycle commuter stated that the low temperature wouldn't affect their choice of cycling in winter, because the main barrier for the non-winter cycle commuter was the slippery roads but not the low temperature. This participant was not concerned with the cold feeling, but the slippery roads when the temperature was below zero. As is shown below:

“If the risk of slippery is 0 %, then I often cycle to work. When slippery and the temperature is below zero, I don't cycle.”-Member 2 in focus group 2

According to what is shown in the quote, to this participant, it was not the feeling of cold that affected her decision, but the slippery roads when the temperature was minus 0. Hence, it is easy to see that to this non-winter cyclist, the low temperature was not related to her winter cycle commuting.

What's more, most of the participants expressed that when the temperature was low, they were not affected by the cold, because most of them stated that they had good clothes and warm gloves to protect them from the cold. As is shown below:

“No [The low temperature doesn't affect me]. I have good clothes.”-Interview 1

According to the interview results, it is obvious that low temperature was not a barrier that could lead to non-winter cycle commuting. Although the low temperature was a risk and can be dangerous to the participants, such as the health problem brought by the low temperature, it didn't serve as a hindrance to doing winter cycle commuting.

The results gathered in this study contradict the argument of Cox (2019) that the low temperature, which is manifested as space, is related to the cycle behavior. Besides, the results in this study also contradict the previous studies about the hindrance of low-temperature (Flynn et al., 2012; Spencer et al., 2013; Saneinejad, Roorda and Kennedy, 2012). However, the interview result that temperature was not considered an important aspect that could affect winter cycling agrees with the study that low temperature in winter is not the most important factor (Bergström and Magnusson, 2003).

#### 4.3.4 Darkness

Darkness was discussed by the participants. As is stated in the introduction part, darkness is a traditional seasonal issue in Eskilstuna municipality. On winter days in Eskilstuna municipality, the day has already become dark at 5 pm when the commuters are off work. Cycling in the darkness creates challenges for commuters. Three types of issues were mainly focused on by the participants. One is about the lack of visibility. The other is about the cycle lights stealing. The third is about the lack of responsibility of cyclists.

First, lack of visibility was considered a determining issue in deciding to cycle to work in winter. Being visible to other traffic is important when cycling in the darkness. However, the darkness in winter times is a great problem that prevents the participant from cycle commuting because she cycles to work during the rest time of the year except winter. What this participant worried about were the dangers that were caused by the not visibility. The anxiety of not being seen by the drivers was a big problem for the participant, especially when riding inside the city with so many surrounding lights. The statement was as below:

“I don't like the dark... because I don't think I am visible enough...As I drive the car myself, I know it's hard to see bikes.” -Member 1 in focus group 2

The interview results in this study are an example of the idea of Cox (2019) who states that the space that surrounds the cyclist and where the cycling happens can affect cycle behavior. The lack of visibility of the space deterred the cyclist from cycling to work in winter. What's more, this result in this study follows the previous findings that darkness can affect cyclists negatively (Gatersleben and Appleton, 2007; Nankervis, 1999; Spencer et al., 2013).

Moreover, the cyclist also mentioned in this quote that the invisibility of cyclists was because of so much traffic. The traffic lights on the road make cycles invisible to others and to the drivers, which leads to the risk of getting crashes. The mixing of traffic lights made it even harder for the cyclist to be seen by the drivers.

“I think it's most difficult to be visible in the city where it's much traffic and much other lights” -Member 1 in focus group 2

The traffic issues can be related to the domination of the cars. Nowadays, even though cycling is encouraged, there are still many cars on the roads. The car lights create problems for the cyclists who cycle in the darkness. With so many car lights, it is hard for the cycles to be recognized in the darkness. In the study conducted by Isaksson-Hellman (2012) about car and cycle collisions, it was found that in the darkness the collision between the car and the cyclist can cause more severe bodily injury to the cyclist. Thus, it is easy to see that the domination of cars can cause problems for cyclists when they are cycling on the roads.

Second, according to another participant, the cycle lights stealing was expressed as a problem in the dark winters. To be visible to other road users, the cyclist needed to use the cycle lights. However, the cyclist must take care of the cycle lights in order not to be stolen.

“The problem lies with being visible to others. A cyclist needs to always have charged



front and back lights, and they need to be picked off the bike and into ones [ones'] pocket during the day so that nobody will steal them.”-Member 2 in focus group 1

Thus, it seems that the cycle lights stealing is a barrier for the cyclists to cycle in winter. The cycle light stealing behavior can be explained by previous study researching bicycle theft which states that because cycles are of composite construction, the components such as the cycle lights are vulnerable to the theft (Johnson et al., 2008).

Third, according to the traffic planner, the lack of responsibility of the cyclists in using reflective vests creates difficulty for winter cycling commuting. The municipality has carried out strategies and plans to deal with the darkness problems. The traffic planner in Eskilstuna municipality expressed the issue that the municipality had met when planning for winter cycle commuting. According to him, the Eskilstuna municipality had realized the importance of dealing with the darkness and had taken care of the darkness that was related to winter cycling. For example, the Eskilstuna municipality has installed traffic lights on the main roads and the main cycle networks, such as the enforced traffic lights. As is said in the quote:

“We don't think that's a big issue. And most of the bigger crossings also have enforced traffic lights.” -Interview 2

What is written in the cycling plans in Eskilstuna municipality regarding the safety issues in winter times is consistent with the interview results with the traffic planner. The Eskilstuna municipality does have planned to deal with the darkness because, in the traffic plan, we can see that the municipality has realized the issues of darkness and tried to improve the traffic lights to cope with safety problems that are related to the darkness. From this point of view, it seems that the Eskilstuna municipality's idea is coherent with Cox (2019) because the municipality realized that bicycle practical use decreases drastically during the dark periods. Thus, illuminating the cycle path is crucial to achieving an increase in cycle use. As is written in Eskilstuna (2013a, p.10):

