UNIVERSITY OF STAVANGER

Bicycling & Weather: The effect of weather related factors on bicycle commuters in Stavanger, Norway

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Abstract

Bicyclists and bicycle commuters in many parts of the world face various challenges congenital simultaneously non-motorized transportation and car-centric roadways. Bicycle commuters in west coastal city Stavanger of Norway confront the obstructions of the north Scandinavian climate in addition, which makes bicycling exceedingly a seasonal activity. On the other hand, bicyclists in Stavanger keep on facing limitations of transportations, particularly when defeating northern weather conditions. The purpose of this study was to focus on the leading concerns for bicyclists in Stavanger with the aim of identifying and perceiving distinctive challenges by various weather conditions, which can be defeated by policy, behavioral and infrastructural improvement. The researcher examined the issues surrounded around bicyclists in Stavanger through in-depth contented exploration of transcripts from focus groups and individual interviews. Therefore, precipitation, wind, cold temperatures, inclement road conditions, limited daylight hours and wind were determined as unregulated obstructions for bicyclists all around the year. These obstructions have set the parabolic resistance on many potential bicycling trips. The dealing of such issues was identified to be identical to individual bicyclists that stood on perceptions of cyclists on subtle variations in weather conditions on individual easement and safety.

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DEDICATION

To my beloved parents for their love

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Chapter 1 – Introduction

1.1 Introduction & Background of study

Various previous studies about the relationship between the environment and bicycling show that bicycling is an alternative transportation mode, which has close associations with features of the built-environment, conservation of nature and sustainable development of a society (Hino, Reis, Sarmiento, Parra, & Brownson, 2013). Bicycling is widely advocated to be a beneficial way to achieve sustainable, natural development of a region (Chang & Chang, 2003). Climate change, healthy lifestyles, accessibility, livability and the relevant policies to promote active transport modes over car usage are of increasing societal interest (Böcker, Dijst, & Prillwitz, 2013). Many researchers have investigated the relationship between bicycling and the environment from various perspectives (Böcker & Thorsson, 2014). These perspectives include bicyclists in many areas of the world (Spencer, Watts, Vivanco, & Flynn, 2013), particularly high latitude countries such as Northern America, Canada and the Scandinavian countries face various challenges, including those caused by different weather conditions, such as heavy rainfall, strong wind, snowfall, temperature and seasonal extremes of darkness (Spencer et al., 2013). Therefore, bicycling may be more or less appropriate in all areas at different times of year because of a various types of geographical reasons and different climates, as because of the weather variability. For instance, climates of south European countries are not same as Scandinavian countries; there are differences in the weather between the cities by the sea and cities far away from the coast (Beierle, 2011; Faulks, Ritchie, & Dodd, 2008; Lamont, 2009; Ritchie, 1998; Ritchie & Hall, 1999; Ritchie, Tkaczynski, & Faulks, 2010). Researchers differentiate weather conditions by indicating as bad and good weather conditions for cycling and these will now be addressed.

As stated in the above paragraph, various weather conditions are challenges for bicyclists, bad weather conditions such as heavy rain, strong wind, snowfall and low temperature are real obstacles for the cyclists to cycle. These kinds of weather conditions are challenges for cyclists who use bikes as their only form of transportation and the reasons are, firstly, it is risk of accidents to bike in the bad weather conditions and secondly, it is not comfortable. On the other hand, good weather conditions refer to sunny days with mild temperature and gentle breeze or no wind, which are very favorable conditions for bicycle commuters. The studies prove that cycling behavior, practices and enjoyment depending heavily on weather conditions (Amiri & Sadeghpour, 2015; Flynn, Dana, Sears, & Aultman-Hall, 2012). It is delightful to bike on a lovely sunny day with a mild temperature and it is not comfortable in heavy rain, windy, snow, low and very high temperature. Therefore, according to the above-mentioned studies, both good and bad weather conditions have effects on the desire and intention of the bicycle commuters to bike or not to bike.

A study conducted by Spencer et al., (2013) mentioned that, the lifestyle is unstable in northern geographical climates, which requires daily and seasonal adjustment in order to live comfortably. In their research in Vermont, USA, they examined how bicyclists narrated and perceived the initial ways of their bicycling practices, which influenced and formed the geo-environmental context. Bicyclists face challenges in using non-motorized systems and in addition as a cold northern region, there are obstacles posed by unstable environmental conditions such as sudden heavy rain, heavy wind and snowfall. Therefore, bicycling has become a seasonal activity for many areas. Research within the last decade around the North American and northern European cities such as; Vermont, Portland, Stockholm, Amsterdam, Copenhagen and Berlin shows that despite the obstacles, bicycling is a functional transit mode and durable substitute to automobile transportation

in many northern American and European cities (Iacono, Krizek, & El-Geneidy, 2010; Pucher, 2005; Pucher & Buehler, 2008; Pucher, Buehler, & Seinen, 2011; Wahlgren & Schantz, 2012). The published article of Spencer et al. (2013) cited this statement too. Therefore, based on these above-mentioned pieces of research and the research of Spencer et al., (2013), this study adopts a similar approach that focuses on Stavanger region of Rogaland where the variations of the weather conditions may hinder bicyclists to bike ("Rainfall/ Precipitation in Stavanger, Rogaland, Norway," 2014; "Welcome to Destination Rogaland," 2014). According to this study, local bicycle commuters in Stavanger confront a variety of daily and seasonal weather variations, but still bicycling is as an important part of the city's recreational and transportation networks for them.

1.2 Purpose and the aim of this study

The main purpose of this study is to understand the relationship between the weather conditions and bicycling behavior in Stavanger. This study is aiming to investigate various climatic situations that obstruct and encourage bicyclists to bike in the Stavanger region, Norway. This study aims to recognize and realize the bicycling behavior within the Stavanger region in different weather conditions. It further aims at the perceptions and opinions of bicyclists towards biking in the bad weather and good weather conditions in Stavanger; where bad weather refers to heavy rain, strong wind, very high-low temperature; ice-conditions on bike paths etc. and good weather condition refers to lovely sunny days with mild temperature gentle breeze. More precisely, this study aims to present the effects of various obstacles that are caused by unstable weather conditions on bicycle commuters in the Stavanger region. Thus, the purpose of this study is to focus on bicyclists in the Stavanger region, to identify their perceptions and opinions towards the challenges by various weather conditions; and in addition, it is to investigate the effects of different climatic conditions

on their cycling behavior. It will then investigate cyclists' opinions on how these challenges can be overcome by the improvement on bicycling infrastructure in Stavanger, Norway. These opinions and perceptions of the bicycle commuters in Stavanger can express a general idea of bicycling behavior in this region. Therefore, these can be helpful suggestions for policy makers, in terms of investment on the planning for bicycling facilities in the Stavanger with various weather conditions. A very recent study in Calgary, Canada was conducted among the cyclists on a newly implemented bike lane and concluded similarly (Amiri & Sadeghpour, 2015), by suggesting the policy makers in terms of investment on the planning for bicycling facilities.

1.3 Research objective

The objective of this study is to examine how local bicyclists in Stavanger describe the primary ways of their bicycling practices and behavior, when various weather conditions have impact on this. This study will address the effects of various challenges that are caused by unstable weather conditions on bicycle commuters in the Stavanger region. So more specifically, the objectives of this study are:

- To investigate the role that individual preference for various weather conditions plays in cycling to work in Stavanger.
- To investigate various challenges that are caused by unstable weather conditions, such as heavy rainfall, heavy wind, heavy snowfall, low temperature, darkness etc. that affect the desire and intention of the bicycle commuters to bike in Stavanger region.

1.4 Research questions

The research questions are:

- What role does individual preference for various weather conditions play in biking to work in Stavanger?
- What are the various challenges that caused by unstable weather conditions, which affect the desire and intention of the bicycle commuters to bike in Stavanger region?
- What are the cyclists' opinions on how these challenges can be overcome by the improvement on bicycling infrastructure in Stavanger, Norway?

1.5 Thesis structure

This study is organized in five chapters. Chapter 1 discusses the introduction and background of study, purpose and aim of this study, objectives and questions of this study. Chapter 2 presents a critical review of relevant literature, where the researcher analyses recent and previous empirical studies in the field. Chapter 3 explains aspects of research methodology and the method of this master thesis along with the materials and study context. Chapter 4 presents the findings of the study along with the analysis and discussion of the results. Chapter 5 reflects upon the limitations of the current research and then conclude the master thesis with recommendations from this study.

Chapter 2 - Literature review

This chapter presents a critical review of relevant literatures, where the researcher analyses recent and previous empirical studies in the field. There are a number of studies found, which were conducted in USA, Europe, Australia and Asia about bicycling. Similar studies are referring the studies on transportation research record, transportation and environmental sustainability, physical activity and transportation, bicycling tourism and sustainability, physical activity and health, accident analysis & prevention on bike paths in transport system, motivation for active transportation, environmental health and public health, transportation policies & practice and so on. The studies are regarded from recent published journals in the USA, Europe, Scandinavia and Australia in the above mentioned research fields. Based on the previous empirical studies, this chapter is going to start by demonstrating the relationship of bicycling with the various factors of season, weather and climate. According to those various factors, this chapter will narrow down to describe the specific variables of this study, which have large impacts on bicycle commuters in Stavanger. In order to do so, this study reviewed the literatures according to many previous and recent studies in the similar field.

