UNIVERSITY OF TWENTE.

PUSTRAL-UGM

Center for Transportation and Logistics Studies

How to improve the ‘Sepeda Kampus’ bicycle sharing system

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BSc. Thesis

February - June 2016

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Preface

You are reading now the final report of my internship. The occasion that led to the writing of the report is the final stage of the bachelor degree. For this final stage a research must be conducted where the knowledge that was gained during the previous years of study is applied at a particular project. The research that will be described in this report was conducted at the Universitas Gadjah Mada in the department Pusat Studi Transportasi dan Logistik.

I have chosen to do this internship outside the Netherlands because I thought going to another country and working there would be a great experience which can help me later in my work as civil engineer. To do an internship and writing a report with the focus on the traffic and transportation aspect of civil engineering was an easy choice. I am very curious about how the future of transportation will look like and how people will deal with the new rising problems. One development within the traffic and transportation aspect of civil engineering is the introduction of so called bicycle sharing systems which have gained more and more attention during the last years. During my search for an interesting subject for my research I came across these bicycle sharing systems and their development. They caught my attention because they are a flexible and environmentally friendly way to move around in cities. These two aspects are from my point of view the things we need to focus on in the development of the traffic and transportation in the upcoming years. Because of the high population and the related busy traffic I have chosen to go to Asia to do my research. The opportunity to go to Indonesia was based on the fact that the University Gadjah Mada already has such a bicycle sharing system and that the University of Twente, especially the ITC, has very good connections with them.

Before starting the report I would like to thank some people which made it possible for me to live and work in a different country for nearly 3,5 months. I would like to thank the people from PUSTRAL, which helped me whenever it was necessary. Especially I would like to thank Listi who arranged so many things for me and helped me a lot with everyday things in Yogyakarta. Also I would like to thank my three supervisors Mark Brussel, Tom Thomas and Arif Wismadi, from the beginning on their feedback was helpful and made this report also possible.

Contents

Abstract

The masterplan of the Gadjah Mada University aims to achieve a more sustainable and environmentally friendly campus. The introduction of a bicycle sharing system is an embodiment of the vision. The aim of the implementation of this bicycle sharing system is to increase the meeting between students across the campus. The bicycle sharing system should also improve the connectivity between the university buildings and contribute to a healthier environment. In 2011 the bicycle sharing system called 'Sepeda Kampus' was introduced as follow up of the in 2005 introduced 'Sepeda HIjau UGM' (Green bicycle UGM).

The centre of transportation and logistics of the Gadjah Mada University helped to introduce this system and is currently working on the improvement of the system. This research will contribute its part to improve the system, it will look at the characteristics of the system, the relationship between cycling behaviour and the characteristics and analyse which improvements will help to promote that more people use the bicycle sharing system. The research that is going to be described in this report will give an answer to the following research question: 'Which factors influence the bicycle travel demand of the bike sharing system at Gadjah-Mada University in Yogyakarta'.

To answer this question an online survey was constructed which covered four different aspects that are relevant to the research. First socio-demographic characteristics were collected followed up by questions about the current bicycle usage. These two categories were followed up by statements about characteristics of the bicycle sharing system, people could agree or disagree with these statements. The last section of the survey consists of seven combinations of stated improvements. The underlying idea here was to analyse which factors will influence people so that they will cycle more with the 'Sepeda Kampus' system.

Between the 29th February 2016 and the 12 May 2016, 1936 valid responses were collected. The biggest group which participated in the research were the students, this could be expected because students are also the biggest group within UGM. One important finding of this research is that the more positive people are about the system the more they cycle with or without the system. The next thing is that the weather influences the choice to cycle the most. The results from the last section of the survey indicate that for users and possible users of the systems single policies are just effective as the introduction of all three policies.

Based on the answers to the statements and the stated improvements the most important factors to increase the travel demand are better service, more and easier accessible stations within the area. To increase the safety more bicycle paths which are better signed, or even physical separated from other traffic, should be established.

1. Introduction

The research was executed at the Gadjah Mada University at the centre of transportation and logistics studies. The centre for Transportation and Logistics Studies (PUSTRAL) is a research centre for transportation and regional development. Its commitment is supported by excellent quality of researches from various disciplines which are the main assets to answer the problems and challenges in transportation and regional development

1.1 Context

The research “Motorization and non-motorized transport in Asia - Transport system evolution in China, Japan and Indonesia” (Walter Hook, Michael Replogle, 1996) shows that traffic in Indonesia is dominated by motorcycles, they contribute to 70% of the total amount of traffic to and off work. These motorcycles are according to Hook and Replogle one reason of the growing air pollution in Asian cities. Also they investigated that the average travel speed in Asian cities is about 10km/h, this speed could easily be achieved by bicycles. The low average travel speed and the air pollution are two main concerns of traffic researchers. The high amount of motorcycles is also an issue on the area of the University-Gadjah-Mada in Yogyakarta. Based on their masterplan the University-Gadjah-Mada (UGM) has introduced in 2011 the so called ‘Sepeda Kampus’ system where students and employees from UGM can borrow a bicycle to go around the campus after they came to UGM by bicycle, motorcycle or car. This system is further development of ‘Green Bike UGM’ which was introduced in 2005.

Basically there are two main reasons two introduce a bicycle sharing system on a campus, one reason is to solve the parking and traffic problem on the campus and the other reason is for sustainability and health reasons. A statement by Dr. Joyce illustrates that very well “We did it (bicycle sharing) as a means of reducing the need for parking, but as we looked at it from the standpoint of fitness, health and sustainability, we realized we have the opportunity to create a change.” (Zezima, 2008). The statement “Sustainable and practical personal mobility solutions for campus environments have traditionally revolved around the use of bicycles, or provision of pedestrian facilities” (Ian Vince McLoughlin, I. Komang Narendra, Leong Hai Koh, Quang Huy Nguyen, Bharath Seshadri, Wei Zeng, Chang Yao, 2012) is also an indication that bicycle sharing systems on a campus become more and more interesting. At UGM the system was introduced, next to the previous two reasons, to increase the connectivity between campus buildings. In the current situation the traffic within the campus is either terminating traffic people coming to UGM or traffic that uses one of the four main roads, which run through the campus, to enter or exit Yogyakarta. The ‘Sepeda Kampus’ system aims to reduce the terminating and internal traffic, these trips are now mainly done by motorbikes.

In recent years adoption of and studies on this wide spread urban public transportation “revolution” have spread across the globe. Two key questions for the success of bike sharing programs are how many ridership bike sharing systems can attract, and what influences their effectiveness (Jinbao Zhao, Wei Deng, Yan Song, 2014). Results from researches show that the usage of the bike sharing systems increases when the urban population, the number of docking stations, the number of members and the government expenditure increases. Other researches show that the land-use, demographics and environmental conditions influence the usage of the bike sharing systems. The article ‘Factors influencing the choice of shared bicycles and shared electric bikes in Beijing’ found that bike share users are sensitive to levels of comfort and effort, temperature will also temper demand (Andrew A. Campbell, Christopher R. Cherry, Megan S. Ryerson, Xinmiao Yang , 2016). The research by A.A. Campbell et al. also states that a bike sharing system should be deployed in a dense area with a high intensity of short trips, the ‘Sepeda Kampus’ is a bicycle sharing system in a dense area however the intensity of the short trips is until now unknown. They also prefer a high amount of small stations over a low number of big stations. These PBS more mostly

used to solve the so called ‘first or last mile’ problem. ‘Offering workable solutions that help a person traverse this “first or last mile” between home, work, or another destination and transit, increases the likelihood that residents will leave the car at home’ (BAAQMD, 2016). For Yogyakarta the PBS is mainly aiming on reducing the motor bicycle usage.

From the different articles that deal with difficulties of bike sharing systems it can be seen that these systems are very complex and one has to keep many things in mind to make a bike sharing system successful. Whether those difficulties and possible solutions also apply to the ‘Sepeda Kampus’ system in Yogyakarta is unknown, this is why this research is executed.

1.2 Objective

The main purpose of the research is to explore and explain the factors that can help to increase the travel demand of the bicycle sharing system at the Gadjah-Mada University. Based on these factors recommendations can be made. Therefore it is necessary to determine the various characteristics and factors of the bicycle sharing system.

1.3 Research question

To reach the objective an answer to the following research question must be found:

Main research question:

Which factors influence the bicycle travel demand of the bike sharing system at Gadjah-Mada University in Yogyakarta?

Sub questions:

- What are the characteristics of the bike sharing system at UGM?
- How are the characteristics from UGM similar or different to characteristics from comparable systems?
- Is there a relationship between the characteristics of the travel system and the travel demand?
- Which factors are based on the findings important to increase the travel demand?
- Which recommendations can be made on the basis of the research findings to increase the use of the system?

These sub questions can again be split up in sub-sub questions, these can be found in Appendix A

1.4 Reading guide

This reading guide will help to understand the structure of this report and make it easier to follow the argumentation. This report fill generally follow the structure of the conceptual model presented in Figure 1. First the system and environmental characteristics of the system will be analysed. The chapter followed by that will be the chapter about construction of the survey. After the data from the survey is collected an analysis will be executed. Based on this analysis a comparison between the results from this research and from other researches on this topic will be done. Finally the conclusions will be drawn on which recommendations will be based.

The general set up of a chapter will be a short introduction to the chapter and what it will be about. After that different sections of the chapter will describe and analyse the chapter specific things. At the end of each chapter a summary will present the important things of the chapter.

2. Methodology

In the following the research method is described and which work is going to be executed to answer the research question. The methodology this research will use is illustrated in the following figure.

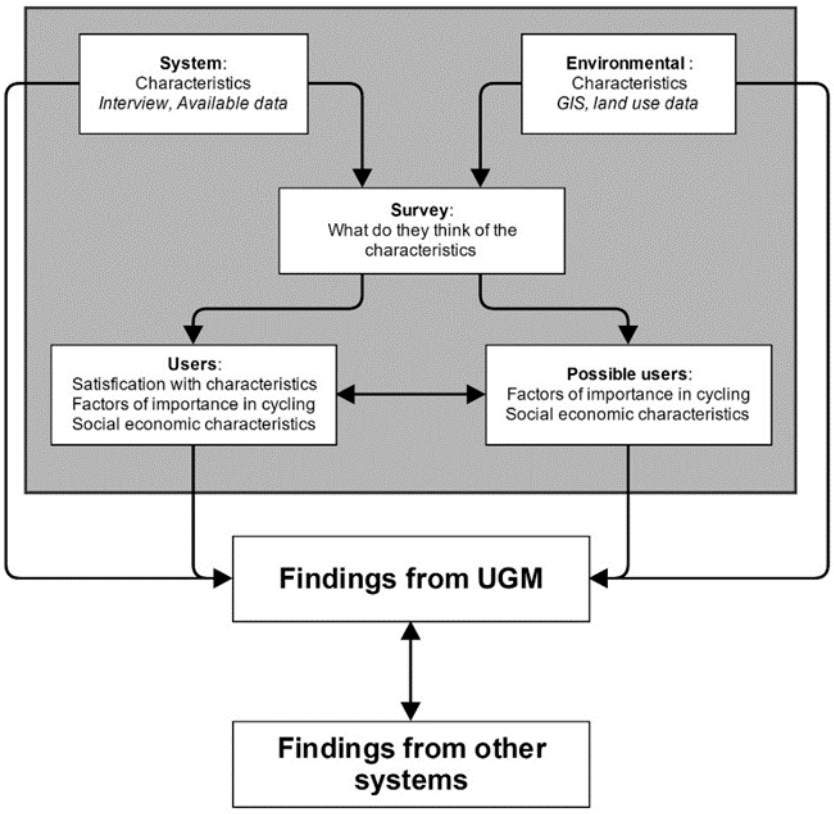

Figure 1 – Conceptual model

In the available literature different characteristics are described, the different researches use different types of characteristics they analyse. The article 'Mining bicycle sharing data for generating insights into sustainable transport systems' by (Oliver O'Brien, James Cheshire, Michael Batty, 2013) summarizes the characteristics and provides an overview about the various characteristics of a PBS. This research will due to the limited amount of time focus on the following characteristics:

- The aggregate characteristics
- The spatial characteristics
- The environmental characteristics
- Main users characteristics

The first three characteristics are required to measure the performance and quality of the system. The main user characteristics are used to determine which people actually use the system and what their social-economic characteristics are. It is important to realize that the difference between characteristics and factors is very small. For example the total amount of bicycles is an aggregate characteristic of the system while the amount of bicycles available at a station is an important factor why people might or might not cycle, for this reason one has to be careful while analysing the characteristics. The characteristics from UGM will be tested on the basis of the guidelines for successfully bike-sharing system designed by ITDP.

From Figure 1 it can be seen that the first step is to identify the system and environmental characteristics at UGM. As described this research will focus on four different characteristics. The systems characteristics can be analysed by looking at the aggregate characteristics – number of docking stations, number of docking points, number of bicycles available. The spatial characteristics are also related to the system, for this type of characteristics we need to identify the system's area of influence and the mean distance between docking stations. The characteristics of the main users are also part of the system characteristics. For the analysis of the environmental characteristics a closer look must be taken at the roadway characteristics. These characteristics have to deal with the available infrastructure and the land use of the area.

There are different methods necessary to identify the different characteristics. Each type of data needs to be analysed in its on specific manner. All this data is needed to identify the special characteristics of the bicycle sharing system at UGM. The information from the analysis of the characteristics is also required to obtain possible differences between the objective analysis and the outcomes from the survey.

The next step in the research is to prepare a survey based on the characteristics identified in the first step. This survey needs to provide insights on the opinion, of the users and possible users, about the characteristics. The set-up of the survey is crucial because as it can be seen from Figure 1 the next step of the conceptual model is to identify the 'satisfaction with characteristics' 'factors of importance in cycling' and as already mentioned the 'social economic characteristics' of the users and possible-users.

The difference between users and possible users of the system is required to identify characteristics and factors why people might not cycle. This can be retrieved by looking at the results from the possible users. To guarantee an adequate comparison between users and possible users the survey will ask the same questions to both groups, this is also done to identify possible differences in outcomes.

The information from the surveys is essential to come to conclusions and to answer the research question. Different descriptive an inferential statistics will be used to summarize the results from the survey. The next step in the conceptual model is to summarize the findings to 'Findings from UGM'. Before the research questions can be answered all information from the characteristics, factors, survey, possible users and users must be summarized.

After the findings are summarized a critical review must be carried out, this review is done by comparing the findings from UGM with the findings from other researches on this topic. Another part of this review is to determine the possible differences in findings and try to explain causes of the differences. With the critical review, the results from the characteristics analysis and the results from the survey the research questions can be answered.