“It is important that a cycle path is illuminated if increased bicycle use is to be achieved. The lighting is important from a safety point of view but also the safety aspect. Unlit pedestrian and bicycle lanes have low utilization and work in the bicycle network during the day, but not in the evening. This means that the bicycle's practical use is drastically reduced during dark periods.” -(Eskilstuna, 2013a, p.10)

As is said in the quote, the municipality realized the lack of brightness on the bicycle lanes can result in a low cycling rate. At the same time, the municipality has the following plans:

T1. All main cycle lanes must be illuminated. (Project department / Street department / Torshälla city administration)

Investment cost: SEK 0.5 million / year

T2. Other lanes that are illuminated must be illuminated without any gaps. (Street Department) Investment cost: SEK 0.25 million / year

T3. A lighting program for the municipality's other urban areas will be developed. (Planning department / Torshälla city administration)

Resource cost: SEK 1 million

-(Eskilstuna, 2013a, p.10)

However, the traffic planner expressed that even though the traffic lights have been installed, the cyclists should be responsible to take care of themselves and other road users. During the interview, the traffic planner declared serious concerns about the citizens' awareness of using the reflection vest, since the reflection vest was not needed by the law. There is uncertainty

about how much the municipality should tell citizens to use reflection vests because using reflection vests is not written in the law. However, they should be responsible for their safety, they should be aware of the use of reflection vests. But it seems that there were still some people who were not responsible for this. Thus, the lack of responsibility is a barrier to enhancing winter cycle commuting.

“Our big discussion is how much should we tell people to use the reflection vests.”-  
Interview 2

It is reasonable that the traffic planner has such concerns. Even though using the reflection vests is important, there are still some cyclists who don't use them. This concern has been discussed in previous studies about the day-light hour and the study shows that the prevalence of visibility aid use is far below optimal (Hagel et al., 2007) and only a small number of cyclists use high visibility clothing (McGuire, 2000). McGuire (2000) states that it is important to improve the visibility in darkness by using a reflective vest, however, the author mention that the cyclists don't realize this. When talking about car crashes, the car drivers also think that the lack of visibility of the cyclists can cause accidents (Wood et al., 2009). Thus, it can be concluded that the lack of responsibility in using reflective vests might create safety problems and might be a big barrier to winter cycle commuting. And it is meaningful to consider using a reflective vest for the cyclist to guarantee cycling safety. Besides, it is important to mention that the lack of responsibility from the car drivers can also affect cycling negatively because as mentioned in a previous study by Biernat et al. (2018), the commuters accuse the behavior of car drivers, such as their traffic offenses.

#### **4.3.5 Wind**

As is presented in the previous part, windy weather is common winter weather in Eskilstuna municipality. The wind was discussed by both the winter cycle commuters and the non-winter cycle commuters. What's more, the traffic planner in Eskilstuna municipality also expressed his idea about the wind as a winter cyclist himself. Multiple ideas about the wind were expressed in the interview because the influence of the wind is determined by the different situations. Four types of opinions were expressed during the interview about the relationship between the wind and the winter cycle behavior.

To begin with, the wind wasn't considered a problem in the winter cycling behavior. Even if it was windy, the wind could not prevent the cyclists from the cycle to work in winter. Even one of the non-winter cycle commuters showed that the wind in winter couldn't create problems for her. As is shown in the quote:

“I don't like it, but this [the wind] isn't the problem.”-Member 1 in focus group 2

Second, one non-winter cycle commuter showed a positive attitude toward the wind because of the exercise that the windy weather could bring to her. Even though she would not choose to cycle to work in winter, she was positive about the wind and the wind was not the factor that inhibited her winter cycle tendency. When there is wind, it requires more strength to pedal, and it gives cyclists a chance to exercise. She appreciated the physical activity that the wind brought. As is stated below:

“I think it's a good training. I get the training and that's [the wind is] not a problem for me”-Member 2 in focus group 2

Thus, for this participant, the wind can serve as a motivator to decide to cycle to work in winter.

Third, uncertainties about the influence of wind were stated by the cyclists, because of the uncertain direction of the wind. The reason is when cyclists are cycling in the same direction as the wind, the wind pushes them along. However, when people are cycling toward the wind direction, the wind is a barrier and prevents the cyclist from moving forward when it is very heavy. The cyclist expressed an uncertain idea about the wind. As is shown below:

“Sometimes the wind is irritating, but it's the same with slopes, depending on your direction.”-Member 2 in focus group 1

According to the quote above, it is shown that it is hard to define the wind as a motivator or a barrier because it is related to the wind direction. And the wind was not a determining issue for the cyclist to cycle or not in winter.

Forth, the traffic planner expressed his opinions as a cycle commuter because he cycled to work all year round. He argued that the wind itself was not a problem, but when the wind was combined with other elements, such as the cold temperature, it made it harder to cycle in winter. The combination of the wind and other harsh weather elements was not appreciated. This makes the wind a negative aspect of cycling in winter because it makes cyclists feel colder.

“It's true when it is cold and wind at the same time, it feels even colder.” -Interview 2

Thus, as is shown in the quote, the wind was considered a negative aspect when combined with other harsh weather. Hence, the wind appears to be a barrier for the cyclist.