2.1 Season, weather and climate related connection for bicyclists

Many researchers within the transportation sector are conducting studies to comprehend the challenges against bicycling to increase cyclists and development of social (Burton, 2003; Burton, Jenks, & Williams, 2013), climate related (Dill & Carr, 2003; Hanson & Hanson, 1977) and physical benefits of transportation (Dill, McNeil, Broach, & Ma, 2014) in proactive ways, in addition to achieve the green sustainable environment by environmental friendly transportation

mode (Sallis et al., 2013; Tolley, 1990; Wadud, 2014), traffic fulfilment (Bassett Jr, Pucher, Buehler, Thompson, & Crouter, 2008; Schäfer, 2009). The statement above is drawn from the recent study of Spencer, et al., 2013. Findings of the above-mentioned studies proved and recommended that it be worth confronting the challenges against bicycling to achieve a green viable society. These researchers related bicycling with social development, improvement in the environment, improvement in the health sector, developing transportation infrastructure and the achievement of significant moves towards sustainable societies.

Several other recent studies have supported these advantages of bicycling such as (Bauman & Rissel, 2009; Oja et al., 2011). These authors mention various reasons like; bicycling is a very good physical exercise, which actually assist to reduce the expenses of healthcare system in a society in the long run. They farther demonstrated that infrastructure of cycling is very cheap, paddling itself is free and it is quicker way of local transportation. So, despite high increase in bicycling behavior over the last 10 years, there are still challenges by socio-economic issues; expenses, time of travelling, safety, environmental, psychological factors for the bicyclists (Heinen, van Wee, & Maat, 2010). This statement depicts the challenges from various sectors for bicyclists. They further described the challenges by unstable weather conditions are in many areas of the world as environmental factors that effect on bicycle commuters. The researchers, such as (Dill & Voros, 2007) observed various climatic variables; such as rain, wind, snow, temperature, which influence highly on the bicyclists whether to bike or to be in doubtful to bike besides these socio-economic issues. In addition to those variables, another study of Spence, et al. 2013 included day light hours and road conditions in the rain or in the snow. Therefore, based on the study of Spencer, et al. 2013 in Vermont, USA, this study focuses on the specific weather related factors in

Stavanger region that impact on local bicycle commuters such as temperature, wind speed, day light hours, precipitation (rain, snow and ice), road conditions and infrastructure of bicycling paths. The effects of individual variables on the local bicycling commuters are addressed in the following parts of this chapter.

2.2 Temperature

Many researchers within last decade mentioned temperature as a cabalistic cause, which has a great impact on bicycle commuters (Bergström, 2003; Bergström & Magnusson, 2003; Flynn et al., 2012; Parkin, Wardman, & Page, 2008; Thomas, Jaarsma, & Tutert, 2013). A recent published article depicted that temperature is even able to impact on the bicycling behavior (Brandenburg, Matzarakis, & Arnberger, 2004) while it becomes uncomfortable with the other weather conditions such as precipitation. When the temperature is high with uncomfortably hot (Miranda-Moreno & Nosal, 2011), that is even considered as a motivator to bike in several cases, as this is a way of good exercise by sweating more (Thomas, Jaarsma, & Tutert, 2009). On the other hand, low temperature is commonly taken into account as an opposite (Rondinella, Fernandez-Heredia, & Monzón, 2012; Winters, Friesen, Koehoorn, & Teschke, 2007). Bicycling in low temperature is also considered as good exercise to warm up the body. So in brief, previous studies describe temperature as meaningful and useful variable of the research process in this field. Above-mentioned studies found that low temperature along with rainfall, wind, snow, fog, ice conditions make uncomfortable to bike or demotivate the bicycle commuters. Weather condition with mild temperature and gentle breeze makes bicycling very delightful, whereas, in several cases very hot temperature is a kind of motivator to bike because of geographical locations. Moreover, previous studies show that temperature influences on female bicyclists differently than the male (Saneinejad, Roorda, & Kennedy, 2012). Temperature is proven as more significant factor for

female bicyclists than men. Studies found that females combined walking with using their bicycles, while males combined cycling with the public transports on the trips in the high and low temperature conditions. Females seek to be more warmed up in the cold temperature by combining their trip with biking and walking. In the same way, in the uncomfortable hot weather females tend to combine biking with walking in their trips.

2.3 Darkness

Darkness is one of the dominant factors that is influencing to reduce bicycling during the winter time (Cervero & Duncan, 2003). Because of the shortage of light in the winter, many bicyclists change their transportation mode to the public service. Studies have shown that shortage of day lights tends to lead to many bicyclists becoming inactive. The reasons behind that are proven in the past research addressing poorly developed bicycle paths with sufficient lighting. Cloudy conditions also create similar choice transportation mode for bicyclists. Past researches by Thomas et al., (2009) & (2013) also ascertained that sunlight and cloudy conditions have big impact on the behavior of the bicyclists. Moreover, according to same studies, darkness along with rainfall, snowfall and windy conditions have never been considered as bicycling friendly. The bike paths through the forests without lamps are considered more dangerous and more likely to result in accidents for the bikers. More scientists take into account that less road lamps and street lights are also operative measure in reducing the safety and increasing the possibility of accidents of the bicyclists (Kim, Kim, Ulfarsson, & Porrello, 2007). Recent study even presented that female bicyclists are more likely to value lighted bicycling facilities than the male and they calculate darkness as a travel factor (Heinen, Maat, & Van Wee, 2011). According to the researches, female bicyclists give extra value to bike in the lamp facilitated bike paths because of less bike accidents by crashing with other bikers and safety reasons.

2.4 Precipitation

There are several situations of the precipitation in the weather condition such as rainy, snow, sleet and ice condition (Bergström & Magnusson, 2003; Cervero & Duncan, 2003; Parkin et al., 2008). That means precipitation is defined by several individual weather conditions such as rainfall, snowfall, ice, fogy and sleet. Studies of the same researchers show that all types of precipitation have a big effect on bicycle riding behavior. The number of bicyclists is often determined by the duration of these kinds of weather conditions, which has been proven by the study of Thomas et al., (2009) & (2013). Rainy condition is more unlikely tolerable for recreational bicyclists but on the other hand, it is slightly different for the regular bicyclists (Brandenburg et al., 2004). That means the bikers who do not bike as their only form of transportation do not prefer to bike in the rainy conditions, which shows rain is a big hindering factor for the bicycle commuters. More precisely, same study shows that the regular bicyclists who use their bike as the only form of their transportation, still bike in the rainy conditions, which is not as comfortable as in the dry condition. Rainy condition along with wind are significant challenges for bicycle commuters. Moreover, precipitation with snow, fog and ice conditions are also one of the biggest challenges for the bicyclists who bike regularly and that is found in the study of Flynn et al., (2012). Recreational bicyclists do not prefer to bike in any of the precipitation conditions. However, the regular bikers try to avoid biking in the snow and ice weather condition. Because in the rain situation, bicyclists can wear waterproof cloths but in the snow and ice condition on the bike path, there are risks of more accidents even when the commuters use snow tires (Rietveld & Daniel, 2004; Rondinella et al., 2012). Moreover, the research shows more precisely that the injury rate in this kind of weather conditions is even higher for women bicyclists than the men bicyclists (Krizek, Johnson, & Tilahun, 2005) and the study by Spencer et al., (2013) cited this statement too.

2.5 Road conditions

Empirical studies show that various road conditions have big impacts on the bicycling and bicycle commuters (Bergström, 2003; Bergström & Magnusson, 2003), in the words of Spencer et al., (2013), "…including snow clearance, ice treatment and driver interactions". Road conditions with connection to bicycling are defined here as the infrastructure of roads, attitudes of the road users and the maintenance during the bad weather conditions such as removing the snow, ice treatment by salt, draining the water in the rainy condition, maintaining enough shadow to get protection from the wind, interactions and interruptions by the drivers for bicyclists. Studies of several researchers such as (Bergström & Magnusson, 2003; Winters et al., 2007), mentioned that "…cold-climate bicycling suggest that measures such as snow removal, road salting, or sanding could mitigate cycling declines due to freezing conditions…" Spencer et al., (2013) cited that statement in their published article as well. These maintenances on bike paths during the cold weather are useful to reduce accidents. The attitudes of the drivers on the roads can be a reason of interaction and interruption for the bicycle commuters (Horton, 2007; Mullan, 2012). Researchers refers the attitudes of the drivers to rough driving, drive on the specific bike lanes, not giving priority in the roundabouts, which make bicycling uncomfortable and more risky for the regular bikers. In the same time, bad weather situation is an additional reason of less safety in the road. Past studies show the reasons careless driving in the bad weather is stress of the drivers in the bad weather. They mentioned more precisely that road users, who are on the way to work in the bad weather condition, feel stress of being on time at work. Moreover, the differences within the attitudes of the drivers in different genders were found in the bad weather conditions (Walker, 2007). More interestingly, researchers stated that different perceptions among the male and female cyclists; also male and female drivers on the road too (Emond, Tang, & Handy, 2009; Garrard, Rose, & Lo,

2008). These studies show that female drivers become more stressed than the male in the bad weather for the possibility of getting late at work and such stressful driving occur more accidents with bicyclists. Therefore, within all these connections, female cyclists percept more unsafe than the male cyclists in the bad weather condition. Researchers mention age of drivers and bicyclists as another demographic variable at this point. Younger drivers below 35 years of age are more likely to be involved in road accidents with bicyclists because of the less experience on driving in the bad weather condition. Again, younger bicyclists below 35 years are more likely to commit accidents on the bike paths because of comparative careless biking in the bad weather condition. Thus, the above-mentioned researches show how road conditions in the bad weather can become challenge of bicyclists in various perspectives.