3. Characteristics

3.1 System characteristics

This chapter provides a general overview of the system and its characteristics. The following sections will describe how to use the bicycle sharing system and will explain the spatial and the aggregate characteristics of the system. Next to this the environmental characteristics will also be analysed. The traffic streams and the land use are also part of this chapter. The collection of this information is the first step in the conceptual model.

3.1.1 Spatial characteristics

This section will provide information about the geographical aspects of the system. It will determine the systems area of influence and the mean distance between docking stations. Also the available information about elevation will be analysed. The spatial and aggregate characteristics are collected and analysed using a geographical information system (GIS). Yogyakarta is a city within the special province of Yogyakarta. The urban campus of the Gadjah Mada University is located in the north of Yogyakarta. The following figures will show the exact location of the campus area.

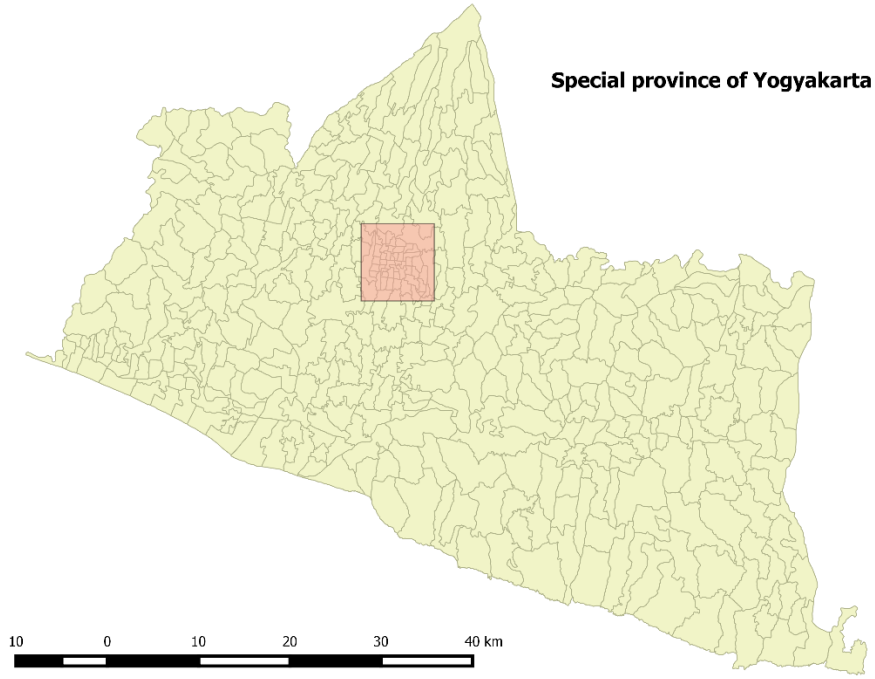

Figure 2 - Special province of Yogyakarta

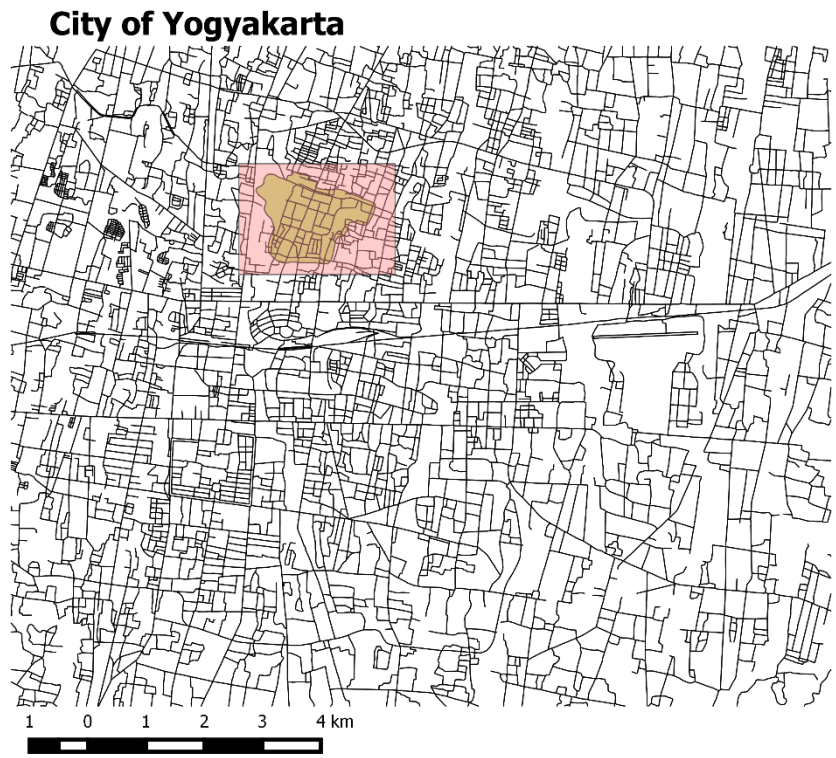

Figure 3 - City of Yogyakarta

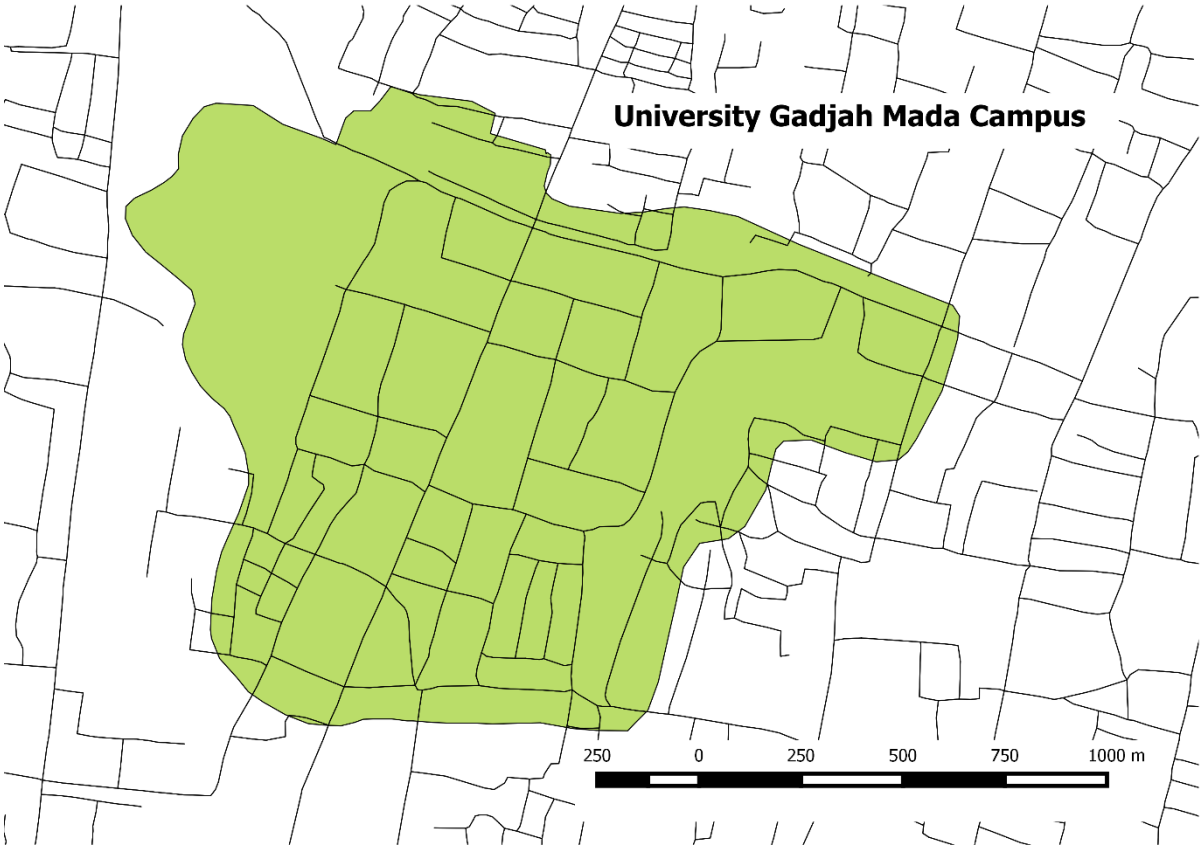

Figure 4 - Campus area

The systems area of influence is regulated by the rules of the system. All trips need to be within the area of UGM, therefore the boundaries of UGM must be clear. The northern boundary of UGM from West to East is the 'Pogung Kidul' followed by 'Jalan Teknika Selatan' followed by the 'Jalan Agro'. The western boundary of the campus is determined by the 'Jalan Kesehatan' and the 'Jalan Yacaranda'. The 'Jalan Prof. Dr. Sardijto', 'Jalan Terban' and 'Jalan Colombo' form together the southern boundary. In the East the campus is limited by the 'Jalan Prof. Dr. Drs. Notonagoro' followed by the 'Jalan Imogirir Barat Km 7 Desa' and the 'Depok'. The Indonesian word 'Jalan' means road that is why this word appears so often. The total length of this boundary is 6.4 km, which results in an area of 2.0km².

3.1.2 Aggregate characteristics

In this section the aggregate characteristics of the bicycle sharing system will be analysed. It will present the number of docking stations, the number of docking points and the number of available bicycles.

The necessary data was provided by a report about the 'Sepeda Kampus' and the website http://sepedakampus.ugm.ac.id/. This data provides information about the number of stations, the location of the stations and other information that is going to be used for this research. In Figure 5 the green area shows the area of the campus of UGM and the yellow points mark the locations of the bicycle sharing stations. In total there are 17 stations across the campus. The following list shows the name of the stations:

1. Perpustakaan
2. Gelanggang
3. Lembah
4. Agro Fauna
5. Taman Biologi
6. Teknik
7. Kesehatan
8. Vokasi
9. GMC
10. Bank UGM
11. Farmasi
12. PAU Pascasarjana
13. Hotel UC
14. Dinas
15. Klebengan
16. Bengkel

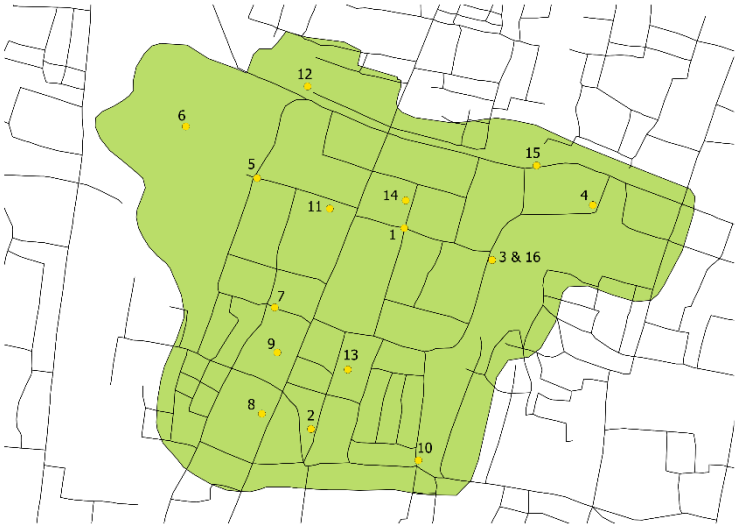

Figure 5 - Locations of the stations

The stations are built out of standardized docking 'shelters', these shelters provide space for eight dockings points. Such a standard shelter can be seen in Figure 6. These standard shelters can be moved between different stations to guarantee a sufficient amount of docking points per station.

Each station of the bicycle sharing system consists of a different amount of these shelters. Figure 7 shows a closed shelter, some stations have the opportunity to lock the bicycle in a closed shelter. These closed shelters are used for transportation, they fit on a small truck so that the operator can move the bicycles to another station where not enough bicycles are available. Table 11 in appendix B gives an overview of the name of the station, the exact location, the ideal amount of bicycles, the maximum amount of bicycles and the amount of

bicycles at each station at the 11th February 2016. The ideal amount is based on experiences of the operator. The system was introduced in July 2011, based on the experience of the previous four years the ideal amount of bicycles per station is determined.

Figure 6 - Standard shelter


Figure 7 - Closed shelter

Before the research can go on three things must be mentioned that are important. The first thing is that 'Bengkel' and 'Lembah' are at the same location, 'Bengkel' means workshop, at this station the bicycles are repaired if they are broken. At first the station 'Bengkel' was at a different location but due to a lack of space they moved the station close to 'Lembah'. In the system they are listed as two station but in reality they are one station with facilities for repairs. The second thing is that not all stations are electronic, some stations use manually filled books to register the users of the systems. For this reason the data of some stations is less reliable. The last thing is that the station 'Jl. Tevesia' is excluded from the research because during the research this station is still under construction. It is unclear where the station is located and what the ideal and maximum amount of bicycles is.

To determine the distance between the docking stations Google maps was used. Unfortunately the option for bicycles is not available for Yogyakarta, so the 'walking' option was used to measure the distances. With this option all possible trips between different stations are calculated. The result can be seen in Table 12 in appendix B, in this table all distances are measured in meters. The longest possible trip between two stations is 1997m and is a trip between the stations '4. Agro Fauna' and '8. Vokasi'. The shortest possible trip is between the stations '1. Perpustakaan' and '14. Dinas', this trip is only 120m long. The average distance between two stations is 932,78m this would take about 4 minutes to cycle.

The elevation of the area is also a spatial characteristic of the system. To determine the elevation again the geo information model is used. The model provided by PUSTRAL shows only level curves with a difference of 6,25m. For our research we would like to have a more detailed description of the elevation of the UGM campus area. Therefore the level curves are interpolated using a GIS-software. An image of the newly generated level curves together with the streets can be seen in the following figure.