To conclude with this part: when considering wind as an element, multiple results were shown in this study. There were four types of results in this study that is related to the relationship between wind and winter cycle commuting. First, the wind wasn't considered a determinant factor that could prevent cycling behavior. This result doesn't agree with the results of a previous study that wind speed can decrease cycle commuting (Flynn et al., 2012; Saneinejad, Roorda and Kennedy, 2012). Second, the uncertain direction of the wind makes different influences on the cyclist. Hence, the wind is not considered a motivator or barrier in this study, because the influence of the wind is not determined. The result is not the same as what is stated in the previous studies about the barriers that the increased wind speed is negative to cycle commuting (Flynn et al., 2012). Third, the results show that the combination of the wind and other weather is a negative aspect. This result is consistent with the previous study from Spencer et al. (2013) that when paired with the other factors, such as precipitation, the wind can be more deterrent. Forth, it appears that the physical activity that brings by cycling in the wind is appreciated by one of the participants, which is in line with the result that cycling is a good train of physical activity and is healthy for people (Sommar et al., 2021; Schantz, Salier Eriksson and Rosdahl, 2020). The result in this study follows the study of Cox (2019) that the wind, as an element of space can affect the decision of cycling, because, according to the interview results, the wind sometimes performs as a motivator, but sometimes it functions as a barrier.

#### **4.3.6 Snow**

As is discussed in the introduction, snowy weather is common weather in Eskilstuna municipality in winter. When it came to snow, participants presented two kinds of ideas. Some participants conveyed negative attitudes, which mainly focused on the soaking up by the snow. Others didn't consider snow a big problem because they had good clothes.

One winter cycle commuter also expressed a strongly negative attitude toward the snow. The commuter said that normally she was ok with it if it only snowed, but a combination of snow and rain would be a big problem.

“This winter has been a lot of snowing and raining when I needed to cycle. But this is the first time in my life that I found it irritatingly much.” -Member 2 in focus group 1

To these commuters, they did complain about the snow. It is clear to see from the interview results that snow is a barrier for them, mainly about personal safety and security that snow caused, and the irritating and annoying mood caused by the combination of snow and rain.

However, different opinions were gathered from other participants. For them, snowy weather didn't inhibit them from winter cycle commuting.

“Modern clothing will dry up quite fast anyway unless you really get soaked.”-Member 2 in focus group 1

No negative attitude was presented by these participants. Thus, snow was not a problem. The important reason was that they had good clothes and modern clothing that could prevent them from soaking up.

According to the interview results, the attitude toward the snow was not identical. On one hand, the negative feeling toward the snow can serve as an example of Cox (2019) who states that the weather can affect if a cyclist chooses to ride or not because rides are shaped by environmental factors, such as snowy weather. The study proves the statement by (Flynn et al., 2012) that snow can explain participants' negative attitudes toward winter commuting. What's more, the result also confirms the study that in the snow areas snow can lead to less cycle percentage (Fenre and Klein-Paste, 2021). On the other hand, snow is acceptable, because they can buy modern clothing to get rid of the problems that are caused by the snow, such as being soaked up. It seems that good clothes in winter are important. Since the soaking up problem is mainly about the melted snow and the rain. Rietveld and Daniel (2004) state that using waterproof clothing might be a preventive measure to deal with the negative effect caused by the precipitation.

## 4.4 Society

### 4.4.1 Culture

In terms of culture, the interview results showed different attitudes. There were mainly two competing points of view. Some held the opinion that culture could not affect the choice of winter cycle commuting. Others considered culture a motivator that could affect more people to cycle.

On one hand, one winter cycle commuter claimed that culture was not a factor that could encourage her to cycle to winter. The reason what she cycled to work was she liked cycling, but not because of the culture.

“I don't think it's a culture. I think it's just me.”-Interview 1

On the other hand, positive attitudes toward culture were expressed. When asked about their ideas about the influence of culture on winter cycle commuting, some participants considered the culture was like an upward spiral trend. The more people cycle in winter, the more people would be attracted to cycle.

“In some way, I think it [the culture] will, because many people think it's good for the climate and your own health cycling. I think it is something that you think about...I will leave the car at home today and take my bike instead.” -Member 1 in focus group 2

“The more [people] going by bike, I think it's like an up for going spiral [upgoing spiral], the more others are going by bike.”-Member 1 in focus group 1

Thus, culture was seen as either a positive or an unimportant factor, depending on different participants. The effect of culture on the winter commuting patterns cannot be determined by the interview results. While the earlier studies have documented the positive influence of culture (Pucher, Komanoff and Schimek, 1999), commuters in this study expressed different attitudes. Culture, as a component of society, can work as a motivator for winter cycle commuting. This result proves Cox (2019) which demonstrates that cycling behavior can be influenced by society. What's more, it is reasonable to understand why these participants held the points of view that culture can influence cycling behavior, because Sweden has a cycling culture and cycling is a rather ordinary and major means of moving around (Rosen, Cox and Horton, 2007). But for the participant who didn't think culture is important, she might be influenced by other reasons, such as the convenience that cycling brings to her. Because she said in the interview that:

“If I think it's the most practical way to get to work, I don't have to get a bus or anything.”-Interview 1

From this side, her winter cycling behavior is also in line with Cox (2019) that says some cyclists are rational riders and they cycle for practical reasons, such as the convenience that cycling brings to them. Cox (2019) mentions many aspects that are related to cycling behavior. Understandably, different commuters might be influenced by different factors that are mentioned in Cox (2019).

#### **4.4.2 Social Norms**

When it comes to the social norm, the interview results showed different perspectives from the participants. The winter cycle commuters and non-winter cycle commuters discussed the influence of social norms on them in deciding about cycling to work. Different kinds of social norms lead to different results among the participants. The results mainly focused on three aspects: social norms about sweating, clothes that they wear, and the norm of environmental protection.