2.6 Wind Speeds

High speed of wind is able to reduce the bicyclists on the road, because of risk and uncomfortable and difficult bike riding situation, as it has been mentioned in the recent studies of Flynn et al., (2012) & Thomas et al., (2009). The study shows that in the very windy weather condition the number of bicyclists become less (Tin, Woodward, Robinson, & Ameratunga, 2012). In the words of Spencer et al., (2013), "Wind speed, or rather the binary presence or absence of wind, is especially important, because stronger winds tend to deter cyclists more than lighter winds", where they refer the findings of Flynn et al., (2012); Heinen et al., (2011) & Thomas et al., (2009). Biking in heavy wind is more dangerous because there is always a chance to blow away or fall over from the street and on bike paths, which can causes serious accidents. Biking in heavy wind condition from all directions is never fast and even fast biking is more dangerous because of both high speed of bike and the wind. So it becomes more tiring to bike in high and variable wind conditions. Therefore, it seems like very windy weather conditions have significant effects on the bicycle

commuters than the passersby or pedestrians (Saneinejad et al., 2012). That means in this weather conditions, many bikers do not prefer to bike, but they become pedestrians or prefer to use pubic transports. Regular local bikers who use bikes as their only form of transportation, heavy wind conditions become a very big challenge for them.

2.7 Other relevant factors

According to the analysis of the above-mentioned previous studies, this chapter has presented various challenges, which are caused by the weather. Several recent studies of several researchers show some other relevant factors, which are hindering and motivating bicyclists to bike or not to bike (Burton, 2003; Burton et al., 2013; Heinen et al., 2011; Heinen et al., 2010). They found the expenses of other transport modes as a motivational factor for bicyclists to bike. For example, the expenses of public transports and the use of personal cars or motor bikes depend on the fuel prices, whereas bicycling is free of cost. Therefore, studies show that fluctuations in travel expenses are such thing, which has influence on the bicyclists. Time of cycling to work compare with public transport and other transportation modes are mentioned here too as an effective factor too, as biking to work is lot quicker than using cars or public transports in many cities in the world. It is further mentioned about the interest in healthy living in society is a motivational factor to bike. Moreover, the same study also noted that existence of changing or shower facilities after bike to work has influence on biking behavior. These facilities at working places are able to motivate cyclists to bike to work and to be punctual. That means lake of these facilities stand as challenges for bicycle commuters in addition to the challenges caused by the unstable weather conditions.

To conclude this chapter it can be said that various kinds of weather related barriers have been addressed in this chapter based on the recent and previous studies. Researchers have demonstrated the challenges for bicyclists from the environmental and socio-economical perspective. This chapter has presented firstly the connection of bicyclists to season, weather and climate related factors. Then it has farther defined several weather related challenges and other socio economic relevant factors individually. More precisely, this chapter has identified specific variables and challenges for bicyclists caused by weather such as temperature, darkness, precipitation, wind, road condition in the unstable weather. Then the expenses of public and other transportations, healthy living, time of biking to work, changing and shower facilities at work are identified as socio economic challenges. Referencing a number of relevant studies by various authors these individual variables of this study proven sensible, valid and useful for this study in Stavanger. Therefore, same as previous relevant studies, this study will be able to draw number of recommendations with suggestions to make bicycling safer and more comfortable by mitigating all these weather related and socio-economic challenges in Stavanger. The next chapter is going to present the methods of this study.

Chapter 3 - Methodology and methods

This chapter provides a detail account and full justification of how the research has been conducted. In order to do so, the chapter will describe the context of the study, research methodology, research materials and units of analysis, strategy, sample, data collection and analysis that are used in this study. The main purpose of this study is to focus on bicyclists in the Stavanger region, to identify their perceptions and opinions towards the challenges by various weather conditions; and in addition, to investigate the effects of different climatic conditions on cycling behavior. The objective of this study is to examine how local bicyclists in Stavanger describe their bicycling practices and behavior; and how various weather condition, infrastructure impact those practices and behaviors. Therefore, according to the purpose and objective, the main research question is; *what are the various challenges that cause by unstable weather conditions, which affect the desire and intention of the bicyclists to cycle in Stavanger region*? This chapter outlines and explains the methodology and methods, which are employed to achieve objectives of this proposed research.

Research processes can be divided into two major categories namely qualitative and quantitative (Saunders, Saunders, Lewis, & Thornhill, 2011). Qualitative methods are those methods used in analyzing qualitative data. It is more likely to look into people's in-depth feelings, for example, attitude (Miller & Kirk, 1986). Unlike quantitative research, which uses ad hoc procedures to define and measure variables (Seale, 1999), qualitative research tends to focus on describing the process of how we define and measure variables in everyday life (Silverman, 2000). On the other

hand, quantitative processes are those, which are used for deductive analysis. Moreover, qualitative researches find precise results of the studies with 'who' or 'what' research questions (Savin-Baden & Major, 2013). In the words of Savin-Baden & Major (2013), research methods can be classified in a dichotomy between quantitative and qualitative research. As far as the description and explanation of phenomena are concerned, quantitative research focuses on analyzing numerical data whereas qualitative research deals with meanings, examining the attitudes, feelings and motivations of people (Neuman & Neuman, 2006; Savin-Baden & Major, 2013). Therefore, according to purpose and objectives of this research, the current study designed and implemented qualitative methods.

Generally, there are three types of research approaches such as, exploratory, descriptive, and explanatory approach (Neuman & Neuman, 2006; Saunders et al., 2011; Savin-Baden & Major, 2013). Exploratory approaches are useful when the purpose is developing hypotheses, models or theories (Neuman & Neuman, 2006; Saunders et al., 2011; Savin-Baden & Major, 2013). Descriptive approaches are used to explain event revealed with a reference theory or model. The explanatory approach is useful to test cause-and-effect relationships (Savin-Baden & Major, 2013). Based on the previous studies in the similar field and considering the purpose, objectives and research question, this research used descriptive and explanatory approaches.

3.1 Context of Study

In this section, the researcher is going to describe the geographical location and the unstable climatic conditions of Stavanger, where this research has been conducted. This descriptive part is

intended to assist the readers to realize the challenging weather conditions of Stavanger for bicyclists and the importance of this study in this region.

All the respondents participating in this study live and work in Stavanger region, using bicycles firstly, as their primary mean of transportation, secondly, their secondary mean of transportation and thirdly, for recreational and outdoor activity purposes. Stavanger is located on the south-west coast of Norway, which is the third largest metropolitan area in the country (Irena Guidikova, 2014). According to the same report, Stavanger is the administrative center among 26 other municipalities of Rogaland County, with the local municipality itself is the most populous in the county with the population of 130,750. The county Rogaland is situated on the west coast and borders to the counties Hordaland, Telemark, Aust-Agder and Vest-Agder. The approximate population is 460,000 and in terms of population, it is fourth largest in Norway ("Welcome to Destination Rogaland," 2014). The area of Stavanger is 9,400 square kilometers, which is thirteenth largest in Norway. Rogaland is often referred to as a miniature of Norway because it has everything to the landscape with high mountains, deep fjords, farmlands, forests, rivers and lakes along with the long stretched beaches ("Welcome to Destination Rogaland," 2014). According to the precipitation report, Stavanger region experiences average rainfall of 1200 mm per year. On average there are 221 days a year with more than 0.1 mm of rainfall (precipitation) or about 19 days with a high quantity of rain, sleet, snow per month ("Stavanger Weather in Norway, 2013, 2014, 2015," 2015). During the driest month April has average of 51 mm and wettest month September has an average of over 153 mm of rainfall (precipitations), (see Table 1) ("Rainfall/ Precipitation in Stavanger, Rogaland, Norway," 2014). Though the weather condition seems adverse for bicycling, no past studies addressing the impacts of weather on bicycling in the Stavanger were found to exist. However, according to previous researches in the similar field,

which were conducted in Burlington, Chittenden county precipitation, temperature, speed of wind and snowfall have negative impact on bicycle commuters (Flynn et al., 2012; Sears, Flynn, Aultman-Hall, & Dana, 2012). In their words, "…morning precipitation, low temperatures, increased wind speeds and snow negatively impacted the likelihood of commuting by bicycle" and this statement was also cited in the research conducted in Vermont, USA (Spencer et al., 2013).