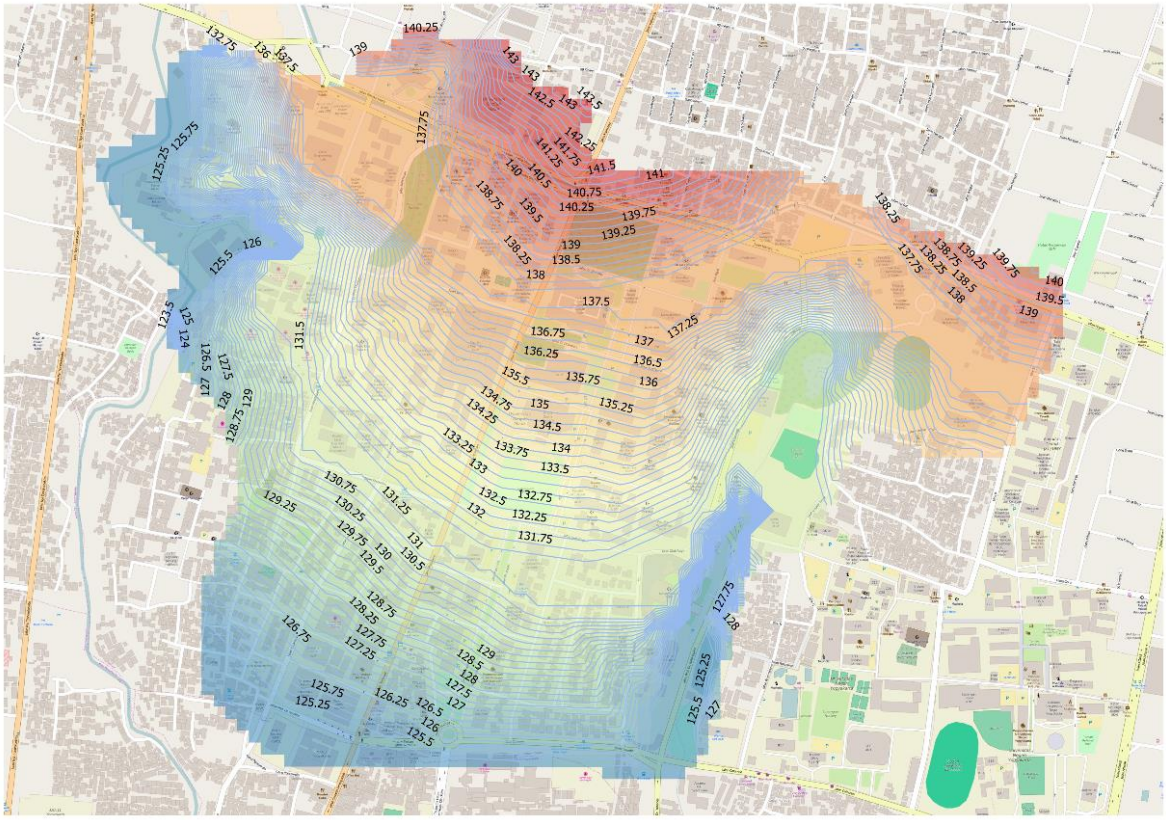

Figure 8 - Area with interpolated level curves

With these interpolated level curves it is now possible to determine the gradient of each road. Table 13 in appendix B shows the ID of the road, the length, the minimum and maximum elevation, the difference between these two values and the gradient

From Table 13 in appendix B we can see that there is one steep elevation of 5% (ID 9741) one possible has to cycle. If people cycle from ‘Jalan Prof. Dr. Notonagoro’ up to the Masjid Kampus UGM they would have to cycle up this steep elevation. The mean gradient of the UGM area is 1%. By looking at the values of the gradient and the experiences during the time in Yogyakarta it can be concluded that with a little amount of effort one can cycle up the elevations. So from the data and the personal observations it can be said that the elevation is not a reason why people might not use the system. The elevation might be an issue why people do not use the system in combination with the weather, when it warmer one has to put in more effort to cycle which makes it less attractive. This aspect will be covered by the survey.

3.1.3 How to use the system

The ‘Sepeda Kampus’ bicycle sharing is a free system that is intended for students, faculty staff as well as guests of UGM. The bicycle infrastructure is not just available for the system users, it is also available for users of personal bicycles. To use a bicycle from the bicycle sharing system you first have to register. The registration is done at every station by an officer. For the registration and the usage of the system a personal ID is necessary. After the registration one can immediately use the bicycle. Before one can leave the station the departure has to be registered also by an officer. The bicycles should only be used within the area of UGM and be returned to a ‘Sepeda Kampus’ station. After the arrival at the destination station an officer will register your arrival. The usage of the bicycles is limited to 30 minutes for each trip, this is sufficient time to cycle to another station. The system is available on Monday till Thursday from 06:00 to 18:00 and on Friday from 06:00 to 17:00. (Kampus, 2016). Since the 24th October 2015 the system is also open on Saturdays because there are some lectures on Saturday.

3.1.4 The standard bicycle

This section will give a short description of the bicycle that is used for the bicycle sharing system at UGM. The bicycle has six different gears which can be changed manually at the right side of the handlebars. The bicycle also has two breaks, one for the front wheel and one for the back wheel. To transport things a basket in front of the handlebars is installed and at the back a carrier is installed. To this basket a serial number for identification purposes is attached, this serial number can also be found attached to the carrier. For the night the bike also has a dynamo which generates electricity for the lights of the bicycle. Every user gets a lock for his/her bicycle so one can secure the bicycle outside the docking stations. The following picture shows a bicycle that is used by the bicycle sharing system at UGM.

Figure 9 - Standard bicycle

3.2 Characteristics of the main user

Some characteristics of the main users are already described in the section ‘How to use the system’, the main user must be a student, faculty member, staff or a visitor of the UGM. The other characteristics are identified by the survey and will be presented in the ‘Analysis’ chapter of this report.

3.3 Environmental characteristics

This chapter is used to describe the environmental characteristics of the bicycle sharing system. The roadway characteristics, the available infrastructure and the land use of the area are examined.

3.3.1 Available infrastructure

During a field trip it was discovered that the data provided by PUSTRAL does not cover all streets on the UGM campus area. For this reason an Openstreetsmap (OSM) file is added to the data. The data provided by OSM is more accurate and consists of nearly every street in the UGM campus area. With the additional data this model provides information about the location of roads and bicycle paths. Both models, the one from PUSTRAL and the OSM-model indicate that on every road on the UGM campus bicycle paths are present. This might be the case according to the model but from the field trip different results were collected.

After the OSM-data was added it was obtained that some roads that the PUSTRAL-model showed were not shown by the OSM-model. Two images showing the OSM- and the PUSTRAL-model can be seen below. Because of the different degree of accuracy the OSM-model is used for the research because it is more detailed.

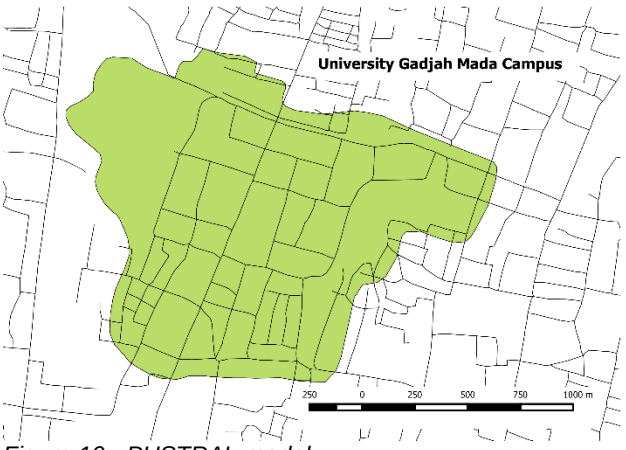

Figure 10 - PUSTRAL-model

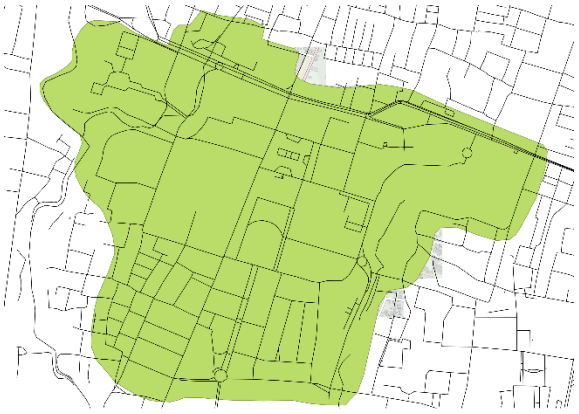

Figure 11 - OSM-model

From the following pictures, which were taken during the field trip on 10.02.2016, can be seen that there are some roads where bicycle paths are indicated/available and some where they are not indicated/available. If the bicycle path is indicated with a dashed yellow line there is no physical separation from the other traffic. During the field trip it was also discovered that neither the PUSTRAL- nor the OSM-model show all roads within the area. Especially small roads within the faculties, where it is possible to cycle or walk, are not mapped. The following analysis of the roadway characteristics is not only for the roads of the model, it also covers the small roads on the UGM campus. The information from the small streets was collected by a field trip.

Figure 12 - Bicycle path only on one side

Figure 13 - No marking for bicycle path

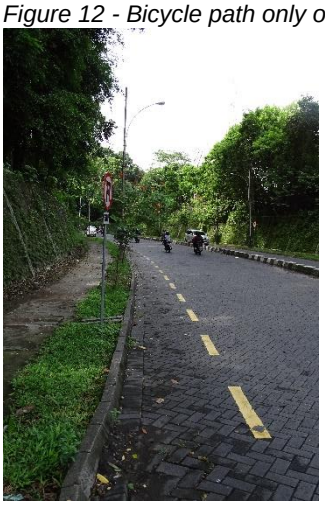

Figure 14 - Clear bicycle path marking

Figure 15 - Two types of marking

During the field trip it became clear that there are roads like in Figure 14 where an obvious marking of a bicycle is present. Unfortunately most of the roads that were visited had markings similar to Figure 12 or had even no markings like in Figure 13. A thing that also became clear during the field trip was that there are different 'types of marking', there are paths that are indicated with a yellow dashed line and there are paths that are indicated by a green path surrounded by a white dashed line, Figure 15 show these two types of marking. There are places like in Figure 15 where these two types overlap and therefore become very unclear, but there are also places where one type ends and the other type starts.

The lighting of the bicycle paths during night is also a feature of the available infrastructure. There are differences in how well the streets are lighted during night, the main roads like 'Jl. Kesehatan', 'Jl. Persuatan' 'Jl. Colombo', 'Jl. Teknika' and 'Jl. Agro' are well lightened. The smaller roads within the campus area are not well lightened. There are several reasons why the lighting at night is not good. At first the distance between two streetlights is bigger than in Europe, the other reason are trees. These trees are covering parts of the streetlights so that the light is not evenly spread across the street.

3.3.2 Roadway characteristics

This section will describe the road surface in the UGM area and obstacles that are on and in the road. The surface of the bicycle paths on the campus are either made of asphalt, concrete or cobblestones. The biggest part of surface is made out of asphalt followed by cobblestones, only a few sections have a concrete surface. You can distinguish between three different states of bicycle paths that are made from cobblestones. The distinctions between the different states is based on the records and experience from the field trip.

In case of the cobblestone and asphalt surface it is possible to distinguish between three different states. The first state is an evenly and flat paved surface with no or minimal failures. The difference between the first and the second state is that the second state is not that

evenly paved. Some cobblestones stand out or there are some holes in the asphalt and this makes the surface less even. The last of the three states is the most irregular paved state. In this state not only some cobblestones stand out or the asphalt has some holes, in this state there are also obstacles in the path like manhole cover. The use of cobblestones as surface has some problems, at some points in the area the cobblestones have sunk and therefore created holes in the bicycle path. For the bicycle paths that have concrete as surface, there is only one state because all paths have a similar state. The state of the concrete surface is flat with some small holes between the abreast concrete section. Pictures from the field trip which indicate the different states can be seen in appendix B.

Another topic that raised attention during the field trip were obstacles on the bicycle path. The obstacles that are on the bicycle path are very different, mostly these obstacles are cars parking on the bicycle paths. The problem of cars parking on the bicycle path were described by people from PUSTRAL even before the field trip was executed. They indicated that as a major problem. The other obstacles next to the cars are obstacles that were put on the bicycle path to secure construction work or plants that hang into the bicycle path. An obstacle that was put on the bicycle path for construction work can be seen in Figure 16. A picture of a plant that is hanging into/blocking the bicycle path can be seen in Figure 17. Also there are some speed bumps in the smaller streets within the faculties. These speed bumps stretch across the whole width of the street including the bicycle paths.

Figure 16 - Obstacle for construction work

Figure 17 - Plant hanging into the bicycle path

3.4 Traffic streams

In this section the bicycle movements will be analysed. The most frequent used stations and routes will be determined. After that these results are linked to the land use to obtain possible relationships.

3.4.1 Bicycle movements

To measure the performance of the system it is essential to determine the main bicycle movements, this means how many trips are made and what the most favourable routes within the campus area are. With the available data from 2015 it is possible to determine the average number of borrowed bicycles per day and the routes between the most frequent used stations. The following table shows the amount of borrowed bicycles per day. The low amount of borrowed bicycles on Saturdays might be due to the fact that there is only a small amount of classes on Saturday which means not so many people come to UGM.

Table 1 - Average number of borrowed bicycles per day

	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
Average per day	447	474	455	445	345	5

With the available data it is also possible to determine the most frequent used arrival and departure stations.

Table 2 - Most frequent used stations in 2015

Arrival	Departure
Perpustakaan	Perpustakaan
Gelanggang	Teknik
Vokasi	Taman Biologi
Taman Biologi	Vokasi

With the information from the most frequent used stations it is possible to determine the most frequently used routes within the campus area. The following figure shows these routes in red.

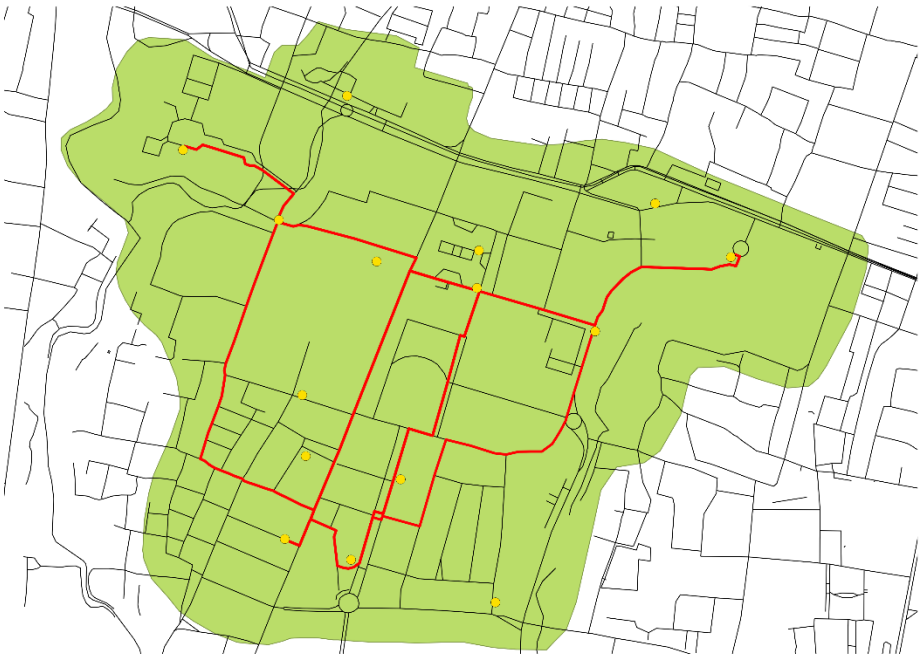

Figure 18 - Routes between most frequent used stations

The following graph shows the amount of borrowed bicycles per day, from this graph an interesting thing can be obtained.