To begin with, participants expressed different ideas about sweating. Some considered it deterrent, but others didn't. The non-winter cycle commuters perceived sweating after cycling to work as a negative factor. They believed in the social norm of cleanness in mind, that's why they didn't want to be sweaty at work. It could be conceived that sweating was a limiting factor in bicycle use. As is said in the quote:

“I cycle so slow to avoid sweating...I do that because I don't want to sweat when I come to the office.”-Member 2 in focus group 2

However, to other participants, sweating was not regarded as a problem that could stop them from cycling to work. The sweating was not pressured for them because it wasn't refused by her coworkers but appreciated because of her cycling behavior. Thus, sweating was not related to cycling to work in winter.

“They [My colleagues] are fine with that [my sweating]. They know that I'm cycling, and they respect me for it.”-Member 2 in focus group 1

What's more, the topic of working clothes was asked of the participants. According to the interview results, the norm of working clothes was not a factor that can influence their tendency of the cycle to work in winter. The winter cycle commuter expressed that she didn't feel the pressure to wear fancy working clothes but cycling clothes. The cycle commuters indicated that people in Sweden were casual about their work clothing.

“It [The clothes] doesn’t matter... It is quite casual often.” -Interview 1

Another commuter expressed a similar attitude toward the work clothing.

“I think in Sweden, it's very much accepted that you may dress as you want. ”-Member 2  
in focus group 1

Moreover, the interview result indicated that the environmental protection norm was a motivator to push commuters to cycle to work in winter. Cycling to work was appreciated by people. However, driving a car to work was perceived as ashamed. One participant argued that because of his occupation, he and his co-workers had a negative attitude toward driving cars to work in the cycling norm. This participant works in the Swedish energy agency, so protecting the environment is an important norm for him and his co-workers. He expressed that people wanted to be in the norm and didn’t want to be the outsider. As is shown in the following:

“Like I said, I work in the Swedish energy agency...you have a lot of environmental  
buffs... I think those that go by car is [are] more ashamed.” -Member 1 in focus group 1

In the interview, the social norm was discussed in a detailed manner from the above three aspects. The effect of sweating on winter commuting was described as a barrier by some participants which is in line with previous studies that the choice of cycling is dependent on social norms (Cox, 2019; Heinen and Handy, 2012; Heinen, van Wee and Maat, 2010). The sweating social norm can be explained by Lee (2016) that in some working places working appearance that is related to sweating can increase the challenges of cycle commuting (Lee, 2016). What’s more, the environmental protection norm works as a motivator that promotes cyclists to cycle to work in winter, which also agrees that the cycle behavior can be affected by the social norms (Cox, 2019; Heinen and Handy, 2012; Heinen, van Wee and Maat, 2010). In the end, the working clothes didn’t seem to affect the cyclists’ cycling behavior, because the participants expressed that people were not strict with working clothes in Sweden. However, it would be complex to conclude because the norm of working clothes might be related to different companies, because there can be a difference in working appearance between people in different companies. This casual norm of working clothes can be further developed because it will affect the cycling behavior to some extent if some companies are stricter with the working clothes.

#### **4.4.3 Cycle-Friendly Atmosphere**

The question about a cycle-friendly atmosphere was discussed by both the winter cycle commuters and the non-winter cycle commuters. Positive attitudes and no specific attitudes were discovered in the interviews.

First, one participant didn’t consider cycle-friendly atmosphere, the advertisement, would affect her cycling to work in winter.

“It would be good, but I don't think that I would choose my bike more often because of  
that [the advertisement].”-Member 1 in focus group 2

By contrast, other participants expressed a positive attitude toward the cycle-friendly atmosphere, including the cycling advertisements, comparison campaigns, and the cycling activities that were held in the municipality. When asked about if people’s attitudes toward winter cycling would be affected when there were advertisements about that the celebrities cycling to work in winter, the traffic planner showed positive answers.

“If our royalties, the king and queen can do it [cycle], then everyone can do it” -Interview  
2

Some participants believed that comparison campaigns should be put in workplaces.

“I think, really that it's more effective. If your workplace has a comparison” -Member 2 in focus group 1

Additionally, the other participant expressed that advertising was important, but different kinds of advertisements should be shown to different groups of people. For example, the women commuters and some old commuters.

“I think that right, but just not for the whole society, but for groups. You have to be very specific [about] what you need to if you're going to use it, which are your targets for the campaign.”-Member 1 in focus group 1

What's more, technology was recommended by the participant to develop and improve a cycle-friendly atmosphere. Nowadays, mobile phone Apps can be used to create a cycling atmosphere. According to the quote below:

“We have like 2 years ago, and people are crazy about it, and you have this like a step counting contests. People can be animated to go by bike, obviously, but I think it needs to be advertised more.”-Member 2 in focus group 1

Moreover, during the interview with the traffic planner, advertisement on TV was considered a good way to develop winter cycle commuting.

“I think every TV channel can be available to get that kind of knowledge. It's important.”- Interview 2

The traffic planner also stated that there was a big weather difference between the south and the north. According to him, north Sweden is colder, but south Sweden is not as cold as the north part. If the television advertisement is about the people who live in the more northern part of Sweden cycling to work, and the people from the south can cycle to work in winter. The traffic planner stated that they could send a winter broadcast of a winter cycling conference on the national TV channel. Then the local press would write about it. For example, if in the TV channel, there were people who lived in the north of Sweden could cycle, then, of course, the people who lived in the south could cycle, and there were much more population in the south.

According to the interview results that are shown above, there is no concrete result about the influence of a cycle-friendly atmosphere, because of the different opinions of the participants. The no influence attitude is in contrast with (Heinen and Handy, 2012; Pucher, Komanoff and Schimek 1999 ). By contrast, others' positive attitudes showed that a cycle-friendly atmosphere is a motivator for winter cycle commuting, which is in line with the previous study that advertisements with famous people or appealing messages can be sent to improve the public image of cycles (Heinen and Handy, 2012; Pucher, Komanoff and Schimek 1999 ).