Table 1 – Stavanger climate statistics

Weather Stavanger 2014	
Average precipitation Annual	47 inches
Minimum - Maximum temperature (degree Celsius)	-4 – 11
Maximum wind speed	58 km/h
Average wind speed	19 km/h
Average air pressure	1012 h Pa (2013)

Source: ("Rainfall/ Precipitation in Stavanger, Rogaland, Norway," 2014; "Stavanger Weather in Norway, 2013, 2014, 2015," 2015)

3.2 Research Materials and Methodology

3.2.1 Methods

As mentioned at the beginning of this chapter, depending on the main purpose and objectives of this research, a qualitative method was adopted. A focus group interview is a fundamental process of qualitative data collection (Neuman & Neuman, 2006; Saunders et al., 2011; Savin-Baden & Major, 2013). According to them, this data collection method allows researchers to gather information about participants' perceptions related to a specific research area. Focus group interviews also lead participants to engage in many different form of everyday conversations, which provide useful data that cannot be gathered by others processes of data collection (Kitzinger, 1995). It provides information on how a group thinks about an issue in social perspective. More importantly, focus group interviews are often well accepted by the members of research

communities with high validity (Kitzinger, 1995; Savin-Baden & Major, 2013). That is the reason why, more and more often qualitative researchers are choosing to adopt focus group interviews as a method of data collection (Kitzinger, 1995). Previous studies in the similar field by Sears et al., (2012) and Spencer et al., (2013) used the focus group interviews as their data collection method. Therefore, following the examples set by the above-published researches, this study used focus group interviews.

There are some disadvantages of focus group interviews as well (Neuman & Neuman, 2006; Saunders et al., 2011; Savin-Baden & Major, 2013). According to them, it is time consuming and the quality of the data depends on the willingness of the participants. Discussions need to be in such an environment that is favorable to the conversation that may not be readily available (Patton, 2005). Moreover, gathered data from focus group discussions are normally more difficult to analyze than are the data from the individual interviews (Savin-Baden & Major, 2013), because of multiple perspectives and multiple voices. On the other hand, face-to-face individual interviews are able to provide in-depth information (Kvale & Brinkmann, 2009) from personal perspective. Individual interview data collection methods are able to provide precise and independent answers on specific topics in qualitative research (Coffey & Atkinson, 1996), while the results of focus group interviews show broader opinions and perspectives in group consensus (Kvale & Brinkmann, 2009). Research conducted about the weather factors and bicyclists by Spencer et al., (2013) in Vermont, USA used five face-to-face individual interviews in order to gain independent and personal opinions after the focus groups. Therefore, following the strategy of Spencer et al., (2013), this master thesis used five face-to-face individual interviews in addition to focus group interviews to achieve personal and independent perceptions. In the words of Savin-Baden & Major

(2013), individual interviews serve to explore how individuals make meaning, whereas focus groups serve to gain understanding about group consensus. Therefore, according to the suggestions of Savin-Baden & Major (2013), it is useful to conduct a small number of two to four individual interviews in addition to focus group interviews in qualitative studies, in order to compress the results and to make the results manageable. Because, this technique provides precise and fundamental opinions about the discussed topic after the focus group interviews, where individual interviews act as supportive strategy of focus group interviews (Kvale & Brinkmann, 2009; Savin-Baden & Major, 2013). More importantly, this technique is often well accepted by the members of research communities with high validity because of more specific results in individual setting (Kitzinger, 1995; Savin-Baden & Major, 2013).

3.3 Samples

This study was conducted at the University of Stavanger. Total number of participants were 29 bicycle commuters from Stavanger. Bicycle commuters under 18 years of age were not targeted in this study. Therefore, participants were between the age of 20 and 64 years. There were 12 female among the respondents. Female respondents were between the age of 23 and 64 years. On the other hand male were between the age of 20 and 62 years. There were 15 students among the participants and the rest were full-time employees at the University of Stavanger. Most of the students were working on part-time basis in several places like bars, restaurants, hotels and they use their bicycles to go to work. All the participants were presented as anonymous and the participation was free of cost.

3.4 Data collection methods

In this section, two separate types of data collection methods are addressed individually that were conducted. This study divided the interviews into four focus groups (n = 24) (Spencer et al., 2013).

After that, same as the strategy of previous study by Spencer et al., (2013) and based on the suggested techniques of Savin-Baden & Major (2013), this study conducted five personal interviews during April and May 2015 in Stavanger as data collection methods. Therefore, a combination of focus groups and personal interviews expressed the opinions of bicycle commuters regarding the current study in both group and individual settings. These additional five face-to-face individual interviews were conducted in order to understand the personal opinions in depth about the topic (Spencer et al., 2013 & Savin-Baden & Major 2013). Previous similar study by Spencer et al., (2013) in Vermont, USA applied both methods of data collection in order to combine the results in individual nature of bicycling and the attachment to a greater bicycling community felt by many cyclists in group settings (Spencer et al., 2013). Therefore, based on the similar study in Vermont, USA by Spencer et al., (2013), this study in Stavanger, Norway applied both types of data collection methods to achieve combined and precise results.

3.5 Focus group discussions

This study conducted at first focus group discussions (Spencer et al., 2013) to understand the perceptions of bicyclists in the group settings. The discussions were conducted with convenience samples (Spencer et al., 2013) of adult bicyclists who use bicycles to go to work at least occasionally and mostly use their bicycles to go almost everywhere. Exploratory focus group interviews (Savin-Baden & Major 2013) were conducted to increase researcher understanding of the current research topic. According to Savin-Baden & Major (2013), in exploratory focus group interviews in this study, the groups were asked general questions about the topic for developing specific questions. In the words of Savin-Baden & Major (2013), this technique is highly used where the researchers conduct firstly focus interviews and then individual depth interviews to achieve precise answers. The discussion topics between participants and the researcher are

described in the 'Data collection' section in this chapter (See Appendix – discussion and interview questionnaire). The nominal group technique (Delbecq & Van de Ven, 1971) was followed in order to comprise small group discussions (Savin-Baden & Major 2013). According to Savin-Baden & Major (2013), most researchers choose nominal group technique to moderate focus group interviews to assemble specific questions to discuss in the individual interviews. However, this study has followed exploratory and nominal group technique of focus group interview by following the steps of previous similar study in Vermont, USA by Spencer et al., (2013). Therefore, this study divided focus groups by gender, where there were two groups of women (n = 10, 5 in each group) and two groups of men (n = 14, 7 in each group) (Spencer et al., 2013). Focus group interviews were done about 15 to 20 minutes for each group. Two of the interview sessions were audio-recorded and other two were noted.

3.6 Individual interviews

According to Savin-Baden & Major (2013), the researcher has several responsibilities to conduct fruitful individual interviews, such as attentive listening, observing and note taking. In the words of Savin-Baden & Major (2013), '…individual interviews are the most common and useful method of gathering data for qualitative research and are an integral part of qualitative research tradition.' In this study, individual interviews were conducted based on the study of Spencer et al., (2013) to be able to get precise answers in individual settings. Individual interviews were done by using a semi-structured guide (Savin-Baden & Major, 2013), were ranged from 20 to 25 minutes. The discussion topics between participants and the researcher are described in the 'Data collection' section in this chapter (See Appendix – discussion and interview questionnaire). Two of the interview sessions were audio-recorded and three of the interview sessions were noted for subsequent transcription. There were two female and three male in the individual interviewees.

Focus group interviews are able to spark new ideas from the existing small communities of participants, while individual interviews provides independent perceptions about the issue (Patton, 2005). Patton (2005) further added that small numbers of individual interviews after the focus groups interviews are able to express the opinions, which are more independent, richer and deeper. Thus, the results of qualitative researches become more valid, precise and specific (Patton, 2005). That is why; this study has followed both types of interviews as data collection methods, which is same as previous and similar study in different location by Spencer et al., (2013).

3.7 Data collection and discussion topics

The discussion topics between participants and the researcher are addressed in this section of this chapter (See Appendix – discussion and interview questionnaire). Two of the focus group interviews were audio-recorded and the rest were noted. Focus group interviews were done about 15 to 20 minutes for each group. Two of the individual interviews were audio-recorded and the rest were noted. Individual interviews were done about 20 to 30 minutes each.

Participants were asked similar questions according to specific research questions. In terms of the discussion topics and questions of the interviews, this study followed the questions of the similar study in Vermont, USA by Spencer et al., (2013). Participants were asked specifically about their likes and dislikes (Spencer et al., 2013) regarding bicycle commuting, the specific factors which influenced their decisions to bike or not to bike. Participants were farther asked about the time of the day they decide to bike (Spencer et al., 2013), how would they like to define their bicycle trips, how they become affected by weather conditions while they bike on daily and seasonal basis (Spencer et al., 2013)? What policies or process they believed that would facilitate bicycle

commuters all year around (Spencer et al., 2013). They were asked about the supports of their working place, descriptions of bike paths and routes they commute, opinions about the bicycling infrastructure and how to recruit more bicyclists for the study (Spencer et al., 2013). The researcher asked the participants further questions to clarify their opinions and perceptions on ad hoc based answers (Spencer et al., 2013) by the participants. Common clarification questions were based on the discussion about the use of various transportation modes (Spencer et al., 2013), choices of clothing for bicyclists and motivation to bike in the winter (Spencer et al., 2013) (See Appendix – discussion and interview questionnaire). Detail results of interviews are quoted, transcribed and explained in the next chapters.