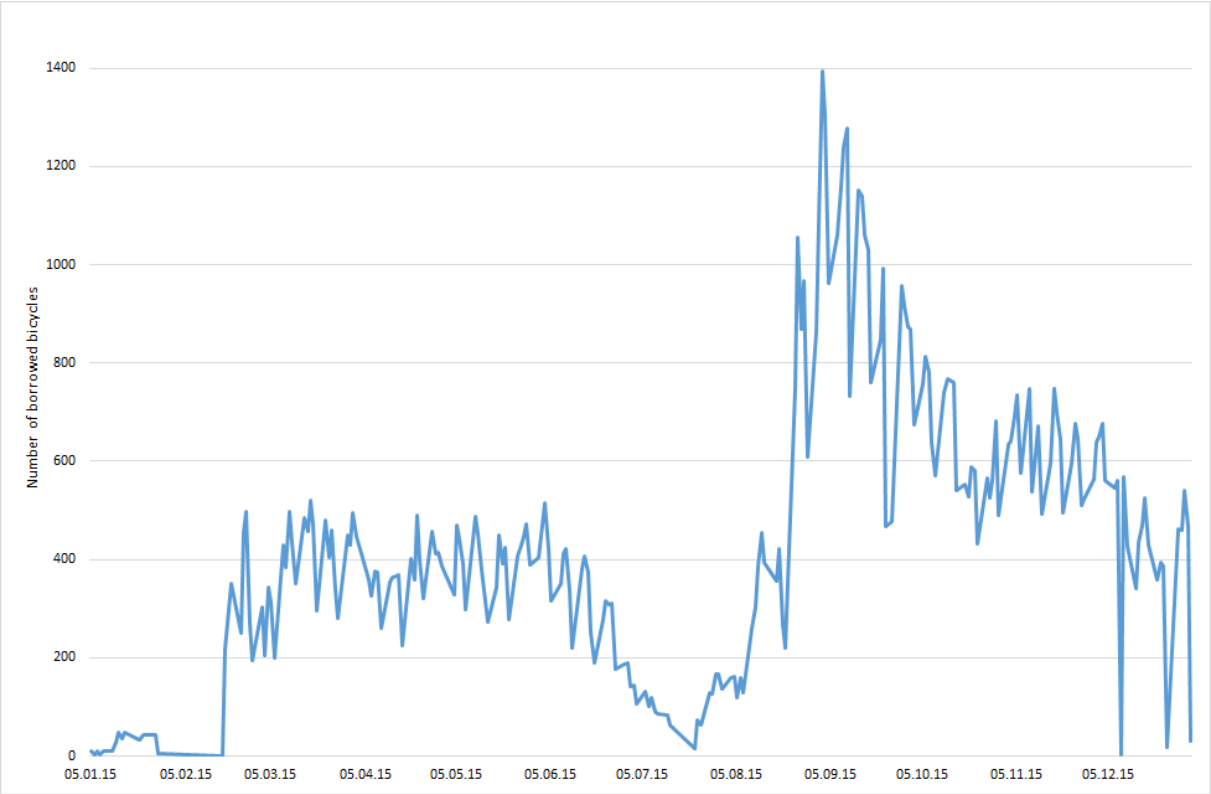

Figure 19 - Number of borrowed bicycles per day

The interesting thing is the peak in September, this is when the academic year starts. This peak was explained by the people from PUSTRAL. A policy from the university forbids the new first year students to use their motor bicycle to come to the university for the first year. In the beginning everybody follows the rule and uses the ‘Sepeda Kampus’ to travel within the campus boundaries. But after about two months people get exhausted from cycling that is why they then use their motor bicycle even if it is against the rule.

The data used in this chapter is from 2015, for a more accurate results the data from 2016 is required. The traffic streams are now based on the shortest routes between the most frequent used stations. To get a more detailed image of the traffic streams of the bicycles within the campus the bicycles have to be equipped with GPS, with the GPS data it would be possible to determine the individual routes each bike takes. Also a more accurate digital system would help to keep track of the movements. PUSTRAL is currently working on the development and the implementation of this more developed PBS for the campus.

The internal traffic streams of cars and motorbikes are unknown because until today there is no information about car or motorbike trips within Yogyakarta. PUSTRAL is currently also working on the OD-matrix of Yogyakarta but at the time of the research no information was available. From the observations that were made during the 12 weeks in Yogyakarta it can be said that most of the internal traffic is done by motor bicycles.

3.4.2 Land use

In the introduction it was already mentioned that the land use might influence the usage of the PBS. First a closer look at the available literature regarding the correlation between bicycle usage and land use will be taken. The research ‘Land use effects on bicycle ridership: a framework for state planning agencies’ states that ‘when land use diversity increases, …, people tend to rely on non-automobile modes more frequently’. (Yuchen Cui, Sabyasachee Mishra, Timothy F. Welch, 2014). Another study found that ‘stations in areas with higher job or population density or stations with higher number of point of interests (such as restaurants, retail stores and universities) in the vicinity experience higher arrivals and departures’ (Alexander, 2012). To analyse if this is the case in Yogyakarta Figure 20 was constructed. This figure shows the different types of land use and the location of the station. From the previous section we know the most frequent used arrival/departure station. From Figure 20 it can be seen that the most frequent stations are located in different land use types. For the UGM campus it therefore can be concluded that it does not matter in which land use type the station is located.

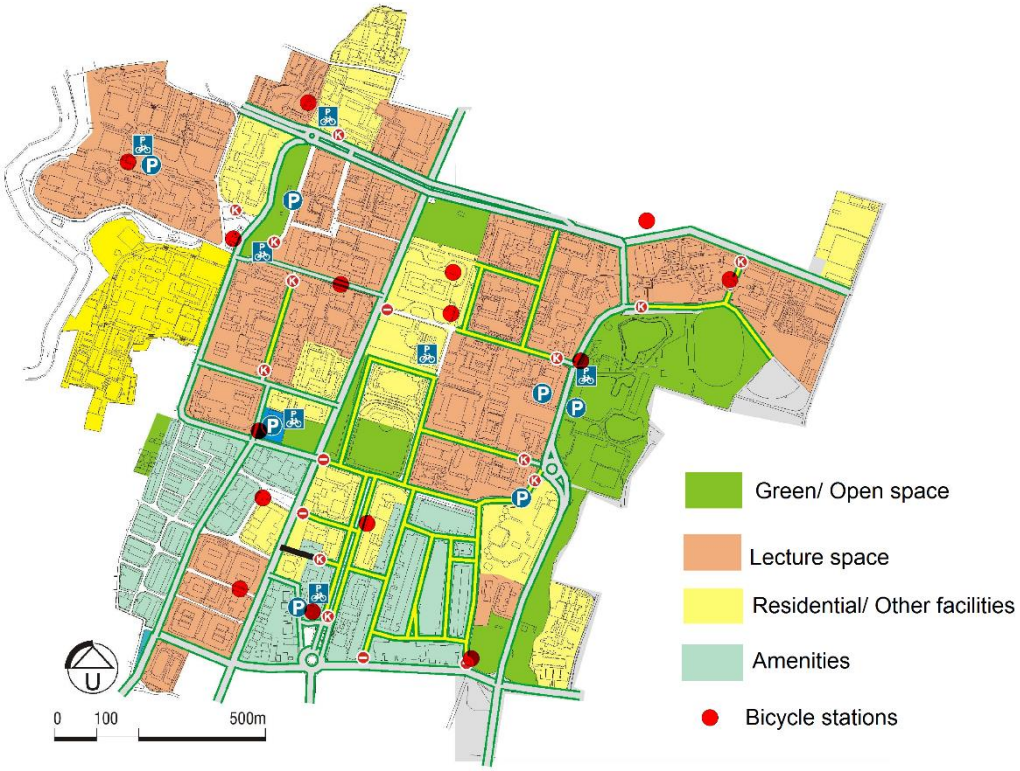

Figure 20 - Land use

3.5 Conclusions from characteristics

After all characteristics from the 'Sepeda Kampus' bicycle sharing system are analysed it is time to evaluate these characteristics. This will be done on the basis of the planning- and design-guidelines which are developed by ITDP, the guidelines also include performance metrics which examine the performance of a PBS. These guidelines can be divided into four groups

- Planning guidelines
  - Minimum system coverage area: 10km²
  - Station density: 10-16 stations per km²
  - Bikes/Residents: 10-30 bikes for every 1000 residents (within coverage area)
  - Docks per bike ratio: 2-2,5 docking spaces for every bike
- Bike guidelines
  - Durable
  - Attractive
  - Utilitarian
- Station guidelines:
  - Theft-proof locking mechanisms or security systems
  - Clear signage and use instructions
  - Quick and easy electronic bicycle check-in/check-out system
- Performance metrics
  - System efficiency: average number of daily uses: 4-8 daily uses per bike
  - Market penetration: average daily trips per resident: one daily trip per 20-40 residents

((ITDP), 2013)

When applying these guidelines to the 'Sepeda Kampus' system one has to keep in mind that these guidelines are developed for large scale PBS in big cities not for PBS on a campus. However these guidelines are used to measure the performance. The 'Sepeda Kampus' meets some of the requirements but not all. The coverage area and the station density is way lower than suggested in the guidelines. In case of the bikes per residents ration the system meets the requirements. At UGM about 70.000 people work and study, with 1010 bicycles this results in about 14 bicycles per 1000 residents. The docks per bike ratio is unknown at UGM. The bicycles of the system meet all requirements of the bike guidelines. The station guidelines are nearly all met except the easy access guideline, currently there are only a few stations which are electronic. Both performance metrics are not met, the average number of daily uses per bike is about 0,4, this is 10 time lower than the suggested guideline. The average daily trips per residents are at UGM are about 5 times lower than the suggested guidelines.

To compare the performance of the 'Sepeda Kampus' system with other PBS from across the globe the tripdata from other systems is required. This data is not available, but 'The Bike-share planning guide' from ITDP provides the following image which shows the performance of other PBS analysed by ITDP.

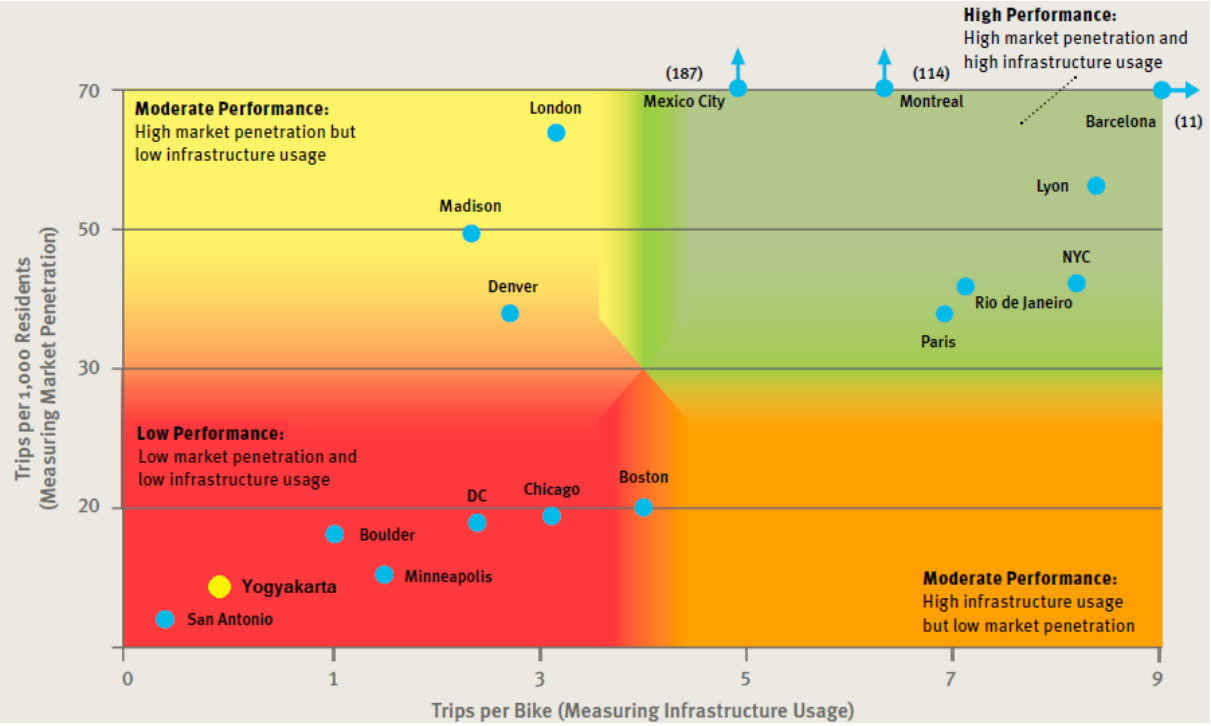

Figure 21 - Performance comparison between different PBS

The ‘Sepeda Kampus’ system was added to the image and it can be seen that the system is in the left bottom quarter which means it has a low performance. Only the system from San Antonio performance worse. The seven systems in the right top quarter meet the ITDP performance metrics for a successful PBS.

According to the guidelines from ITDP the ‘Sepeda Kampus’ has some characteristics which helps it to be effective, but especially the performance of the system is very bad. The performance of the system is the main issue of this research. This research will help to increase the travel demand of the system.

During this chapter the information about the system was collected and analysed. The important information that were determined in this chapter are number of stations, location of stations, elevation of the area, available infrastructure, quality of the road surface, lighting during night and safety. All this information will be part of the survey in the next step. The survey will ask participants about their attitude towards different aspects of the system.

This information is also required to answer the research questions. The research questions that can be answered based on this chapter are the following

- What are the characteristics of the bike sharing system at UGM?
    - What are the physical characteristics?
        - What are the facilities of the system?
        - What is the available infrastructure on the area of UGM, what is its quality and how is it being used by various modes?
    - What are the spatial characteristics?
        - Where are the sharing stations located?
        - Which area does the system cover?
        - What is the topography of the area?
    - What are the operational characteristics?
    - What are the characteristics of the usage?

4. Construction of the survey

After the system characteristics are identified the survey must be prepared, the setup of the survey is the next step in the conceptual model. The survey is the central point of the research, it must provide information about the users and possible users of the system and their behaviour. Designing a survey consists of three different parts, the first aspect is the sample, the second one is the method of data collection and the last one is the individual questions. All three parts will be described in this chapter

4.1 The sample

For the purpose of this research a simple random sample is used, this means a subset from a population is chosen. The population in this case are all students, faculty members, staffs and visitors from UGM. The exact size of the population is unknown because it is unclear how many people visit the UGM area. What you certainly know, is that there were about 61.000 students and about 14.000 faculty members in 2015. A randomly selected subset of individuals which will represent this population will be chosen. The survey will be a cross-sectional survey which means that it is executed only once. Follow-up research may use the results but this survey is not designed for longitudinal purposes.