Eskilstuna municipality seems to have realized the importance of cycle-friendly atmosphere. The Eskilstuna municipality has taken procedures to improve winter cycling. First, the traffic planner stated that the municipalities had carried out campaigns to develop winter cycling. For example, the municipality used Facebook to share information about winter cycling and showed people how to prepare themselves during the winter days. As is shown below:

“Well, the easiest one is posts on our Facebook page. Use studded tires and the right clothes such as these small encouragements for people that almost are going to cycling winter...For people to know that it is not difficult to ride your bike in winter.” -Interview 2

Eskilstuna (2013b) states that Eskilstuna municipality has collaborated with different companies, such as Volvo and Mälars Hospital, by holding bike-to-work campaigns. Meanwhile, the municipality has used a cycling ambassador, who can inspire others to choose to cycle, as an element to attract citizens to cycling. Moreover, to give citizens a safety awareness of cycling, an annual bicycle and bicycle helmet campaign started in 2009. Even though it is not sure if these campaigns were not held to improve winter cycling, these campaigns can facilitate improving people's awareness of this cycle-friendly atmosphere. Thus, these are important to winter cycle commuting.

What the municipality has done here is in line with some of the participants' preferences, which is the cycle-friendly atmosphere is important. The campaigns and the cycling ambassador agree with the motivators that were preferred by the commuters. Thus, the Eskilstuna municipality might be able to inspire more commuters to cycle in winter by carrying out the campaigns with some companies and taking advantage of the advertisements. These advertisements can be represented by famous people and important figures to inspire more people to cycle to work in winter. Besides, advertising winter cycling to specific groups of people and using Apps on mobile phones might function well as implications to inspire more winter cycling.

#### 4.5 Policy

The participants were asked about their experiences with cycling policies. During the interview, various ideas were got from the winter cycle commuters, the non-winter cycle commuters, and the traffic planner. On the one hand, the commuters expressed that their decision of cycling will not be affected by the policy or plans. On the other hand, both positive and negative attitudes were shown in the interview.

To begin with, the policy wasn't treated as an important aspect that could influence the participants cycling to work in winter. There were mainly two points that explained this result.

First, the result of this interview showed that policy wasn't seen as a determinant issue to whether to cycle to work in winter. It was not a factor that could make them change their decisions about whether cycle to work in winter because they had a strong feeling about cycling to work. As is shown in the quote:

"It [The policy] doesn't matter to me. I decided to cycle, anyway."-Interview 1

Second, the policy was not an element that could affect the cycling behavior because the policy couldn't deal with the problems that prevented them from cycling in winter, such as the risks because of the slippery road. It is not an element that has a decisive function. The participant didn't care about what was written in the policy, but care about what could be done to deal with the important issues. When asked about if the policy would affect her cycling behavior, the participant said that:

"No, because if the risk of slipping is still there, I don't want to cycle in the winter." - Member 2 in focus group 2

However, both obvious positive and negative attitudes were shown in the following paragraphs because of the benefits and the obstacle of the policy.

First, one cyclist expressed a positive attitude toward the policy. She held the opinion that a good policy could give her a feeling of safety. The participant expressed as follows:

"Yes, I feel more secure in the traffic environment, I think that [the policy] would affect me."-Member 1 in focus group 2



What is stated in the quotation proves that to this participant, a relative supportive policy plays a crucial role in making decisions about cycling to work in winter. Thus, the policies were considered a determining factor and can motivate her to cycle.

Second, a strong negative attitude toward the issues of the policy was presented during the interview. The participants were critical of the fact that the policy was more focused on cycling during the election period. However, after the election, the policies about cycling were not well taken care of in real planning. The parties showed ambitions about what they would do, but after the election, the plans and the ambitions seemed not to have been carried out as was said during the election period. It is stated in the quote that:

“During the election round. They try to and say my party will do...we are going to have more bikeways, get rid of some of the cars.”-Member 2 in focus group 1

As is seen above, the negative attitude toward the implementation policies. Hence, it seems that participants have an expectation of the carrying out of the policies, which means policies are motivators for them to cycle in winter if the policies are well planned and carried out in the real life, instead of during the election period.

Meanwhile, another participant expressed a negative attitude toward the cycling action that was carried out for a period and the action hadn't been long-lasting. because the policy could not function well if it only lasted for some time.

“They had bigger ambitions for the cyclist a couple of years ago... They built more cycle lanes than now. It's a bit of stuffs in their priorities facing out other things.” -Member 1 in focus group 1

It is easily seen that the cyclists are looking forward to long-lasting policies. And they consider it as important. Thus, we can say that the long-lasting plans might have the potential to promote winter cycling.

According to the interview results with the commuters. The influence of policy on winter cycling behavior is different to different cyclists, and the effectiveness of the policy and plans are also decided by how well the plans are carried out. The minor influence of policy on decisions on participants in this study doesn't agree with Cox (2019) that the policy formation process is necessary to bring about the required changes in cycling advocacy. But the positive attitude toward the security that the plan brings and the expectation for a well-made and long-lasting plan are seen as having the potential to increase winter cycling, meaning the cycling behavior can be affected by the policy, which is in line with (Cox, 2019). The participants' experiences were also in line with the previous study by Pucher, Dill and Handy (2010) that policy is critical to improved cycling plans such as the land-use policies and transport policies.

Besides all the attitudes from the commuters, the traffic planner expressed his opinion on winter cycle commuting. The interview results showed various aspects of the policy and cycling plans for winter cycling. Most of the results are about the challenges that the Eskilstuna municipality met in developing winter cycle commuting, which might be considered barriers for winter cycle commuting.