3.8 Coding

The researcher coded all the transcripts manually for discussions of weather factors, instead of using search criteria to make sure a thorough data collection and explanation (Coffey & Atkinson, 1996). According to Coffey & Atkinson (1996), coding is an important tool to analyze interviews and discussions, which is referring to the identification and linkage of instances of common themes in an overall data set (Spencer et al., 2013). Therefore, in the discussions about weather factors, the researcher coded minimum one category that based on the context, words and contents that were used by the participants. The researcher followed the similar scripts to guide the discussion in focus groups and individual interviews (Spencer et al., 2013). Therefore, comparison between the transcripts from the two data collection formats were conducted and found to provide similar results (Spencer et al., 2013). Thus, all the transcripts then provided same results as if they were from a common data source in the data analyses (Spencer et al., 2013).

Coding of weather conditions are rain, snow, sleet, ice, light conditions, temperature, road salt, wind and plowing, which are based on the previous studies in similar field by Spencer et al., (2013); Flynn et al., (2012) & Sears et al., (2012). These coding for the variations in the climatic conditions were not only predetermined according to the previous lists (Spencer et al., 2013 & Flynn et al., 2012) of indicators composed in the other researches, but these were also determined by the discussions of participants. The codes identified corresponding patterns and the descriptions of weather variations with the assistance of the context surrounding each coded illustration. In most cases, weather related variables were mentioned simultaneously and in these cases researcher reviewed them in all appropriate code groups. Therefore, this study has identified and coded climate related elements such as precipitation: rain, snow, sleet and ice, light conditions, temperature, road conditions: road salting, road works or plowing, driver interactions and wind (Spencer et al., 2013). It has farther coded 'general weather' as a category of unstable weather (Spencer et al., 2013), which is referring to various types of weather in the same day and interactions between unspecified weather variables. The category of precipitation, daylight and night-lamp conditions, road conditions, wind and temperature were coherent with the weather related variables, which were also identified by several past researches in the similar fields. The researcher coded all the variables from the individual perceptions because according to previous studies, individual perceptions provide a better replication of the discussion topics by the interviewees and focus group participants (Flynn et al., 2012, Sears et al., 2012 and Spencer et al., 2013).

3.9 Validity

Saunders et al., (2011) ascertained validity as the conception approximately the verdicts that whether they are meaningful to whatever they actually be existed. Savin-Baden & Major, (2013)

further developed that bringing together the elements of authorization, which will intensification the soundness of the learning. In this perspective, essential accomplishments is performed in order to keep up the rationality of the information in this study. Therefore, all the steps of methodology and methods of the current study are proven coherent with various previous studies in the similar research field.

3.10 Reliability

In the words of Saunders et al., (2011), the faithfulness of research is whether the measures will pride the alike domino effect on supplementary junctures or not, whether will the comparable opinion be grasped by supplementary eyewitnesses or not. Savin-Baden & Major (2013) demonstrated that irrespective of steadfastness is to bounce guarantee that if the identical research is done with the same cases by other researchers previously. Then, similar conclusions establish reliability of the proposed research. They further recommends hanging accurate credentials of the measures; as well as the researcher will see to such thing to identify the compatibility of results. The researcher of this study made sure to follow the strategies and steps according to various previous researches to achieve reliable results, which has been presented and discussed in the following chapter.

3.11 Limitations

There were several limitations of data collection and it is important that these limitations are open acknowledged and accommodated in the interpretation of the results. However, according to Patton (2005), small numbers of individual interviews after the focus groups interviews are able to express the opinions, which are more independent, richer and deeper. In addition to that, in the words of Savin-Baden & Major (2013), p. 369, it is possible to achieve reliable and valid results in qualitative researches by conducting two to four individual interviews. Therefore, the limitations

could be a relatively small sample size in the focus group interviews and individual interviews because of financial boundaries in this master thesis. Moreover, this research did not include non-cyclists, as because it was outside the scope of this study. Non-cyclists refers to those who never chose to ride bike, due to various reasons such as weather, not concern about physical activity and not well facilitated in their lifestyle (Spencer et al., 20123). This study did not apply the inter-coding reliability tests (Patton, 2005), because the total process of this research and the data set were coded by one researcher. The results of this research may not be able to provide the views of all bicyclists in the Stavanger area, because of the above-mentioned limitations. However, this study is able to identify the specific challenges towards bicyclists, which are caused by the unstable weather conditions in Stavanger region and that is the main objective of this study. The next chapter presents the results of this study supported by in-depth interpretation and integrated discussion of the findings.

Chapter 4 – Results and Discussion

This chapter presents a detailed account of the results of this study supported by in-depth interpretation and integrated discussion of the findings. The researcher quoted the interviews; firstly from the focus group discussions and secondly from the individual interviews (Patton, 2005), in order to get precise opinions and independent perceptions (Patton, 2005) of the participants. Then the researcher presented them separately and discussed according to the variables of this study. Temperature, wind, various weather condition in the same day as 'general weather', snow, rain and plowing were mentioned in all focus groups and individual interviews as variables of this study. The key discussion topic in all focus groups was 'the various challenges that cause by unstable weather conditions, which affect the desire and intention of the bicycle commuters to regularly cycle in the Stavanger region'. Then as a sequence of this topic, further discussions were held on how the challenges can be overcome and why commuters would ride a bike in Stavanger, Norway. All participants identified consistently of temperature, wind, general weather conditions, snow and rain as challenges for bicycling in Stavanger, Norway. All participants suggested that these factors might affect a broader group of bicycle commuters in Stavanger, Norway.

All focus groups discussed about wind, general weather, rain, light conditions, ice and temperature (see Table 1) as challenges by weather for bicyclists in Stavanger, Norway. Three of the focus groups discussed about plowing, one of the women groups 'Women Group 1' did not mentioned about it. Although road salting was an activity of road management in the snow and ice condition,

it was discussed as weather related factor in one focus group and that is the Men Focus Group 1. Snow was discussed in one group of men and one group of women. Gender differences did not play a large role in the weather factors affecting bicycle commuting. The only indicator of weather factors was identified by one gender and that was road salting, which is obviously a part of the activity of road management in the adverse weather. Quoted responses directly from the participants' speech about the individual variables are now addressed.

Table 1 - Gender differences in weather related factors discussion in transcripts

Conditions	Men % of total segments	Women % of total segments
Combined weather	11.2	16.1
Wind	8.1	4.6
Rain	20.1	18.5
Snow	15.0	10.4
Ice	8.8	12.2
Light conditions	16.1	14.6
Temperature	17.6	18.4
Road salting	3.6	0.3
Plowing	3.6	8.1

4.1 Discussions about reasons to bike

In the discussions about the reasons to commute bicycles in Stavanger, all the participants answered almost same reasons. However, inconvenient public services- buses, physical activity and transportation expenses were found as the reasons why participants ride bicycles in Stavanger.

"Well, I don't like the timing of buses. Many times, I waited more than 15 minutes for buses while I was already late for classes or work. On the other hand, many times, the buses left earlier than the due time. I really cannot find a word to express how angry I become at that time."
Individual interview 2 (female)

"No matter what, I do not want to use buses in Stavanger because of timing, expenses and I feel suffocated. So, it is not healthy for me either. I want to bicycle as a better alternative, which takes me on time to my destination and it is good exercise for me too." Individual interview 3 (male)

"My biking activity actually saves my time & money and runs on my fat. But the buses in Stavanger actually kill my time & money and only save my fat." – Individual interview 4 (male)

"Yes, in my point of view, bicycling in Stavanger is one of the best transportation modes. Buses always take much longer time to reach destinations as because, buses take the longer routes and there are changes of busses in between as well." Women focus group 1

"Only bad weather conditions are the biggest challenge for bicyclists in this city. It is always very windy and rainy here. Otherwise, bicycling is very delightful. Moreover, cycling is free of cost too since Stavanger is one of the expensive cities." – Men focus groups 1.

In addition to these, all focus group discussions mentioned also about the schedules of bus services on Sundays and public holidays in Stavanger, which is not very frequent service. Therefore, bicycling is actually one of the best options to them apart from the bad weather conditions.

4.2 Temperature

Temperature was discussed as a certain factor, which affects bicycle commuters in terms of general comfort levels. The preferred range of minimum and maximum temperature identified the preference of riding bike or not to bike. Opinions from the focus groups were as follows:

"Most probably below -5 degree Celsius, I would not be riding a bike. It is a very uncomfortable temperature for me. Moreover, I think this is very disappointing in this century if a regular bicyclist has to change decision of biking because of temperature." - Women focus group1

Temperature was also discussed as a significant factor in bicycling while it combined with other weather factors such as precipitation:

"Well, okay, if the temperature was below -5 degree Celsius and no snow or ice at all, in the month of November, I would still ride a bike. What I mean is, to me low temperature is not really a matter while there is not any snow and ice on the bike paths. Bike paths become slippery and it causes accidents. Moreover, my fingers freeze up and that is complete unsafe feelings." – Women focus group 2.