4.2 The method

The article ‘Collecting survey data’ (Research, 2016) presents the different advantages and disadvantages of various survey collecting methods, these remarks were taken into account while choosing the appropriate method for this research. For this research the survey will be collected using the internet survey technique. It must be ensured that the survey is available in English and Bahasa Indonesia so that the problem of language barrier is minimized. To prepare the survey the ‘Google forms’ tool will be used. It allows to construct a survey with different types of questions and then distribute it to the participants via E-mail. Another advantage of this software is that all responses are directly transferred into a table-file which makes it easier to analyse in SPSS. The survey was distributed via social media and the official UGM-mail service, the UGM-mail service is the official E-mail system of UGM and with this method about 70.000 persons received the survey.

4.3 The questions

The questions of the survey need to help to answer the research questions, they must provide information about the characteristics of the users, their behaviour and their opinion on certain aspects of the system. To formulate the questions for this research different scientific articles about the bicycle use on campuses across the world were analysed. The articles which conducted a survey along students, faculty members and staff got special attention. The researches were conducted at the following campuses:

- Boise State University (USA)
- University of Michigan – Flint (USA)
- University of Idaho (USA)
- University of Graz (Austria)
- Universiti Teknologi MARA (Malaysia)
- Autonomous University of Barcelona (Spain)
- University of Sheffield (United Kingdom)

From these seven different researches it can be obtained that there are some topics which each survey covers. Based on these researches the following three categories can be distinguished:

1. General information – gender, age, occupation and car/motorbike ownership.
2. Cycling behaviour – how often people cycle using the 'Sepeda Kampus', how often people cycle without using the 'Sepeda Kampus', and for which purpose they use it
3. Attitude towards cycling – how much do certain aspects affect their bicycle use

The survey that is going to be constructed for this research will cover these three different topics. It will also cover a fourth option, this fourth option are questions about if their cycling behaviour would change if different aspects of the bicycle sharing system would change. This category is added to the survey to identify how the cycling travel demand could be increased.

Before the questions start it is helpful to give a short description of the purpose of the survey to help the participants to set the survey into context. This information must also be available in Bahasa Indonesia. After the short introduction the participants will have to decide in which language they would like to answer the questions. Based on this decision the questions will appear to the participants in different languages.

4.3.1 General information

The questions that are going to be asked in this section must provide information which will help to group the participants. The first question of the research will be about the gender and there will be two possible answers, male and female. The question concerning the age will be an open question and this means the participants can give their own response. The next general information that is going to be gathered is to which category of user the people belong. For our analysis of the survey it is also important to know where the people work/study. For this the following open question is added: 'At which faculty do you work/study?'. This is another an open question. The last general information is about if people own a car, bicycle or a motorbike. The possible answers to all of these and the following questions can be found in appendix C.

4.3.2 Cycling behaviour

This section of questions will provide insights in the cycle behaviour of the users and possible users of the bicycle sharing system. The first question is about how often people use the bicycle sharing system. The participants will have to choose from a certain frequency.

If people answered 'I have never used the system' in the previous question they will not have to answer the following questions, the following three questions are special for people who already use the system. To identify the purpose why people use the bicycle sharing system the following question is asked: 'For which purpose do You use the Sepeda Kampus?'

The next two question special for the users are: 'What is your most used departure station?' and 'What is your most used arrival station?'. Both question can be answered by selecting one of the sixteen stations. These two questions mark also the end of the section just for users.

The next question, which will be for users and possible users again, will ask how often people cycle without using the system. This question will indicate if there is a difference in usage and attitude of people who cycle more often/ on a regular basis and people who do not cycle at all. The question that will be asked is: 'How often do you cycle without using the 'Sepeda Kampus' system'.

4.3.3 Attitude towards cycling

To analyse the attitude towards cycling the bicycle motivators and barriers stated by Rybarczyk and Gallagher and the aspects described by Titze et al are used. These two researches have things in common, they both ask questions concerning the safety during cycling, the travel distance, lighting at night, possibilities to park the bicycles, the social support and the weather. Another thing that they have in common is that they both use a 4 point scaling system. This 4 point scaling system is used so that a direction can be obtained, this means it can either be seen if the participant agrees or disagrees with an aspect. To analyse the attitude of the participants towards cycling the things the survey have in common are summarized to the following statements

- The on-road safety on the campus is good
- There are sufficient bicycle paths
- The bicycle paths are well signed
- There is sufficient lighting in the evening
- There are enough stations to return the bicycle
- The distance between stations is too long
- The weather influences my bicycle use
- It is attractive to cycle across the UGM campus
- Seeing more bicyclists makes me want to cycle more
- I am not interested in cycling because it is unpleasant

The question that is going to be asked is: 'How much do you agree with the following statements?'. The possible answers are strongly agree, agree, disagree and strongly disagree.

4.3.4 Change in behaviour

To analyse the possible change in bicycle behaviour a stated preference survey is used. In this type of survey the choice of individual participants is made under experimental conditions. The purpose of stated preference studies is to assess how respondents' choice vary in different hypothetical situations (Arif Wismadi, Prima Romadhona, Januar Praha, 2014). In a stated preference survey you can ask, "If you faced this particular situation, what would you do?" (Sanko, 2001). For the stated conditions the respondent is faced with a choice between a finite numbers of mutually exclusive alternatives (Stephane Hess, John M. Rose, 2009). A stated preference survey instead of a revealed preference survey is used because it should be analysed if people would use the bicycle sharing system more if things that are not available yet would be present. With a revealed preference survey it is only possible to analyse the current preference and not the future preference, which is why a stated preference survey is used for this research.

At PUSTRAL people are already working on how to improve the 'Sepeda Kampus', for the future they distinguish between six different groups of policies that will try to introduce to the bicycle sharing system. These six groups of policies are:

1. Infrastructure policies
2. Operating policies
3. Supporting policies
4. Service policies
5. Regulation policies
6. Information policies

As earlier already mentioned this research will not focus on the operational aspects of the system. This research will therefore focus on the following three types of policies: infrastructure, supporting and service policies. These policies are also chosen because PUSTRAL wanted to collect data about these specific policies. Within these policies there will be actions that will try to improve the current system. The actions for each policy are:

- Infrastructure policies
    - A very safe dedicated lane only for bicycles
    - Clearer marking
- Supporting policies
    - More stations
    - Detailed description of the route to the other stations
- Service policies
    - Easier borrowing procedure
    - Longer opening times

With these three categories it is possible to create seven different situations, the possible combinations are:

1. Only infrastructure policies
2. Only supporting policies
3. Only service policies
4. Infrastructure and supporting policies
5. Infrastructure and service policies
6. Supporting and service policies
7. Infrastructure, supporting and service policies

The survey needs to present the participants a clear description of each policy so that the participants know what policy will lead to which actions. The final survey with all questions, answers and descriptions can be found in appendix C.

All the information of the stated preference section, this means names of the policies and actions within the policies, were taken directly from the developments of PUSTRAL. The suitability however of certain actions to certain policies can be questioned, for example ‘More stations’ could also be an action within the infrastructure policies. ‘Detailed description of the route to the other stations’ could also be assumed to be part of the service policy. Nonetheless nothing was changed so that the results from this research can easily be sued within PUSTRAL for further research.

5. Analysis

This chapter will describe how the data that were collected with the surveys is going to be analysed. There must be different steps executed to come to conclusions based on the data. The steps are preparation of the data, transformation of the data, and analysis of the data after the last step the results from this research will be compared with findings from other similar researches. For the analysis of the data different types of statistics will be used. The first type is descriptive statistics, with these descriptive statistics an initial description of the data will be given. The other type of statistics are inferential statistics, this type is used for the main conclusions from the data. The properties of the underlying distributions will be derived by the analysis of the data. This type also helps to test hypothesis which result in conclusions for the whole population based on the sample

5.1 Preparation of the data

Because an online survey was used the answers of the respondents were immediately imported into an excel file. In this file the answers to the same questions were presented in different columns based on the language the participants had chosen. So the responses in Bahasa had to be copied into the columns of the English responses. After the excel file was entered into SPSS some adjustments of the data must be done. There are two different types of question open and closed questions. In the case of closed questions the participants can only select from the given answers, while in case of open questions people can fill in their own answer. Both types of questions are analysed and transformed in the same way. The given answers must be transferred into numerical values, this is necessary so that SPSS can work with the data. The answers and accompanying numerical values can be found in appendix D –‘Table 14’. Most of the answers are given by the survey but the questions ‘At which faculty do you work/study?’ and ‘For which purpose do you mainly use the 'Sepeda Kampus' system?’ have the possibility for participants to give their own answer. From the different answers to the ‘work/study’ open question 26 different categories were formed, these 26 categories where participants work or study are based on their responses. If locations are close to each other like library and central office they get the same numerical value. For the question for which purpose the participants use the system the open answer option is included in case the participants do not use the system for one of the stated purposes. Based on the answers to this open questions two categories are added, one is the purpose of sport and the other is that people use it for more than one of the stated purposes.

5.2 Descriptive statistics

This section is used to present some descriptive statistics of the results. These descriptive statistics give an overview of the observations. The data was collected between the 29th February 2016 and the 12th April 2016, in this period 2045 responses were collected. Of the 2045 responses 109 cases were excluded from the analysis because the participants did not fill in all general information. After these cases were excluded 1936 valid cases are left for the analysis. 40,8% of the participants are female and 50,9% are male. Based on their answers it is possible to divide the respondents into age groups. The first three categories are based on the study year, the other five categories are based on categories that are used by similar researches. The following table shows the different age groups

Table 3 - Different portions per age group

Age	Portion of the respondents
17 ≤ 18 (1st year)	8,4%
19 ≤ 20 (2nd year)	22,5%
21 ≤ 22 (3rd year)	17,6%
23 ≤ 25	15,5%
26 ≤ 30	11,3%
31 ≤ 40	13,1%
41 ≤ 50	8,6%
> 50	3,2%

The biggest group which answered the questions are the students, which could be expected because the students are also the biggest group at UGM. 23,3% of the people and therefore the highest amount work or study at the engineering faculty. About two fifth of the respondents own only a motorbike followed by 16,2% which own a bicycle and a motorbike. Figure 22 and Figure 23 visually represent these two results.

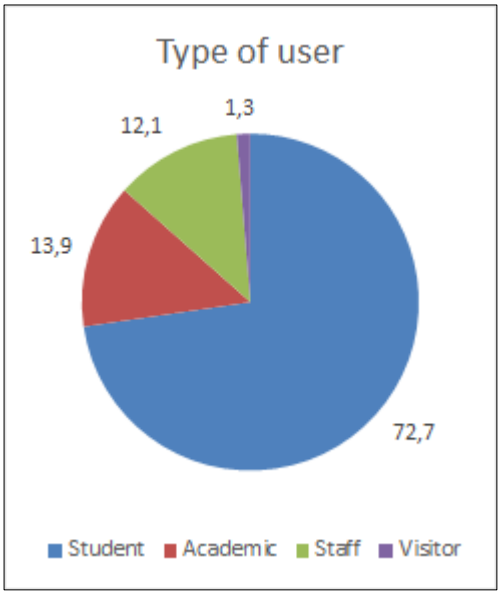

Figure 22 - Portion of different type of user

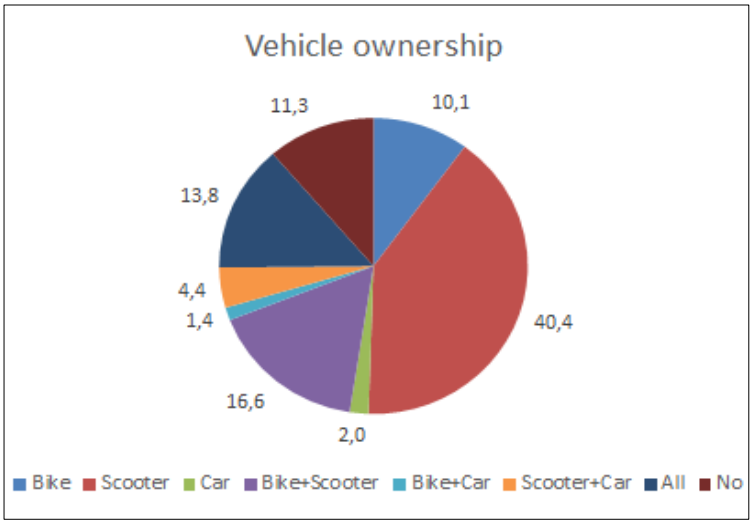

Figure 23 - Portion of different vehicle ownership

Until now only the general information collected by the survey has been described, for this reason the next descriptive statistics will describe the other three sections used in the survey, the first is the cycling behaviour. Based on the answers to the question how often people use the 'Sepeda Kampus' it is possible to determine two groups. The first group are people who answered 'Never' they are the so called 'Possible users' of the system. The second group are the people who already have used the system and therefore gave an answer between

‘Once a month’ and ‘Daily’. Of the total amount of valid responses 36,3% can be defined as ‘Possible users’ and 63,7% can be defined as ‘Users’. That was not expected because it was assumed that the ‘Possible users’ group would be bigger than the ‘User’ group. If this values are extrapolated and using that the average user cycles once a week, you would have about 2.300.000 bicycle movements per year and this is 22 times higher than what actually was measured in 2015 (101.718 movements). So it can be assumed that the distribution between possible users and users is not representative for the whole UGM population. This could be explained by the fact that users are more interested in this research than potentially users.

The next thing in cycling behaviour are the arrival and departure stations, Figure 33 in appendix D shows the portion of trips leaving and arriving from each station. From Figure 33 it can be seen that there are on the one hand stations which have more arriving than departing trips and on the other hand there are stations which have more departing than arriving trips. The huge difference at station number 2 ‘Gelanggang’ can be explained by the fact that there is a bus station and parking area close to ‘Sepeda Kampus’ station. At the end of the day, that is how the people from PUSTRAL explained it, people use the ‘Sepeda Kampus’ to go to ‘Gelanggang’ and then go home. The difference in portions of arriving and departing at station number 6 ‘Teknik’ can be explained by looking again at the elevation. The engineering faculty is located higher than the campus which makes it unattractive to cycle there but attractive to leave from there because people can easily cycle downhill.

The next descriptive statistics will focus on the section of the survey which presented various statements to the participants. Again we will distinguish between two groups, the first group are respondents who agree with the statement and the second group are participants who disagree with the statement. From the following table which shows the ‘agree’ (‘Strongly agree’ & ‘Agree) and ‘disagree’ (‘Strongly disagree’ & ‘Disagree’) portion per statement it can be seen that there is normally a 50/50 distribution between agree and disagree except for five cases.