To begin with, the traffic planner stated a positive attitude about the cycle plans in Eskilstuna municipality. As is shown below:

“In terms of strategic planning where we're very much ahead and then know what to do in city planning to encourage the sustainable transports” -Interview 2

As is shown above, the traffic planner admitted that what is written in the document is very updated. This can be shown in the traffic plan documents. For example, when related to the cycling policies and plans, the Eskilstuna municipality has focused on developing cycling.

Eskilstuna (2013b) mentions that the revised master plans in Eskilstuna municipality have a clear goal of prioritizing the cycle as a mode of transportation. It is also stated that bicycle was claimed to be the norm when planning for buildings. In addition, convenient, safe, and secure cycle paths to the important destination points, such as workplaces are prioritized in the plan. What's more, this plan shows the municipality has the target of motivating sustainable transportation, and the goal is to double bicycles from 13% to 26% by 2020. Thus, it appears that the municipality has the target of developing cycling plans and has shown attention to cycling in the plans. Obviously, winter cycling will be benefited from these plans because winter cycling is a mode of cycling, and winter cycling can benefit from the secured cycle path to the workplace and the goal of motivating sustainable transportation.

However, challenges were expressed in the following paragraphs. To begin with, the traffic planner expressed negatively about the measures that were carried out, because there were challenges when it came to putting what was written in the plan into action. As is shown below:

“It is a bit disappointing. And maybe that's one of the obstacles as well that we don't take the steering documents seriously enough.”-Interview 2

It can be seen from the quote that even though the municipality has very detailed plans considering encouraging cycling, there is a problem that the municipality doesn't pay enough attention to carrying out the plan. Thus, it seems that a lack of action and measures might be a barrier to developing winter cycling.

Besides, there is not enough attention paid to winter cycling, because it takes such a small part when compared with other modes of transportation. The lack of attention was considered a challenge that deterred the development of winter cycling on a large scale. The traffic planner's statement is showed as below:

“The money spent interest of this [winter cycling] is not that high. Both the society, also both the government and others find winter cycling as something that the small group of people do and not cycling for the bigger mass of people.”-Interview 2

In addition to the lack of awareness of the society and the municipality, the traffic planner also expressed concerns about the lack of actions in the Sörmland region. The lack of action on winter cycling plans from the Sörmland region is an important issue that deters the development of winter cycling. Because when it comes to the resource that is spent on winter cycling, the resources come from the Sörmland region. The result stated that the Sörmland region didn't exert enough pressure on the municipality, and the resource that was spent on winter maintenance was not enough.

“And hospitals in Sweden are funded by the regions, but the region doesn't put any pressure on municipalities to increase winter maintenance.” -Interview 2

As is stated above, not enough attention paid by the region is considered a challenge for developing winter cycling. Hence, it is a barrier to enhancing winter cycling in the Eskilstuna municipality. However, considering about carrying out the plan, there are more challenges.

The interview with the traffic planner identified the challenges and barriers that prevent the Eskilstuna municipality from carrying out the plans, such as the lack of action in practice, the lack of awareness, and the lack of actions in the Sörmland region. All the barriers are important, but this study aims to identify the motivators and the issues. By analyzing the barriers and issues, the result of this study can only offer implications to the Eskilstuna municipality. However, when mentioning how to carry out the plans, is another research field, such as how to make the balance between different areas and how to spend the resources. It would be interesting to see how the winter cycling plans can be carried out in future research.

## 4.6 Economy

The economic factor was asked among the participants. The interview got two interesting results. On one hand, the participant didn't think the economy will affect their decision of buying a car. On the other hand, the participant talked about their colleague from relatively poor countries considering a car is important.

The participants in this study are from Sweden, which is a developed country. People have a high standard of living. Almost all the participants in this study hold the opinion that they have the money to buy a car, but they don't think they consider a car is an indicator of high social status. For them, they don't need to consider the economy of buying a car and they don't consider cars as luxury stuff. Member 1 in focus group 1 stated that she had the money to buy a car, so if she cycled to work in winter or not wasn't decided by the economy.

Even the non-winter cycle commuter, member 1 in focus group 2 said that money was not a factor that prevented her from cycling to work in winter. However, this participant stated that one of her colleagues was from India. That person stated that it was a high social status to buy a car, and it was only the poor people who cycle to work. What the participant expressed is that the people in poor countries tend to buy cars to show their high social status.

“We had colleagues from India a couple of years ago, and we just talk about cycling and they said in India. It is a high status to have a car. They didn't bike because it was just poor people that cycled.” -Member 1 in focus group 2

Now, the contrast is when people have the money to buy a car, they don't buy it and when people don't have the money to buy a car, they consider a car important and a high social status. According to this contrast, we can assume that it might be because Sweden is a developed country, most people have a good economy and a high standard of life. Thus, we can guess that a good economy might work as a motivator for them to cycle because they don't need to buy a car to show their social status. This assumption follows the previous study about the cycling and economy which says in poor societies, cycles are seen as archaic and these societies aspire to the car, however. However, in the most affluent societies, the attitude toward cycling is in the other direction, which means people in affluent countries are prone to cycle (Newman 1999, 189, cited in Rosen, Cox and Horton, 2007). A good economy might be a potential factor that contributes to their cycle behavior because that person can both afford a car and a great bicycle, as well as all the necessary gear and clothing to make it comfortable. Hence, the economy topic in this study might serve as an example of Cox (2019) that the choice of cycling depends on the economic structure.