"While the temperature is consistently under 1 or 0 degree Celsius in the morning or in the evening, I usually do not bike." – Interview 4 (male)

Participants of this study expected some more facilities on the bike paths. Since the weather is adverse in Stavanger most of the times for bicycling, bicycle commuters of this study suggested as follows overcoming the challenges caused by temperature.

"Since bicycling is an environmental friendly way of transportation, in my point of view, Stavanger should be more structured and more facilitated for bicycling. Recently, we have some service facilities such as, 'airing the wheel and screwdrivers to tight the screws of bikes' on few bike paths, which are highly commendable. I hope that these sort of facilities are going to be in most of the bike paths in Stavanger. I, as a regular bicyclist actually expect more facilities like protective clothing or wind breaks on bike paths, which can be borrowed from a vending machine

by a loaning card. It may sound like a highly ambitious plan but it is possible. Because, things are being modernized." – Interview 5 (male)

"Moreover, I think most of bike paths should be shaded and roof covered in Stavanger, to get protection from the freezing temperature. I mean same as some bike paths on the way to Sandnes (other Commune)*."* – Interview 2 (female)

The interviews above provided the perceptions of bicycle commuters about the temperature in Stavanger in a variety of ways. Bicyclists in Stavanger would rarely stop cycling because of cold temperatures. Cold temperature is a negative factor and a challenge for bicycle commuters. However, some bicyclists would keep cycling if they were well facilitated as suggested in above discussions such as '*shaded and roof covered'*. Whereas some other bicyclists in Stavanger considered cold temperature as a limiting factor (Nankervis, 1999) to cycle during the winter, which is supporting the findings of previous studies by Nankervis (1991); Winters et al. (2007); Flynn et al. (2012). Bicycle commuters in this study exhibited a wider range of attitudes regarding acceptable ranges of temperature of riding. The suggestions for overcoming challenge of temperature were actually able to provide facility in the light conditions, freezing precipitations too (Spencer et al. 2013). These facilities provided by the transportation authority are actually able to motivate bicyclists in Stavanger.

4.3 Light conditions

In Stavanger, where the daylight hours changes dramatically throughout the year, darkness was typically considered as a seasonal issue that hindered the bicycling habits of some commuters, but not others. Results of all similar studies including this study have shown that light conditions are closely related to the road safety of bicyclists.

"Well, in the winter while the day light is about 2 hours on cloudy days, I believe, the lights on the bike paths should be on 24 hours in order to avoid accidents" Men focus group 1

"In the winter, lights should be on all evening and night. Because, where there is dark through the forests and the parks, there are really bigger chance of accidents." Women focus group 1

Bicycle commuters, which participated in this study, also related the light conditions to unexpected and unpredicted bad incidents.

"Honestly, I personally become scared of happening any kind of bad incident; I mean I feel completely unsafe." – Women focus group 2.

"When there is not much light in the winter, a lot of bicyclists I know get hit by the other bikes or with trees, logs and rocks fallen on the bike paths. So that's why I strongly suggest that the lights should be on all day and all night on the bike paths to provide safe and comfortable biking transportation" – Men focus group 2.

According to the above discussions, it can be seen that daylight in the winter is presented as a challenge for bicycle commuters in Stavanger, where chances of accident were shown as main reason. Participants suggested keeping the lights on for longer hours through the dark bike paths to avoid accidents and to provide feeling of safety in their bike trips to home or to work.

"For me there are enough safe and lighted ways to get home and all alternative bike routes take almost same time, so actually day light doesn't bother me much" - Interview 4 (Male)

"My honest expression is, in the winter when it is dark, cold, rain; I even personally become scared of getting killed or hearted, while I ride bike to go home from the University

through the forest-park, because it gets such dark. I know it might be personal scariness, but I am sure if there was lights I wouldn't be sacred at all" – Interview 2 (female).

"I mean when it's sort of dusk I would bike but I do not have a good sense of how well I might be seen. Bike lights are available, but they are not always trusted. Anytime battery can go off or because of the misty condition bike light may not be visible. Moreover, bike lights can't be an alternative of daylights anyway. It is just a primary safety" – Interview 1 (female).

Light conditions were discussed as a determining factor in the decision to bike or not to bike. Bicyclists might use another form of transportation, while lighting is insufficient. In the summer months, it is more delightful and safer to bike in any route due to longer daylight hours (Spencer et al., 2013). Some bicyclists discussed the importance of road lightings in the winter; all evenings and nights light facilities on the bike paths through the parks, which is able to provide safety and motivate to commute bicycles. Whereas light conditions were not a challenge for all cyclists, however, some interview participants considered lightings facilities in the bike paths in the dark season provides a high safety. Perceptions about commute bicycles in the dark were negative. However, according to Spencer et al (2013), unlike in the previous studies by Bergstrom & Magnusson (2003), Heinen et al. (2011), Krizek et al. (2005), was not found a meaningful difference in terms of light conditions between men and women. In the same way, in this study, participants of both male and female discussed the challenge light conditions in relation to safety issue. Moreover, participants in this study mentioned that lights of the bikes might be helpful and useful, but the bike lights are not always bright enough and not always clearly visible in the dark condition. In addition to that, some commuters mentioned that lights of the bikes could not be compared to the lights of the bike paths and daylights. Participants strongly suggested that lights in the bike paths should be on almost all day long in all winter to motivate bicyclists, not to change

their transportation mode and to provide them safe bicycling facilities. The discussions of bicycle commuters in this study further described about specific time of year, while there is longer daylight and bicycling is more comfortable and safe. However, at that time rain as a partial challenge of precipitation can limit bicycle commuting in Stavanger.

4.4 Precipitation

According to this study, rain, snow and ice conditions appeared to have a significant impact on bicyclists in Stavanger. Some rainy conditions may have been considered tolerable for bicycle commuters in Stavanger. For instance, a forecast of light rain or intermittent seemed generally unlikely to dissuade people from cycling, although there were some exceptions to this rule. However, snowfall and ice conditions replicated more defined reactions from bicyclists of Stavanger. In these types of weather conditions, bicyclists even often in the use of other modes of transportation or a change in commuting behavior such as:

"The only time in the winter I don't bike after a snow storm, because there is big chance of fall over even if I set winter tire. Honestly speaking, I fall over many times on bike paths because slippery by snowfall and ice condition. One day, I fell over in the underveis (underway) and there was a big risk of hit other bike in front of me. Moreover, I cannot stop other bike or a car from running on to me. Therefore, because of all these reasons, in the snowfall and ice conditions I do not bike, though I love to bike all the time and everywhere. Well, I say snow is such a thing, which is beautiful only from the window, not to bike. This kind of weather conditions are real challenges for me to bike." – Men focus group 1.

The interview above explored an opinion not to bike at all in the snow and icy condition in Stavanger because of high risk of fall over and accidents on slippery bike paths. However, the interview below is providing suggestions to overcome this condition.

"I am really very scared to bike in the snow and icy condition in the winter. Because I fell over many times and I was injured. I think that transportation authority should do something to improve bicycling facilities in the snow and icy condition. Instantly, I would like to suggest for shaded or covered more and more bike paths. Well in this city, we have some bike paths and lanes, which are with sidewall partitions but not with the roof shaded. This will provide a comfortable biking in all kind of precipitation and in the heavy wind. I personally think this kind of protections on bike lanes and paths should be available in Stavanger as because it is always very adverse weather conditions in this city." – Interview 2 (female)

"I feel helpless when I am very close to my workplace or to my destination and it starts a sudden rain shower. It is not always possible to be ready with raincoat, waterproof trouser and shoes for rain wherever you go. Rain is one of the biggest challenges I feel in Stavanger to commute bicycle. Because it rains most of the time here in Stavanger." – Individual interview 4 (male).

The expression of the interviews above described the certain difficulty to commute bicycles in the winter precipitation. In the winter season, bicycle commuters are meant to be prepared with raincoats, waterproof trousers and shoes. Moreover, it described the inconvenient feelings in the sudden rain when the bicycle commuters were not ready with the waterproof cloths.

"My workplace is about six miles from my house. When I aim to bike for exercise and going to work simultaneously and in the same time if the rain interrupts, at that time I really hate rain

from deep inside and straightway it gives me feeling that I really don't want to bike anymore in this city. I think only because of rain, we see less number of bicyclists in this city, that's my personal opinion only." - Interview 3 (male)

According to above interviews rain in Stavanger has been identified as one of the biggest challenges to commute bicycles. The other precipitation conditions such as snow and ice were discussed for safe and comfortable bicycling. It was discussed that there was always chance of falling over in the snow and icy conditions. On the other hand, rain just gives an uncomfortable situation, which is not a threat of accident in Stavanger. Therefore, it can be said that, rain and snow were not always discussed negatively, but not either as refreshing or helpful by some participants. Snow was identified as adverse condition for bicycling, while reactions towards ice were same as well as opposite. Precipitation effect on bicycle commuting practices manifested the view that precipitation conditions in the summer such as rain could be just uncomfortable, whereas, precipitation conditions in the winter caused serious safety issues. According to Spencer et al. (2013), their conclusion about negative effects of rain and snow follows the findings of Flynn et al. (2012). Likewise, participants of this study also discussed the negative effects of rain and snow followed the finding of above-mentioned study. Moreover, precipitation and safety issues in the winter aligned with the findings of a previous study (Stinson & Bhat, 2004). The reactions to safety concern and discomfort were similar in the discussions about all precipitation categories by both genders and that is same findings as Spencer et al. (2013).