Table 4 - 'Agree' and 'Disagree' portion per statement

Statement	Agree	Disagree
The on road safety on the campus is good	50,20%	49,80%
There are sufficient bicycle paths	43,03%	56,97%
The bicycle paths are well signed	47,69%	52,31%
There is sufficient lighting in the evening	30,94%	69,06%
There are enough stations to return the bicycle	46,86%	53,14%
The distance between stations is too long	55,03%	44,97%
The weather influences my bicycle use	85,41%	14,59%
It is attractive to cycle across the UGM campus	76,29%	23,71%
Seeing more bicyclists makes me want to cycle more	82,45%	17,55%
I am not interested in cycling because it is unpleasant	9,97%	90,03%

To explain these differences it is necessary to look at the way the statements were asked. In the case of the ‘Sufficient lighting’ the high portion of ‘Disagree’ means that most people think that there is not sufficient lighting during the night. In the case of ‘Weather’ the high portion of ‘Agree’ means that the weather influences the bicycle use of most people. The high portion of ‘Agree’ respectively ‘Disagree in the other three statements means that most people think that it is attractive to cycle across the campus and that if they would see more cyclists they would also cycle, also the most people think that cycling is not unpleasant. The outcome from the ‘It is attractive to cycle across the UGM campus’ statement is also interesting regarding the elevation of the campus. In section ‘Aggregate characteristics’ the elevation was examined and concluded that there are small to big elevations all across the campus.

However looking at the outcomes from the statement it can be said that these elevations does not make the campus unattractive to cycle.

The last section of the survey presented different policies to the respondents, they should then decide how likely it is that they will use the 'Sepeda Kampus' after the introduction of the policies. Again two different groups based on the responses were formed, the one group the will use the system and the one that will not use the system. The portion of people who will use the system after the introduction is in all cases, single policies and combinations of policies, higher than 80%.

5.2.1 Characteristics of the main user

The main user is a male student which is about 20 years old, he studies at the engineering faculty and owns only a scooter. He uses the 'Sepeda Kampus' system about once a month or a bit more frequent, he uses the system to travel across the campus between UGM buildings. The bicycle for his trip is picked up and returned at the 'Perpustakaan' station

5.3 Inferential statistics

There are various methods how to come to conclusions that will help to answer the research questions. In this section the terms regression and correlation are frequently used, for this reason a short description of these terms is given. 'Regression and correlation measure the degree of relationship between two or more variables in two different but related ways.' (Pidwirny, 2006). The difference between these two things is that correlation measures the association between two or more variables. In regression two or more independent variables are used to predict the value of one dependent variable. To calculate correlation coefficient the data analysis option of SPSS is used. This tool calculates the correlation coefficient between variables. The possible outcomes can vary between -1,00 and 1,00. The closer the correlation coefficient gets to -1,00 or 1,00 the stronger is the linear (negative or positive) relation between two variables. A correlation coefficient close to 0,00 indicates that there is no relation between the variables.

To answer the research questions which will help to come to the main conclusion from the research, different hypothesises are constructed. These hypothesises are then tested and based on their outcomes it will be possible to answer the research questions. For this reason it is important to construct hypothesises that are crucial to the research. To do this two things have to be taken into account, first the comparison between users and possible users and the second the research questions.

From the conceptual model in Figure 1 it can be seen that this research will compare the possible users and the users of the 'Sepeda Kampus' system. It is expected that these two groups answer statistically significant to various question. An exception from this is the comparison between the social economic characteristics of the two groups, it is expected that these characteristics are not statistically significant between the groups. From Figure 1 it can also be seen that the factors of importance in cycling will be compared. In this comparison it is expected that the users name other factors than the possible users.

5.3.1 Comparison user with possible user – Social economic characteristics

In this section the following hypothesis will be tested:

'*The socio-economic characteristics of users and possible users are not statistically significant different*'.

In total there are 1936 valid responses, based on the answers 702 (36,3%) can be defined as possible users and 1234 (63,7%) as users. The survey consists of questions about gender, age, type of user, place of work (faculty) and vehicle ownership. All these elements are socio-economic characteristics. Table 15 in appendix D gives an overview of the social economic characteristics of users and possible users. From the visual inspection of the table no big differences between users and possible users can be obtained. To test if there is no statistically significant difference between users and possible users a statistical test will be executed. The statistical test that is going to be used is the independent t-test, this test 'compares the means of two independent groups in order to determine whether there is statistical evidence that the associated population means are significantly different' (University K. S., 2016). The results from the t-test can be seen in Table 22 in appendix D. From the comparison of gender, age categories and faculty (place of work) it can be concluded that there are statistically significant differences between users and possible users of the system. The 'User'-group have a higher female portion and is on average 2 years younger than the 'Possible user'-group. The statistically significant difference in average age can be explained by the fact that younger people are more active and therefore cycle more while possible users are less active and therefore not attracted to cycling. A reasonable explanation for the statistically significant difference in place of work and gender cannot be found. So the hypothesis can be rejected based on the results because three of the five categories are statistically significant different which leads to the conclusion that for the most part the users and possible users of the 'Sepeda Kampus' have different social economic characteristics.

5.3.2 Comparison user with possible user – Statements on characteristics and factors

Again from the conceptual model in Figure 1 it can be seen that the following comparison between users and possible users is based on the 'Attitude towards cycling' section of the survey. The people in the 'Possible user' category may have not experienced the characteristics during cycling with the 'Sepeda Kampus' but they still have an opinion on the characteristics from their movements on the campus. It is expected that the possible users value the statement lower than the users of the system, this means the responses from the possible users are more into the negative direction. Table 5 gives a general impression of how many participants agree or disagree with each statements. In this table the responses are summed up to two categories, in Table 16 in appendix D the frequency of each answer per statement per user category can be seen.

Table 5 - 'Agree-' or 'Disagree-portion' per statement per user category

Statements		Possible user	User	**Statements**		Possible user	User
On-road safety	Agree	48,84%	50,98%	Distance between station	Agree	62,46%	50,80%
	Disagree	51,16%	49,02%		Disagree	37,54%	49,20%
Sufficient bicycle paths	Agree	38,54%	45,61%	Weather influences	Agree	85,38%	85,43%
	Disagree	61,46%	54,39%		Disagree	14,62%	14,57%
Well signed paths	Agree	42,79%	50,49%	Attractive to cycle	Agree	70,47%	79,61%
	Disagree	57,21%	49,51%		Disagree	29,53%	20,39%
Sufficient lighting	Agree	33,07%	29,73%	Seeing more bicyclists	Agree	81,40%	83,05%
	Disagree	66,93%	70,27%		Disagree	18,60%	16,95%
Enough stations	Agree	45,74%	47,50%	Cycling is unpleasant	Agree	14,55%	7,35%
	Disagree	54,26%	52,50%		Disagree	85,45%	92,65%

The hypothesis that will be tested is:

'There is a difference between users and possible users in the way they agree or disagree with statements concerning the characteristics and factors of the system'

To test this hypothesis an independent t-test is executed, the results of this test can be seen in Table 23. From the results it can be seen that the possible users answer to 50% of the statements statistically significant different than the possible users, the statements that the possible users value different are: 'Sufficient bicycle paths', 'Well signed paths', 'Distance between stations', 'Attractive to cycle' and 'Cycling is unpleasant'. So the hypothesis can be confirmed.

Now it is important to look at what was expected. It was expected if the possible users answer different they judge the characteristics more negative than the users. To analyse this the way the statements and were presented and the means of the statements are essential. In all five cases it can be concluded that the possible users answer in the more negative way.

Table 6 - Average per statement per user category

Statements	Possible user	User
Sufficient bicycle paths	2,76	2,62
Well signed paths	2,62	2,49
Distance between stations	2,20	2,40
Attractive to cycle	2,13	1,91
Cycling is unpleasant	3,37	3,58

So the conclusion from the comparison of the statements between possible users and users is, that if these two groups answer statistically significant different the possible users value the characteristics in a more negative way. The difference in responses may be explained by the fact that if people value the characteristics in a negative way they will not use the system which then makes them possible users. Another explanation could be the amount of people who cycle with or without the system in the 'Possible user' and 'User' groups. From the available data it can be seen that the users of the system also cycle more often without the system. That means people who cycle with the 'Sepeda Kampus' are also cycling outside the campus which shows that these people have a positive attitude towards cycling.

5.3.3 Comparison user with possible user – Biggest barrier in cycling

In the previous section it was analysed to which statements the two groups answer different, this section will focus on the biggest, so called, barrier why people do not cycle. The biggest barrier is the characteristic that is valued in the most negative way. To identify the biggest barrier some adjustments in the data have to be done, the numerical values of the 'Distance between stations', 'Weather' and 'Cycling is unpleasant' must be inverted. Also the statements are split up into subjective feelings of the participants and objective factors that have to deal with the system. The objective characteristics are very interesting because they influence the bicycle use and can be easier influenced than the subjective feelings. The following two tables show the results.

Table 7 - Objective characteristics

User	Mean	Mean	**Possible user**
Sufficient lighting	2,91	2,86	Sufficient lighting
Sufficient bicycle paths	2,62	2,80	Distance between stations
Enough stations	2,61	2,76	Sufficient bicycle paths
Distance between stations	2,60	2,62	Enough stations
Well signed paths	2,49	2,62	Well signed paths

Table 8 - Subjective feelings

User	Mean	Mean	**Possible user**
Weather	3,34	3,39	Weather
On-road safety	2,49	2,56	On-road safety
Attractive to cycle	1,91	2,13	Attractive to cycle
Seeing more bicyclists	1,75	1,77	Seeing more bicyclists
Cycling is unpleasant	1,42	1,63	Cycling is unpleasant

We see that the insufficient lighting during night the biggest barrier is why people do not use the system. The second thing of the objective characteristics where the participants are not happy about are the amount of bicycle paths respectively the distance between the stations. That the possible users are not happy about the distance between the stations could be expected because many other researchers identified the distance people have to cycle as an important factor in choosing the bicycle as mode of transportation.

Regarding the subjective feelings of the participants two things need to be mentioned. The first thing to mention is that it was expected that the safety is the biggest barrier because all other researches on PBS and bicycle use identified safety as the biggest barrier. The reason why the on-road safety in Yogyakarta is less important to the participants might be explained by the in general more unsafe traffic. The traffic in Yogyakarta is like in many other Asian cities dominated by motorbikes and very chaotic which leads to unsafe situation. The road users are therefore used to unsafe situation on the road. The second thing that need to be mentioned is the possible reason why people identified the weather as the biggest barrier. The annual average temperature in Yogyakarta is 26,4°C with an average precipitation of 2157mm, this high temperature in combination with the high humidity makes bicycle trips very exhausting. Another thing that can be concluded from the analysis of the biggest barrier is that people find cycling pleasant and that if they would see more cyclists they would also cycle.

According to the ITDP measures the station density is to low, it is interesting to look what the participants think about the station density. The survey included two question that deal with the station density, one regarding the amount of stations and one regarding the distance between stations. The amount of stations and the distance between stations are directly linked with each other. More than 50% of both groups, possible users and users, disagree

with the fact that there are enough stations to return the bicycles. Also both groups say that the distance between the stations is too long. The responses from the participants match the outcomes of the ITDP guidelines that the amount of stations is too low.

5.3.4 Summary statements on characteristics

The previous sections focussed on the analysis of the 'Attitude towards cycling' section of the survey and in special the comparison of the results of possible users and users of the 'Sepeda Kampus'. An important conclusion is the answer to one of the research questions, by looking at the frequency of usage and the objective characteristics it can be said that there is a relation between three characteristics of the system and the travel demand. Another conclusion that can be drawn is that the biggest barrier overall the weather is why people do not use the 'Sepeda Kampus' system. If we look at the objective factors which influence the bicycle use both identify the insufficient lighting during the evening as major barrier, the other characteristics are valued different by the possible user and the user of the 'Sepeda Kampus'. From the first comparison of statements it can be concluded if the two groups answer statistically significant different the possible user group answer always in the more negative way than the users.

All this results will be used at the end of this report in the conclusion section to answer the main research question and make recommendations based on the findings.

5.3.5 Analysis introduction of policies

The preceding sections focussed on the 'Attitude towards cycling'-part, now the focus will be on the last section of the survey. The analysis of the last section will focus on possible differences between the introductions of the policies. For this reason the policies are compared with each other, to examine possible differences a paired sample t-test is used. This statistical test is used because 'the paired samples t-test compares two means that are from the same individual, object, or related units' (University K. , 2016). A distinguishing between possible users and users of the system will be made. This differentiating is important to obtain possible differences in preferences of the two different groups. Also this distinction helps to give a more precise advice for the improvement of the 'Sepeda Kampus' system.

In both cases, possible users and users, first a comparison between the single policies is done, after that combinations of policies are compared. In the end all single policies and combination of policies are compared with the introduction of all three policies. With these t-tests it can be seen which single policy and combination of policies is most favourable. It is expected that the introduction of all three policies is the most favourable, this is why the introduction of all three policies is compared with all possible policies and combinations of policies.

Before the analysis and interpretation of the results it is helpful to recall the numerical values that were assigned to the possible answers. Also Table 17 until Table 21 summarize the results of the stated preference section of the survey.

Table 9 - Possible answers to the introduction of policies

Possible answer	**Numerical values**
Certainly I will use the 'Sepeda Kampus' system	1
Probably I will use the 'Sepeda Kampus' system	2
Doubtful	3
Probably I will **not** use the 'Sepeda Kampus' system	4
Certainly I will **not** use the 'Sepeda Kampus' system	5

5.3.5.1 Comparison between policies – Possible users

The results of the paired sample t-test can be found in Table 24, here only the striking results will be discussed. From the twelve different tests that were executed it can be seen that there is only one comparison that has a p-value higher than 0,05. The possible users answer statistically significant different to the introduction of infrastructure & service and supporting & service. To interpret this result a closer at the two means has to be taken. The infrastructure & service policy has a lower mean, which means more people will use the system after the introduction of this policy compared to the introduction of the supporting & service policy. This result is remarkable because both combinations include the service policy and by combining it with either the infrastructure or supporting policy one becomes more attractive than the other. That the infrastructure & service policy is favourable compared to the supporting & service policy was not expected because if we look at the statements again the possible users value the distance between stations more negative than the sufficient bicycle paths. So it could have been expected that the possible users want to reduce the distance between the stations, which is part of the supporting policy. Nevertheless the possible users prefer a combination of the infrastructure and service policy, maybe because the infrastructure policy also increases the on-road safety which is also an issue for the possible users.

In all other eleven comparison there are no statistically significant differences between the policies. In this eleven cases it therefore does not matter which policy will be introduced because they are evenly effective. This is remarkable because it can be concluded that the single policies are just as effective as the introduction of all three policies.

The last thing that need to be mentioned are the high values of the correlation, these high values show that there are strong linear correlations. This strong linear correlation means if the participant answered that he will not use the system in one question it is very likely that he will also give the same answer in the following question. This leads to the conclusion, people who say that they will not use the system will never use the system regardless the policies.