## 5. Conclusion and Recommendation

### 5.1 Conclusion

This study explores the motivators and barriers of winter cycle commuting by conducting interviews and focus group interviews with commuters and the traffic planner in Eskilstuna municipality. This study makes contributions to the current research by identifying and analyzing the motivators and barriers for cycle commuters in Eskilstuna municipality. In addition, potential research directions are raised by this research for future research on winter cycle commuting. The interview questions that were discussed were mainly established according to the theoretical frameworks that are related to cycling behavior in Cox (2019) which includes the rider, the machine, the space consisting of infrastructure, low temperature, the wind, darkness, the scenery, the society containing social norm, culture, cycle-friendly atmosphere, the policy, and the economy. The factors that might influence cycle behavior are based on the themes above. Thus, by using these themes and carrying out the interviews, motivators, barriers, and irrelevant factors were identified and analyzed. The following paragraphs are about the motivators, barriers, and irrelevant factors considering winter cycle commuting in Eskilstuna municipality according to the individual preferences of the participants.

#### 5.1.1 Motivators

To begin with, factors related to safety, well-being, rational riding and ritual riding, social influence, the cycle, environmental protection, and economy appeared to be the motivators that can potentially positively influence winter cycle commuting behavior.

First, in terms of safety, the cyclists considered that the prioritized cycle lanes and the construction of new cycle lanes that were related to the space where cyclists cycled to work and the policies that provided secure traffic were important. The prioritized cycle routes during the snowy weather were conceived to be positive factors for winter cycle commuting behavior. The reason was that cyclists appreciated the safety that the prioritized routes provided. Second, the motivation for cycling in winter came from the preference for well-being. Participants appreciated the physical activity brought by the wind and the exercises that they could do as rational riders. Third, being rational riders, some participants were positive about the convenience that cycling to work brought to them. And what's more, giving the rational riding a specific meaning and changing to ritual riding may have the potential to encourage winter cycle commuting. Fourth, the social influence, such as the cycling culture, cycle-friendly atmosphere, and the norm of environmental protection, was considered important. Participants in this study thought that social influence had the potential to positively affect commuters' decision to cycle to work in winter. They held the belief that they would be affected if other people cycled to work and some of the participants expressed that they were affected by the environmental protection culture. Meanwhile, social norms contribute as a motivator for some of the participants, because in the cycle norm society, driving cars to work was considered an unpopular behavior. In addition, a cycle-friendly atmosphere could serve as a motivator because of the positive cycle image that was delivered by the famous people or the influencer in the advertisements. However, advertisements for specific groups of people were prioritized according to the interview results because different groups of people had different preferences. Fifth, the cycle as a machine was considered important because a good cycle functioned well in reducing the risk that was caused by slippery roads. According to the interview, the participants conveyed that a good cycle was important when cycling to work in winter. Cycle as a machine is considered important because a good cycle with high-quality tires and cycle lights that can be puncture-free functions well in reducing the risk that is caused by slippery roads and the winter darkness. Sixth, environmental protection was considered a motivator because cycling

to work didn't produce pollution and greenhouse gas. Last, the factors related to the economy have the possibility to become motivators. Cycling is a cheap mode of transport. And the fact that Sweden is a developed country and citizens don't consider cycling as poor behavior, which is a potential factor that they choose cycles to work. Therefore, the above factors related to the space, the policy, the rider, the society, the cycle as a machine, and the economy can serve as examples of the theoretical framework in Cox (2019). And the environmental protection is in line with the previous studies that cycling is important to the environment (Woodcock et al., 2007; de Nazelle et al., 2011; Macmillan et al., 2014; Xia et al., 2013, cited in Prati, 2018, p.369).

### **5.1.2 Barriers**

The barriers regarding problems with infrastructure, issues related to the darkness, the uncomfortable feeling caused by snow, lack of practice and measures of the policy, and cleanness as a social norm have the possibility to lead to less winter cycle commuting.

To begin with, infrastructure problems. The maintenance of the infrastructure was complained about as a challenge that could hinder winter cycle commuting. For example, the refrozen snow after the snow was cleared was recognized as a big problem because even though the snow was cleared the melting snow made the cycle lane slippery. The lack of maintenance on the routes that were close to the commuter's homes, the first 500 meters from the commuter's home, was an important factor that deterred the commuter from cycling to work in winter. The slippery roads on the first 500 meters created a big concern because of the dangerous situation. Even though there was snow plowing on the cycle lanes, the piled snow on the cycle lanes could interrupt the cyclists from moving forward. The gravel could work well in dealing with the slippery. However, the gravel created problems, such as tire punctures, meaning that gravel was not preferred by the commuters as a good way to prevent risks in winter cycle commuting. The negative experience regarding the sudden disappearance of the cycle lanes was a big concern for the cyclists, because it was hard for cyclists to find a cycle lane to move forward near some of the roundabouts. The barrier related to infrastructure follows Cox (2019) in the aspect that cycling behavior can be affected by the space and the infrastructure is concluded in the space.

What's more, problems regarding the darkness. Darkness was also considered a barrier for the winter cycle commuters, which is in line with Cox (2019) from the aspect of the influence of space. Cox (2019) stated that the environment where the cycle behavior happens can affect the choice of cycling. The first problem related to the darkness was the cycle lights thieves, which is related to the darkness. The cycle lights stolen could make the cyclist feel insecure. The second factor related to the darkness was the lack of responsibility of the cyclists. Wearing a reflecting vest was important, but there were still some people who did not use a reflection vest, which created a potential safety problem. The third problem with darkness was the domination of the car and the traffic lights. It is hard for cyclists to be visible to the cars, which could result in safety problems.

In addition, problems with the snow. The uncomfortable feeling caused by the snow may lead to fewer winter cycle commuters because it was annoying to be soaked up by the snow. What's more, the ruts that were caused by the snow could also cause uncomfortableness. The snow on the cycle lanes could be slippery, which could cause danger. Snow, as a type of weather, is discussed by Cox (2019) that the weather is related to the cycling preference.