4.5 Road conditions

According to the expectations of the participants, in this study both road salting and plowing are important and helpful for bicycling only if it is done in the all the bike roads. However, there is an argument about plowing that was evident in this research project. Plowing pushes snow towards

the side of the roads, which are actually bike lanes. Then these efforts to clear roads for vehicle traffic and become a cause of concerns for bicyclists. Because it clears the road for cars, bus-trucks and other road users by pushing the snow on to the bike lanes. Participants mentioned it as a big challenge to bike due to both safety and inconvenience.

"When road workers plow the off roads in the winter, they normally focus on just the travel lane. They push the snow on the side of the roads, which sides are normally used by the bikers. Therefore, in this kind of weather conditions biking becomes more risky and uncomfortable. I definitely think it is a big challenge for bicyclists." – Men focus group 1.

"Well, in my point of view, facilities should be for all type of transportation. If they plow the roads, they should do it properly for each corner of the road. So that neither bicyclists nor other road users supposed to be hindered from using roads." – Women focus group 1

Road-salt is used to melt ice (Spencer et al., 2013) and not to be slippery in the snow and icy condition of weather. However, participants of this study found this to be another cause of compromise for bicyclists. According to Men focus group 2:

"During the snow and ice conditions, I found many roads had been salted and many had not been yet. On a Sunday and on public holiday, I had noticed the roads are rarely salted, which actually unknown by a bicyclists until he/she is already out with bike. Therefore, this type of half-done road conditions create a mess on the behaviors of bicycle commuters and it occurs accidents as well. Moreover, without the salt there would be more slippery surface on the on the bike lanes"

"Actually, 3 years back I used to commute bike in London city while I was studying in London. If I would like to compare biking in London with Stavanger, obviously, it is safer in Stavanger. Because of the priority of the cyclists on the road. However, I believe that our bike

lanes in some part of the city should be wider. Especially I am talking about the long bike lanes in Hinna and Gousel area. Since these places are newly growing areas, bike lanes should definitely be structured wider. Because, in the winter, in the rain, snow and heavy wind, there is always risk of accident to bike in those areas." – Individual interviews 5 (male)

The bicycle commuters who participated in this study perceive few differences in their surroundings because of their exposure to the components and the needs to assess both their own capabilities and those of the other road users around them to tackle adverse conditions. While few of the participants supposed they had less control in adverse conditions, motor vehicle drivers were found as without control and dicey on snowy and icy roads, gesture an additional threat towards bicyclists on road who could be hurt or forced out of safe conditions. This statement is supporting past researches of cyclist and driver interactions by (Horton, 2007; Mullan, 2012), which is cited by Spencer et al. (2013) as well since they found same situation. All bicycle commuters expressed similar attitude in this perspective. Road plowing and salting as a part of road management during precipitation in the winter, were discussed as factors, which is needed improvement. Future scope of this study might be able to evaluate the possible efficacy of improving levels of services on bike paths and bicycle lanes to boost bicycle trips in the winter in Stavanger, which is following similar studies in other regions (Bergström and Magnusson, 2003; Spencer et al., 2013; Winters et al., 2007). In this study road salt was described positively for commuting bicycles when roads were salted adequately in all bike paths, but was one of the least frequently discussed topics overall.

4.6 Wind

Wind was discussed in all the focus group and individual interviews in this study. Heavy wind was considered as a big challenge for bicyclists in Stavanger. This was actually viewed as one of the main determinant of weather factors that makes bicycling very uncomfortable. Negative aspects

of wind for riding bike was making the temperature feel lower than the actual. Moreover, it required more effort to pedal against the direction of wind.

"Heavy wind has only one advantage. While we bike in the same direction as the wind, we can bike faster. But actually wind here blows mostly from all directions anyway." - Men focus groups 1.

"It is very risky to bike in the wind on the bridges in Stavanger. This is a very windy city and wind push away on the side of the road or on the car lane, which is high risk." - Individual interview 1 (female).

"I bike home through the Hundvåg Bridge. It is always really very windy up there and not comfortable. I would like to suggest building steeled sidewalls up to 4 feet high all the way of bike lanes for protection from the wind and to enjoy comfortable bicycling facilities." – Individual interview 4 (male)

All focus groups mentioned about the heavy wind from all directions in Stavanger. Most of the participants considered wind as high risk of accident on the bridges in Stavanger. Some bicyclists suggested building sidewalls on the bridges up to feet high for protection as well.

"Well, what to comment on the windy condition in Stavanger. Wind here blows from all directions in the same time. I think wind is a very big challenge while it is windy condition in this city. I bike sometimes through the 'Hafrsfjord bridge, Tananger' to meet my friends. I see it is not easy while it is windy. Some kind of protected sidewalls can be built on the bike lanes, I think." – Individual interview 1 (female)

According to the interviews above, wind was discussed as one of the major obstructions to bicycling, in some cases as a deciding factor too. In the situation of direction of wind and the direction of biking, it was considered a positive and potentially helpful. However, on the other hand, another discussion mentioned that there was no specific direction of wind in Stavanger. Both male and female discussed about the wind. Men focus group 1 made the only positive comment regarding the direction of wind in general, although this could not be extrapolated to a broader context. The mixed feelings toward wind were similarly definitive as the clearly negative results of wind identified in previous studies (Flynn et al., 2012; Nankervis, 1999; Rietveld & Daniel, 2004; Thomas et al., 2009, 2013; Tin et al., 2012). The past study by Spencer et al. (2013) in Vermont, USA identified wind as less definitive and not a big challenge for bicycle commuters. However, this study found that wind would a bigger challenge if it was paired with other adverse conditions such as precipitation, as because; bicyclists who participated in this study indicated that the weather in Stavanger as a whole was controlling their commuting behavior.

4.7 Summary

To conclude this chapter, it can be said that safety was mentioned as one of the major concerns in all of the identified weather related variables. That means all the weather related variable of this study are limiting the safety of the bicycle commuters who participated in this study. Findings of a previous study by Spencer et al. (2013) also indicated safety of bicycle commuters as a major issue. While some bicyclists in the current study defined particular situations in which they would still commute bicycle during the winter, others felt winter as fundamentally adverse for bicycling in Stavanger. While this was largely due to temperature, light conditions, precipitation, wind and road conditions, the issue of safety stressed across all of these weather related variables and this is

actually following the findings of the researches by Spencer et al. (2013) & Flynn et al. (2012). Collision and injury fears were found as it was reported 200 bicyclists' serious injuries in only Rogaland, Norway, and many more went unreported ("Statistics Norway: Road traffic accidents involving personal injury, 2013," 2015). In this perspective, controlled driving by the other road users in the winter actually indicating as a non-ideal weather related factor. Although in this viewpoint, while drivers are out of control in the winter that is affecting bicyclists' decisions to commute or not to commute. In this study, safety was discussed as a significant concern for bicycle commuters and as serious issue that is linked with a distrust of drivers' control caused of rising vulnerability.

Past studies by Garrard et al., (2008) & Krizek et al., (2005) indicated that dissimilarities in bicycling patterns was existed between genders. However, the findings of the current research in Stavanger show that these differences do not arise from weather conditions and that is following the findings of similar study in Vermont, USA by Spencer et al., (2013). Another past study by Heinen et al., (2010) shows that daylight and rain as adverse weather conditions are existed as bigger challenges to women bicycle commuters than the men. This study did not evident the specific difference between the genders among the participants of this study, which followed the findings of Spencer et al., (2013). Both genders were concerned with darkness, general weather (various weather in same day), precipitation (rain, snow and ice), wind and road conditions. Therefore, this could indicate "underreporting of concerns from men" (Spencer et al. 2013) in the past study, or the reason could be the group that was surveyed in previous research by Heinen et al., (2010), did not have the similar concerns as the participants of this study and the study by Spencer et al. (2013). Previous bicycle and gender studies by (Garrard et al., 2008) have found that

low rate of women bicycling in the US could be connected to safety and risk issue (Spencer et al. 2013).

This study concludes that weather conditions affect bicycle commuting regardless of gender because expression to various weather conditions was an individual choice rather than a gendered one. Past study by Spencer et al. (2013) mentioned the same opinion in terms of gender variance. Therefore, this chapter covered the findings that had been gathered from four focus group discussions of 24 respondents and 5 individual interviews. The researcher stated the discussions and interviews individually according to the variables of this study and discussed the results in detail. Therefore, based on the purpose, findings and discussions of this study, next chapter draws conclusions of this study along with recommendations and suggestions for further research.