5.3.5.2 Comparison between policies – Users

The previous section focussed on the answers of the possible users, this section will analyse the responses of the users of the system. Again only the striking results will be discussed, the detailed results can be find in Table 25. While interpreting the results one has to keep in mind that the users already use the system, so if one policy is favourable this means the people will use the ‘Sepeda Kampus’ more frequently than now.

Of the twelve comparison only two have a p-value higher than 0,05. The responses to the introduction of the infrastructure policy were statistically significant different to the introduction of the supporting policy. The supporting policy has a lower mean which means on average more people will use the system more often after the introduction of this policy. The result that the infrastructure policy is more favourable than the supporting could have been expected for the users. For bicyclists an own dedicated lane is very attractive because it increases the safety and the comfort during the trip. The supporting policy is less attractive for the users of the system because they are used to cycle and the distance between the stations (number of stations) is not a big issue for them.

The other comparison where the respondents answered statistically significant different is the comparison between the infrastructure & supporting and the infrastructure & service policy. The infrastructure & supporting policy has a lower mean, 1,571, compared to the infrastructure & service policy, 1,572. This means after the introduction of the infrastructure & supporting policy more people will use the system more frequent compared with the infrastructure & service policy. The remarkable at this question is that the two question have a mean which is nearly the same but they are still statistically significant different, this can be explained by the high standard deviation of both questions.

For the users group it is also discovered that the introduction of all three policies is just as effective as the introduction of any single policy.

5.3.6 Summary statements on characteristics

After the analysis of the last section of the survey various things can be concluded. If one only looks at the mean the introduction of all three policies would be most effective for users and possible users. The statistical tests however show that the answers to the single policies are statistically not significant different to responses to all three policies. The service policy has for both groups, users and possible users, the lowest mean which means after the introduction of this policy the most people will use the system or use the system more frequently.

The results from the statistical tests show that the responses to the introduction of the policies are in general all the same this means that there is not one single policy or combination of policies which is the most effective. So when choosing which policy or combination should be introduced other factors like initial investments and annual costs have to be taken into account.

6. Critical review

From Figure 1 it can be seen that all elements from the grey area lead to the findings from UGM. The last step of this conceptual model is to compare these findings with findings from other researches about the bicycle behaviour at university campuses. To compare systems first a closer look at other systems must be taken, for this reason the next section will describe five different researches that will be used for the comparison.

6.1 Findings from other systems

In the chapter 'Construction of the survey' the researches that are going to be used for the comparison are already introduced. Unfortunately there are no researches which focus on a bicycle sharing system just for a campus. There are plenty of researches about bicycle sharing systems all across the globe. The problem is that these systems are all bigger, more bicycles, users and bigger area of influence, than the system for the UGM campus, an appropriate comparison is therefore not possible. Therefore researches about the bicycle usage and cycling behaviour on campuses across the globe are used. The following table will give an overview of the campuses that are going to be used for the review.

Table 10 - University campuses used for review

University	**Area**	**Students**
Gadjah Mada University	*201,6 ha*	*61.000*
Boise State University	71 ha	22.259
University of Michigan – Flint	530 ha	8289
University of Idaho	640 ha	11.543
University of Graz	-	31.580
Autonomous University of Barcelona	226 ha	56.228
Madrid University Campus	345 ha	112.871

From this table it can be seen that there are university campuses which have a bigger area than the UGM but less students than UGM, Michigan and Idaho. The campus of the Autonomous University of Barcelona is the one which has similar characteristics with the UGM campus. For each research a short fact sheet is made to give an impression of the results. The exact outcomes will be used and described in the 'Comparison with the findings from UGM' section.

Boise State University:

- 68% female, 32% male
- Most frequent purpose of cycling: transportation (62%) and recreation (42%)
- Students who cycle for transportation cycle regardless the distance
- Students who cycle are younger and live closer to the campus
- Distance matters to cyclists

University of Michigan:

- 61% female, 39% male
- Outcomes from students do not agree with the outcomes from faculty members
- Education, safety and higher automobile costs may cause faculty members to cycle
- More visible cycling culture may cause students to cycle more

University of Idaho:

- Seasonable variations in commuting choice, in warmer months non-motorized traffic increases
- Difference in commuting choice between male and female
- Female students are less receptive to non-motorized transportation
- Female indicate topography and safety a bigger issue than male participants

University of Graz:

- 44,6% female, 55,4% male
- Students who consider the traffic safety on their way to the university as high are 45% less likely to cycle regularly than those who rate the traffic safety low
- People who associate cycling with pleasure are twice as likely to cycle regularly
- If friends cycle to university other students are more likely to cycle to university as well

Autonomous University of Barcelona (UAB):

- 58,4% female, 41,6% male
- Different transport patterns between students and staff due to socio-demographic characteristics
- Unsatisfied demand for non-motorized transportation modes due to inadequate infrastructure

On the Madrid University campus four different universities are located, Fernández-Heredia, Monzón and Jara-Díaz tried to analyse the cyclist's perception. The Madrid University campus planned to build a 4th generation bicycle sharing system. Until now there is no further research about this bicycle sharing system in particular so the research about the bicycle use at the campus must be used. 'The main conclusion is that convenience (flexible, efficient) and exogenous restrictions (danger, vandalism, facilities) are the most important elements to understand the attitudes towards the bicycle.' (Álvaro Fernández-Heredia, Andrés Monzón, Sergio Jara-Díaz, 2014)

6.2 Comparison with the findings from UGM

When comparing the results from the other researches with the findings from UGM one has always to keep in mind that the 'Sepeda Kampus' is a bicycle sharing system especially designed for a campus. The other researches focussed on cycling behaviour in general so when comparing the results one has to be careful.

The first comparison is between the Boise State University and UGM. A thing one will notice is the difference in gender distribution at UGM 60,9% of the respondents were male while at the Boise State University only 32% were male. This differences can possible be explained by a different gender distribution across the two universities. The next thing analysed in Boise is for which purpose the people use bicycles, the most given answer in Boise was for transportation followed by recreation. The problem with these results is that it can be assumed that these answers are collected in a different way than the research at UGM used. This can be assumed because the two portions (transportation and recreation) of usage add up to 102%. The most frequent purpose of usage at UGM is to travel across the campus between UGM buildings. The difference between the most frequent purposes of usage can be explained by the fact that the system at UGM is a sharing system. This means it is specially designed to travel across the campus and at Boise State University the research analysed the general bicycle behaviour. A thing that was discovered in Boise and Yogyakarta is the difference in age between people who cycle and those who do not cycle.

Like the Boise State University, the University of Michigan has a very different gender distribution than the University Gadjah Mada, again this can possible be explained by a different gender distribution across the whole university. The research in Flint found out that the students answered different than the staff. At UGM this was also found except for five of the sixteen compared outcomes. The statements where students and staff of UGM do not agree are 'The distance between stations is too long', 'The bicycle paths are well signed' 'There are enough stations to return the bike', the introduction of the infrastructure policy and the introduction of the service policy. To analyse why there is a difference between the

results from Yogyakarta and Flint the results from Flint are needed, without them it is difficult to say how and why there are differences. The fact that students would cycle more if they see an active cycle culture was discovered in both researches in Flint and at UGM. This similarity in results can be explained by the fact if people see more cyclists the public acceptance to cycle will increase and therefore people are thinking more about using bicycles for transportation, this fact can be obtained in different countries and or cities.

The influence of the weather was discovered in Idaho and Yogyakarta. For Yogyakarta it is not possible to distinguish between the four commonly known seasons, in Indonesia they distinguish between rain and dry season. In total 85% ('Strongly agree' and 'Agree') of the respondents said that the weather influences their bicycle use. In both cases, Idaho and UGM, the results can be explained by the fact that during cycling the people are directly exposed to the weather. For the system at UGM this means that people have to cycle within a climate with high temperatures which will lead to that they will sweat what most people find unpleasant. In Idaho it might not be the heat but the rain, it has the same effect, people get wet and this is unpleasant. The difference in safety perception between female and male that was found at the University of Idaho was not discovered for the UGM system. Women and men gave no statistically significant different answer to the statement 'The on-road safety on the campus is good'. The difference between men and women in cycling was discovered in Idaho and also for 'cycling without the system' for this research, however there is no difference in usage of the system between the gender. How this is possible is difficult to say, this result was presented to people of PUSTRAL but they also did not have answer to the differences.

The different frequency of cycling, which was discovered by the research at the University of Graz, based on the safety perception was not discovered by the research on the 'Sepeda Kampus' there is no statistically significant difference in cycling between the people who agree or disagree with the 'safety-statement'. The fact that a higher safety perception would lead to more cycling that was, according to the research from Graz, find at many other researches is also discovered by the research in Yogyakarta. The result that people who find cycling pleasant cycle more can be find in both researches, University of Graz and UGM.

Like the research from UAB the research at UGM found differences in the frequency of cycling between students and staff of the university. The research from UAB argued that it is due to different socio economic factors, this can be confirmed by the research from UGM. The age and ownership of staff and students are statistically significant different. The difference in the frequency of cycling may be caused by the reason that staff from the university owns more money which allows them to drive a car so that they do not have to cycle while students have to walk or cycle. For the comparison between the findings from UGM and the results from Madrid it is helpful to look at the 'Conceptual model of factors affecting bicycle use' this model can be found in Figure 24 .

In case of the UGM research some of the relations can be found while other cannot be found. That some relations cannot be found might be due to the reason that the research that was executed at UGM did not cover all aspects shown in the conceptual model. The biggest barrier that was identified by the research in Madrid was the safety issue, while in Yogyakarta the biggest barrier the weather is. This difference can be explained by the different climate in the two cities, the high temperature and high humidity in Yogyakarta is a reason not to cycle. A finding from Madrid that can be confirmed by the research from UGM is the relationship between frequency of cycling and the positive attitude towards cycling. Another conclusion, to promote cycling in Madrid, is that efficiency and ecological aspects are most important for people to cycle more. At UGM it was discovered if only one policy

could be introduced the service policy is the most favourable, this policy includes the efficiency aspect.

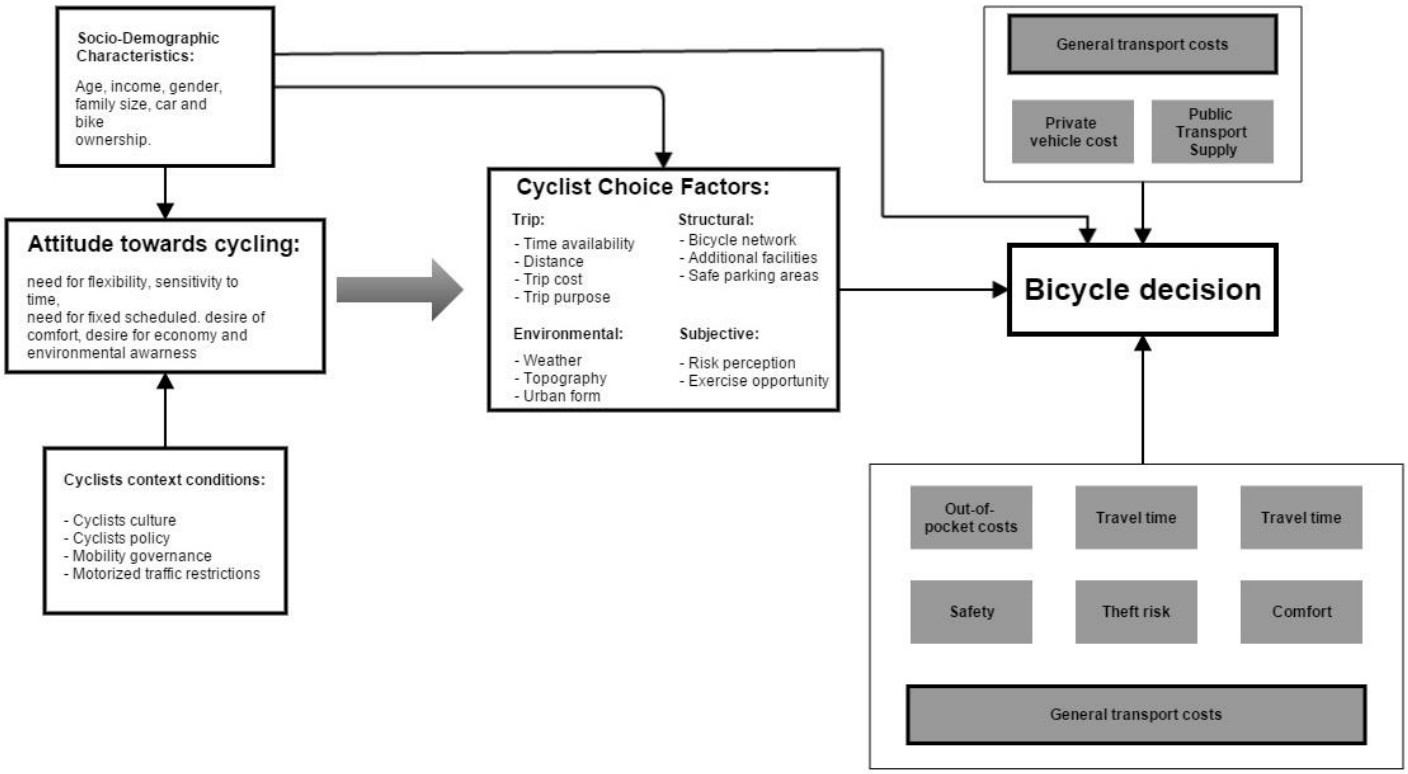

Figure 24 - Conceptual model of factors affecting bicycle use

6.3 Summary comparison with other system

From the comparison with other systems it becomes clear that there are some researches about other systems where the research from UGM agrees with but there are also results that are different between the systems and researches. The research that was executed at UGM has a higher male portion than female portion, this is different from all other researches that was used for the comparison which have a higher female portion than male portion. A thing that all researches and the one at UGM discovered is that if the safety perception increases the frequency of cycling increases. Most of the other researches indicted the safety issue as the most influential from the research at UGM it can be concluded that other factors are more important to the decision to cycle or not than on-road safety. Another thing that become clear is if one thing is compared with two different systems it can lead to different results. For an example at UAB a difference in outcomes between students and staff was observed while at the University of Michigan the opposite was obtained, students and staff answer the same. The results from UGM tend more into the directions of the results from Michigan, however in five of the sixteen categories students answer different then staff from UGM.

7. Conclusions

Subsequently to the critical review the conclusions will be drawn on the basis of the different findings and analysis. This chapter will give an answer to all research-questions and sub-questions. First the sub-questions will be answered followed by the main research question:

Which factors influence the bicycle travel demand of the bike sharing system at Gadjah-Mada University in Yogyakarta?