Last, issues concerning the policies. The lack of measures and practices was negatively claimed. The main issues were focused on lack of action, the lack of attention from the society and the municipality, and the lack of resources from the Sörmland region. It was admitted by the traffic planner that the Eskilstuna municipality had good cycle plans. However, there was a challenge when carrying out the plan considering the lack of awareness and balancing how many resources should be put into promoting winter cycle commuting. One of the reasons was

that when compared with the other traffic mode, winter cycling took up a small proportion. Therefore, the policy is in correlation with Cox (2019) that cycling is related to the policy.

### **5.1.3 Irrelevant Factors**

However, because there was the individual difference, even though the above factors were regarded can affect cycling behavior, the influence of these factors on the cyclists was not the same. This study had an interesting finding that some of the aspects that were regarded by Cox (2019) as aspects that could influence cycling behavior were considered irrelevant to winter cycling behavior. For example, the wind, policy, cycle-friendly atmosphere and culture, snow, low temperature, shower room, parking space, and scenery were considered minor factors by some participants, and could not change the choice of winter cycling behavior, which disagrees with Cox (2019).

First, for some participants, the wind was not a big issue to influence the decision of cycling to work in winter. Second, in terms of the policy, what was written in the policy was not as important as what could be carried out in practice. Thus, the policy was claimed as a minor factor. Third, the cycle-friendly atmosphere and the culture were not regarded as important factors because, for some participants, they just like cycling, and the behavior could not be decided by the atmosphere and culture. Fourth, even though the temperature in winter was low, it was not too low to prevent some participants from cycling in winter and cyclists could deal with the low temperature by equipping themselves with warm clothes. Second, the shower place was a minor factor. No negative attitudes were expressed even though there were no showering rooms. Fifth, parking places with roofs appeared to be not important in this study because they could park at other places. Even though there was no roof in the parking place, no negative experience was conveyed. Sixth, the scenery along the way to work was appreciated, but the appreciation of the good view was not considered to have the ability to affect people's cycling behavior. When comparing the infrastructure, the good view was an extra benefit, but it was not a determination of cycling behavior.

Some reasons might contribute to the results. First, this research has a limited time of the study. Hence, it is possible that the research didn't get enough interview results. Thus, the results might not reflect general ideas. Second, as is discussed by Cox (2019), cycling behavior is affected by multiple factors including the rider, the machine, the space where the ride happens, and the interrelated society, policy, and economy. Thus, it is reasonable that some participants choose to cycle because of some strong reason instead of all the factors. It might be that the participants cycle because of one factor, such as convenience. Thus, other factors couldn't affect his or her winter cycle behavior. It also might be that some non-winter cycle commuters didn't cycle to work just because of the darkness. Then the darkness is the only reason that deters him or her from winter cycle commuting, so this participant doesn't care about other factors. Hereby, to get a more general result, more research about the factors that are related to winter cycling commuting should be carried out. Last, as was mentioned in the method limitation, this research didn't gather enough participants. Thus, the results of the irrelevant factors may change if more participants were gathered. For example, this study only gathered the ideas of the cyclists. The irrelevant factors might change if the non-cyclists' ideas were gathered. Future research with a combination of qualitative research and quantitative research is needed when considering winter cycle commuting.

## **5.2 Policy and Research Recommendation**

According to the cycling plans, the Eskilstuna municipality has established plans to promote and enhance winter cycling, such as paying attention to clearance of the cycle lanes, adding bicycle networks, and improving the darkness that is caused by the special winter weather in Eskilstuna municipality. This study may help develop winter cycle commuting in Eskilstuna

municipality by presenting the following suggestions according to the motivators and barriers that were identified and analyzed. The following four suggestions are suggested.

First, even though individuals had different experiences, similar attitudes toward safety indicated that policies that focus on cycling infrastructure, maintenance, and reducing barriers for the cyclist may be important to enhancing winter cycle commuting. By dealing with the issues related to safety problems, the commuters should feel secure when cycling to work in winter. The second important consideration is the long-lasting policies that can be put into action and practice can facilitate enhancing winter cycle commuting. Third, resources regarding winter cycling from the Sörmland region and the Eskilstuna municipality can help in developing winter cycle commuting. With enough resources, infrastructure maintenance might be achieved. Forth, holding campaigns that allow cyclists to borrow cycles from the municipality is an important factor that can attract commuters to use cycles to work as a commuting mode.

This study identifies and analyses the motivators and the barriers for winter cycle commuting in Eskilstuna municipality and offers implications for the actions in winter cycle commuting in Eskilstuna municipality in the future planning of winter cycle commuting. The municipality and the Sörmland region can use the policy implications for the future planning of winter cycle commuting. When winter cycle commuting has been improved, this study can provide benefits to society, and the economy and improve people's health. As is said in previous studies, cycling is important to health (Oja et al., 2011; Sommar et al., 2021; Schantz, Salier Eriksson and Rosdahl, 2020; Donaire-Gonzalez *et al.*, 2015). On a social scale, cycling helps protect the environment (Woodcock *et al.*, 2007; Woodcock *et al.*, 2007). From the economic perspective, cycling helps save economic costs (Katzmarzyk and Janssen, 2004; Gotschi, 2011). What's more, this study is important for future research. There are some previous studies about the seasonal influence on commuting, such as the influence of low temperature, wind, and precipitation (Spencer *et al.*, 2013). However, it is not easy to find studies that combine all three elements: winter, cycle, and commuting. Thus, the study result of this research can offer implications for future research that are related to winter cycle commuting. Besides, the results can be used and beneficial to improve the winter cycle commuting in other cold areas, such as North American cities and north Europe cities. In terms of the research recommendation, balancing the resources for winter cycling commuting can be researched in the future, such as a principal standard of how much resources can municipalities put into developing the winter cycle commuting. With the principal guideline, it might facilitate the municipalities in deciding how to allocate the resources for winter cycle commuting.

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