Chapter 5 – Conclusion & Recommendations

Various previous studies published in recent decades show that bicycling is an alternative transportation mode, which has a major impact on the built environment and the sustainable development of a society. Bicycling is widely advocated to be a beneficial way to achieve sustainable and natural development of a region, with direct human health benefits (Oja et al., 2011; Rondinella et al., 2012; Winters et al., 2007). However, bicyclists in many areas of the world, particularly high latitude countries (Flynn et. al. 2012) like Northern America, Canada and the Scandinavian countries, face various challenges because of the unpredictable and highlight seasonal weather conditions, such as heavy rainfall, strong wind, snowfall, temperature and seasonal extremes of darkness. Researchers differentiate weather conditions by indicating bad and good weather conditions for cycling (Nankervis, 1999). Bad weather conditions such as heavy rain, strong wind, snowfall and low temperature are real obstacles for the cyclists to cycle (Spencer et al. 2013). These kinds of weather conditions are indicated as challenges for cyclists who use bikes as their only form of transportation and the reasons are, firstly, it poses the risk of accidents to people who cycle in the bad weather conditions and secondly, it is not comfortable. On the other hand, good weather conditions refer to sunny days with mild temperature and gentle breeze or no wind, which are very favorable conditions for bicycle commuters (Flynn et al. 2012; Spencer et al. 2013).

The main purpose of this study was to identify the perceptions and opinions of bicyclists of Stavanger towards the challenges by various weather conditions; and in addition, to investigate the

effects of different climatic conditions on cycling behavior. Therefore, this study set out to understand the relationship between the weather conditions and bicycling behavior in Stavanger. Furthermore, this study aimed to investigate various climatic situations that obstruct and encourage bicyclists to bike in the Stavanger region, Norway. The objective of this study is to examine how local bicyclists in Stavanger describe their bicycling practices and behavior, and how these are impacted by various weather conditions. Therefore, according to the purpose and objective, the main research question is; *what are the various challenges that are caused by unstable weather conditions, which affect the desire and intention of the bicyclists to cycle in Stavanger region*?

Therefore, according to purpose and objectives of this research, the current study was designed upon the implementation of qualitative methods. Based on the previous studies in the field and considering the purpose, objectives and research question, this study used descriptive and explanatory approaches. A focus group discussion is a fundamental process of qualitative data collection (Neuman & Neuman, 2006; Saunders et al., 2011; Savin-Baden & Major, 2013). According to the above-mentioned researchers, this study considered the lacking of focus group discussions (Spencer et al. 2013) such as it is time consuming and the quality of the data depends on the willingness of the participants, discussions need to be in such an environment that is favorable to the conversation that may not be readily available (Patton, 2005). Moreover, gathered data from focus group interviews are normally more difficult to analyze than are the data from the individual interviews (Savin-Baden & Major, 2013). because of multiple perspectives and multiple voices. On the other hand, face-to-face individual interviews are able to provide in-depth information (Kvale & Brinkmann, 2009). Individual interview methods are able to provide precise answers on specific topics in qualitative research (Coffey & Atkinson, 1996), while the results of

focus group interviews show broader opinions and perspectives (Kvale & Brinkmann, 2009). Similar research conducted by Spencer et al., (2013) in Vermont, USA also used five face-to-face individual interviews after they conducted focus group. Therefore, following the strategy of Spencer et al., (2013), this master thesis used five face-to-face individual interviews in addition to four focus group discussions. In the words of Savin-Baden & Major (2013), individual interviews serve to explore how individuals make meaning, whereas focus groups serve to gain understanding about group consensus. Therefore, according to the suggestions of Savin-Baden & Major (2013), it is useful to conduct a small number of two to four individual interviews in addition to focus group discussions in qualitative studies, in order to compress the results and to make the results manageable. Because, this technique provides precise, independent and fundamental opinions about issues after the focus group interviews, where individual interviews act as a supportive strategy of focus group discussions (Kvale & Brinkmann, 2009; Savin-Baden & Major 2013).

This study conducted four focus group discussions (n = 24) (Spencer et al., 2013). After that, following the example set by Spencer et al., (2013) and based on the suggested techniques of Savin-Baden & Major (2013), this study conducted five personal interviews during April and May 2015 at the University of Stavanger as data collection methods. Therefore, a combination of focus groups and personal interviews expressed the opinions of 29 bicycle commuters regarding the current study in both groups and individual settings. These additional five face-to-face individual interviews were conducted in order to understand the personal opinions in depth about topic after the focus group discussions (Savin-Baden & Major 2013; Spencer et al., 2013).

After a thorough descriptive analysis of the findings from the focus group and interview transcripts of 29 bicycle commuters in Stavanger, precipitation (rain snow and ice), wind, temperature, light conditions and road conditions were identified as major geo-environmental factors (Spencer et al., 2013) that impact on cyclists' commuting decisions and wellbeing. The dissimilarities in various weather conditions that affect bicycling patterns were fundamentally personal boundaries, which ascertained by each individual bicyclist for his or her own fidelity. A little variety in climatic conditions resulted in bicycling shifts based on individual comfort and safety preferences, regardless of gender. Outside their individual comfort boundaries, these bicyclists felt more permeable to various weather conditions and their interactions with motor vehicles, and established high importance on individual safety. By recognizing geo-environmental factors (Spencer et al., 2013) that affecting bicyclists in Stavanger, this study finds that both the perceptions and realities of commuting by bicycles are influenced by interacting variables related to weather, comfort and safety. All of the recognized climatic factors impact on safety or comfort from various perspectives. These negative perceptions of factors regarding safety and comfort issues are actually leading to less frequent bicycling at personal level.

The highly specified effects of weather on bicyclists found in these results reflecting the individual nature of the bicycling experience rather than generalized perceptions within a broader bicycling community (Spencer et al., 2013), which is referring to a larger number of bicyclists in the region. Therefore, recommendations for further research might be to conduct a survey delivered to larger number of bicyclists in Stavanger, Norway in order to obtain the perceptions from broader bicycling community (Spencer et al., 2013). If bicycling is to maintain to become a more viable option for all over the year commuting in Norwegian climate, then it is important for bicyclists to

feel safer, specifically while interacting with motorized vehicles in all kind of climatic conditions. This may be accomplished by infrastructure improvements, policy changes, societal shifts, which must be tailored to specific climatic conditions. Based on the findings in this study, the researcher recommends that policy changes aim at bicycling safety on roadways in a variety of weather conditions. These improvements can assist to relieve safety concerns regarding lightings, building sidewalls for protections from heavy wind and roof shed from rain, break taking and service points on bike paths, plowing, snow and road salt in ice conditions. While weather cannot be altered and controlled by policy changes, safety and comfort of bicyclists can be improved by appropriate infrastructure development and maintenance. In addition to that, rules and regulations for bicyclists and other motor vehicle drivers should be clearly defined and implemented in order to make bicycling as sustainable mode of transportation. Therefore, this can provide significant societal benefits in terms of health, safety, environment, bicycling tourism and wellbeing.

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Appendix

Discussion and Interview questionnaire

Part 1 - Motivation for bicycling in Stavanger

1. What are the factors that motivate you to commute bicycles?

2. How would you describe your desire of commuting bicycles and not commuting bicycles?

3. Could you please describe the factors that influence your decision to bike and not to bike?

4. How would you define your bicycle trips?

5. What role does your preference play in biking to work in Stavanger?

6. What other transportation options do you use?

7. How would you compare your bicycling with other options of transportation?

8. What is more convenient and why?

9. What season of the year do you decide to bike?

10. What time of the day do you decide to bike?

Par 2 – Challenges for bicycling in Stavanger

11. What are the challenges do you face as bicycle commuter in Stavanger?

12. What are the various challenges that caused by unstable weather conditions, which affect your desire and intention to bike in Stavanger region?

13. How would you describe the impact of various weather conditions while you bike on daily basis and seasonal basis?

14. What are your opinions about the precipitation (rain, snow, sleet and ice) in Stavanger while you commute bicycle?

15. What are your opinions about the heavy wind in Stavanger while you commute bicycle?

16. What are your opinions about low and high temperature in Stavanger while you commute bicycle?

17. What are your opinions about light conditions of Stavanger while you commute bicycle in the winter?

18. What are your opinions about the general weather (various weather conditions in the same day) in Stavanger while you commute bicycle?

19. How would you describe the road conditions in the snow, ice, sleet and rainy conditions?

20. How would you define the interactions between drivers and bicycle commuters in Stavanger?

21. Are there any other factors that are hindering your bicycling activity?

Part 3 – Suggestions to overcome the challenges

22. How would you describe the bike paths and routes that you commute?

23. What are your opinions on how these challenges (precipitations, wind, temperature, light conditions) can be overcome by the improvement on bicycling infrastructure in Stavanger, Norway?

24. What policies or process would you believe that might facilitate bicycle commuters all around the year in Stavanger?

25. What are your opinions about the improvement of bicycling infrastructure in Stavanger?

26. Does your work place provide shower or changing facilities?

Personal information

Your age: _____

Gender: (1) Female (2) Male

Profession: (1) Student (2) Fulltime job (3) Other _____

Mode of your job: (1) Part-time (2) Fulltime

Mode of your study: (1) Part-time (2) Fulltime

☺ ☺ ☺

Thank you very much for your time indeed