This structure is chosen because in this way first the basics of the system and research are described. After the conclusions are drawn recommendations will be made based on the conclusions. These recommendations will present specific points which should help the operator of the system and policy maker of UGM to improve the system so that the bicycle travel demand can be increased. Some sub-questions and research-questions are already partially answered in the previous chapters, this chapter will again sum up these results.

The first sub-question that will be answered is:

What are the characteristics of the bike sharing system at UGM?

The system uses 1010 bicycles that can be picked up and returned at 16 different stations. These stations consist of two types of shelters, one type that is permanently at the station and the second type that can be moved between different stations to guarantee a sufficient amount of bicycles at each station. The roads on the UGM campus are either made of asphalt, cobblestones or concrete, these roads are available for all modes of transportation. There is a small amount paths within the faculties which can only be used by bicycles or people who walk. The quality of the infrastructure varies throughout the campus. The sharing stations are located across the campus, the exact location, GPS-coordinates, can be seen in appendix B**.** The area which the system covers is limited by the regulations of the system, people are only allowed to use the bicycles within the area of the UGM campus, which means the system covers the UGM campus area. The campus is located between 122,25m and 143,5m above sea-level and has an average gradient of 1%, the steepest elevation is 5% along 273m. The ‘Sepeda Kampus’ systems can be used from Monday till Saturday, the various opening times are describe in the chapter ‘How to use the system’. Before one can leave the sharing stations the user has to be registered by an officer of the station. Students, academic staff, non-academic staff and visitors of the Gadjah Mada University can use the system, the biggest group which uses the system are the students.

The following sub-question that will be answered is:

How are the characteristics from UGM similar or different to characteristics from comparable systems?

The difficulty in this question lies in the fact that there are no researches available that directly deal with a bicycle sharing system especially designed for a campus. There are on the one hand articles about researches that investigate sustainable transportation methods for campuses, these researches frequently advice to start a bicycle sharing system. On the other hand there are many researches about bicycle sharing systems all across the globe, the problem with these researches is that the systems are bigger than the system used at UGM and an adequate comparison is therefore not possible. So unfortunately this sub-research question cannot be answered. However researches about the bicycle behaviour at various universities were analysed to construct the survey and to compare the findings on how to increase the travel demand. Unfortunately these researches do not describe the characteristics of the certain campus.

The answer to the sub-question

Is there a relationship between the characteristics of the system and the travel demand?

was find by the data analysis. By comparing the answers to the different statements between the different frequencies of usage it was discovered that the more positive people are about the statements the more they use the 'Sepeda Kampus' system. The statements covered different characteristics like road quality, weather and the amount of stations. There were also statements concerning different factors like safety, seeing more cyclists and how pleasant cycling is. The more positive people are about these factors the more they use the system.

The last of the sub-questions that will be answered is:

Which factors are based on the findings important to increase the travel demand?

To answer this question two things must be taken into account, the first thing are the answers to the stated improvements and the second thing are the responses to the statements. The observations from the statements are important because the biggest barriers can be obtained. The barriers are the characteristics with which the people were the least happy. Based on the statements the biggest barrier is the weather why people do not cycle followed by the absence of street lighting and the distance between stations which is too big. According to the answers to the stated improvement policies most people would certainly use the 'Sepeda Kampus' if all three policies would be introduced. This means if all factors, infrastructure, support and service of the system, will be introduced this will help the most to increase the travel demand. If the results from the statements about the factors and characteristics are connected with the responses on the stated policies it can be concluded that that the factors that deal with the infrastructure and the facilities are most important to increase the travel demand.

Summing up all the answers to the sub-questions and the other previous chapters it is now possible to come to an answer to the main research question.

Which factors influence the bicycle travel demand of the bike sharing system at Gadjah-Mada University in Yogyakarta?

Like mentioned in the answer to the previous sub-question the weather influences the travel demand very much. But there is not just one factor which influences the travel demand, as Figure 24 shows the decision to cycle is a complex problem. The findings from this research however indicate that the weather is the most important factor which influences the bicycle travel demand. The streetlights during the night, the longer opening times and easier borrowing procedure (service policy) are also important factors. While the street lighting is only necessary during a small time of the operation times of the system other influential factors of the travel demand are the distance between the sharing stations and the signage of the bicycle paths.

7.1 Recommendations

This section will answer the last remaining research question:

Which recommendations can be made on the basis of the research findings to increase the use of the system?

This question was not previous answered because the recommendations should be based on the conclusions of the research.

Based on the findings of the stated preference section it would be most logic to implement all three different policies because it has the lowest mean. This might be the best based on the data but not from a financial point of view. If the resources are limited it might be best to start with only one policy and then introduce the other policies when more resources are available. The policy that should be introduced first is the service policy because after the introduction of this policy the most people, possible users and users, will use the system or use the system more frequently. In the section 'Conclusions from characteristics' on page 21 the ITDP guidelines were introduced and according to them the 'Sepeda Kampus' system does meet the station guidelines and planning guidelines. The introduction of the service policy would help to meet the service guidelines because it includes the implementation of an easier borrowing procedure. The policy that should be introduced after the service policy is the supporting policy because it would help to meet the planning guidelines. At the moment the number of stations is not sufficient and the supporting policy will solve this problem by establishing more stations. At the end the infrastructure policy can be introduced because it requires the most resources and is the biggest intervention.

A problem that might occur during the implementation of the infrastructure improvements are the different governments involved in the improvements. There are different types of roads that run within and across the campus and these roads are organized by different governments, so if one government agrees with the introduction of the policies that does not mean the improvements can be introduced on the whole campus. These complications have to be solved or minimized before the policies effectively can be introduced.

With the current system it is already retraceable who rented which bike so the risk of vandalism and theft is minimalised, for this reason one might think about an extension of the area of usage. If people could use the system outside the campus area it might attract more people because they can cycle to activities outside the campus boundaries.

There are some small other recommendations that are based on the personal experience during the research and the data, these recommendations are:

- Make the station better visible, sometimes it is hard to find them
- Harder control and sanction the parking on the bicycle paths
- Promote the bicycle sharing system in an active way

Because of the limited resources it was not possible to analyse all factors influencing the bicycle travel demand. To investigate the influence of the other, by PUSTRAL developed, improvement policies further research is necessary.

8. Discussion

In this section the results from the research will be discussed, what may have influenced the research and what can be improved for further research.

The first thing that may have influenced the results is the time when the survey was conducted, during the research it was rain season. Every day there was an intensive rain shower, this might have influenced the answers to the statement concerning the weather. To make sure that the weather did not influence the results the research need to be executed during the dry season when there is less or no rain. However the influence of the time is considered small because the temperatures stay nearly the same in dry and rain season.

Regarding the survey there are also some aspects that can be adjusted in further research. Questions about how people come to the campus might be included into the survey, this research did not pay attention to it because it was only interested in the travel demand on the campus. In follow up research the stated preference section should also include a question what will happen if nothing would change. This adjustment can be helpful to better obtain the changes in bicycle usage. Regarding the statements about the characteristics one can think about if the way the questions were asked are a suited manner for this research. Some questions are asked in a certain direction which may influence the individual answers. Psychologists deal with the issue of how to ask certain questions, looking into this issue would have required too much time and would exceed the scope of this research. The characteristics from the statements appeared also in the policies of the stated preference section, but the factors stated by the service policy did not appear in the statement section. These statements were not included because the analysing the service of the 'Sepeda Kampus' would have exceeded the scope of the research. For further research statements regarding the service of the system might be included into the survey. Another point of discussion regarding the survey is the duration of the survey, the number of valid responses decreases throughout the survey. For further research it can be helpful to simplify the survey because the used survey, especially the stated preference section, was very complex.

From the data aspect of the research also some things need to be discussed. The 1936 responses only reflect like 3% of the total UGM population. This problem can be seen in the possible users and users' distribution which is not representative for the UGM population. To make the data more reliable and the answers more universally applicable more responses have to be gathered. Due to the limited amount of time this was not possible.

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10. Attachments

10.1 Appendix A – Research questions and definitions:

10.1.1 Research questions

- What are the characteristics of the bike sharing system at UGM?
    - What are the physical characteristics?
        - What are the facilities of the system?
        - What is the available infrastructure on the area of UGM, what is its quality and how is it being used by various modes?
    - What are the spatial characteristics?
        - Where are the sharing stations located?
        - Which area does the system cover?
        - What is the topography of the area?
    - What are the operational characteristics?
    - What are the characteristics of the usage?
- How are the characteristics from UGM similar or different to characteristics from comparable systems?
    - How can possible differences in characteristics be explained?
- Is there a relationship between the characteristics of the system and the travel demand?
- Which factors are based on the findings important to increase the travel demand?
    - Do the findings from UGM agree with findings from other researches?
        - What are the possible differences between findings and how can they be explained

10.1.2 Definitions:

During this report different abbreviations and other terms will be used that are not clear to everybody. For this reason a short description of the most used abbreviations and terms will be given.

PBS (Public bicycle sharing system) / bicycle sharing system: PBS is a transport system which fills up the missing gaps of the public transport with a high amount of flexibility.
GIS: Geographical Information System
UGM: University Gadjah Mada
PUSTRAL: Pusat Studi Transportasi dan Logistik (Center for Transportation and Logistics Studies)

10.2 Appendix B – Characteristics:

Table 11 - General information stations

		GPS		Capacity		
Station nr.	**Name**	**Latitude**	**Longitude**	**Ideal**	**Maximum**	**Number of bicylces**
1	Perpustakaan	-7.768843	110.379035	65	115	117
2	Gelanggang	-7.77503	110.37614	75	135	169
3	Lembah	-7.76983	110.38175	65	115	100
4	Agro Fauna	-7.76814	110.38487	30	54	41
5	Taman Biologi	-7.767294	110.374483	36	63	40
6	Teknik	-7.7657	110.37228	35	63	53
7	Kesehatan	-7.77128	110.37502	75	135	32
8	Vokasi	-7.774557	110.374620	35	63	74
9	GMC	-7.77267	110.3751	10	18	0
10	Bank UGM	-7.776	110.37946	15	27	0
11	Farmasi	-7.76824	110.37673	20	36	22
12	PAU Pasca sarjana	-7.76447	110.37605	20	36	28
13	Hotel UC	-7.7732	110.37728	15	27	0
14	Dinas	-7.76799	110.37908	60	60	59
15	Klebengan	-7.76692	110.38313	-	45	22
16	Bengkel	-7.76983	110.38175	-	-	184
17	Jl. Tevesia	-	-	-	-	69

Table 12 - Distance between stations (in meter)

Station	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1		835	322	1070	580	962	699	959	764	953	318	770	579	120	1080	322
2	835		1074	1851	1222	1604	605	336	415	500	1023	1510	252	950	1477	1074
3	322	1074		777	901	1283	973	1233	1038	812	639	1085	818	435	403	
4	1070	1851	777		1582	1811	1737	1997	1802	1589	1289	1218	1595	1006	374	777
5	580	1222	901	1582		382	617	1025	816	1518	323	385	1010	635	1502	901
6	962	1604	1283	1811	382		999	1407	1189	1900	705	622	1392	1087	1447	1283
7	699	605	973	1737	617	999		518	248	901	632	1002	394	754	1376	973
8	959	336	1233	1997	1025	1407	518		319	777	927	1409	430	1014	1633	1233
9	764	415	1038	1802	816	1189	248	319		800	732	1201	235	819	1438	1038
10	953	500	812	1589	1518	1900	901	777	800		1271	1630	593	1067	1215	812
11	318	1023	639	1289	323	705	632	927	732	1271		532	803	373	934	639
12	770	1510	1085	1218	385	622	1002	1409	1201	1630	532		1291	650	844	1085
13	579	252	818	1595	1010	1392	394	430	235	593	803	1291		394	1221	818
14	120	950	435	1006	635	1087	754	1014	819	1067	373	650	394		643	435
15	1080	1477	403	374	1502	1447	1376	1633	1438	1215	934	844	1221	643		403
16	322	1074		777	901	1283	973	1233	1038	812	639	1085	818	435	403	

Table 13 - Gradient per street

ID	LENGTH	MINELEV	MAXELEV	DIFFERENCE	GRADIENT	ID	LENGTH	MINELEV	MAXELEV	DIFFERENCE	GRADIENT
8378	742,79	137,75	138,00	0,25	0%	9600	196,81	132,00	133,50	1,50	1%
8527	160,33	140,25	140,25	0,00	0%	9624	65,12	131,75	131,75	0,00	0%
8704	86,75	140,25	140,25	0,00	0%	9625	19,22	132,00	132,00	0,00	0%
8782	236,03	139,50	143,50	4,00	2%	9625	117,07	132,25	132,25	0,00	0%
8862	69,63	142,75	143,00	0,25	0%	9634	113,32	136,25	136,25	0,00	0%
8862	155,29	138,75	142,50	3,75	2%	9645	121,10	131,25	131,75	0,50	0%
8903	160,24	141,50	142,25	0,75	0%	9646	257,03	132,00	133,00	1,00	1%
8903	171,50	142,50	143,25	0,75	0%	9684	131,19	132,50	133,75	1,25	1%
8972	347,68	133,50	138,00	4,50	1%	9699	146,88	131,75	132,25	0,50	0%
9008	98,34	138,25	139,25	1,00	1%	9741	163,89	131,50	131,50	0,00	0%
9008	203,00	139,50	140,75	1,25	1%	9741	272,51	125,50	131,25	5,75	5%
9051	73,43	140,00	140,50	0,50	1%	9744	81,14	126,75	127,50	0,75	1%
9051	168,70	139,00	139,75	0,75	0%	9752	197,28	131,50	131,75	0,25	0%
9057	89,13	140,75	141,00	0,25	0%	9761	237,16	136,00	136,00	0,00	0%
9057	72,40	139,75	140,50	0,75	1%	9763	36,64	127,75	127,75	0,00	0%
9068	22,67	141,00	141,25	0,25	1%	9768	95,10	129,75	131,00	1,25	1%
9068	288,18	139,00	141,25	2,25	1%	9784	49,88	128,00	128,00	0,00	0%
9068	250,99	139,75	141,25	1,50	1%	9784	80,47	127,25	128,00	0,75	1%
9087	140,60	139,00	140,75	1,75	1%	9810	255,76	128,50	131,25	2,75	2%
9087	322,62	138,50	140,75	2,25	1%	9810	78,13	128,25	128,25	0,00	0%
9146	188,66	139,50	140,00	0,50	0%	9811	107,46	131,50	132,25	0,75	1%
9159	159,61	137,75	138,25	0,50	0%	9824	64,49	126,00	126,50	0,50	0%
9194	299,14	137,75	138,25	0,50	0%	9825	122,30	125,25	128,75	3,50	3%
9201	135,44	137,25	138,75	1,50	1%	9825	27,77	125,25	128,50	3,25	3%
9201	331,62	137,75	139,25	1,50	0%	9830	247,88	128,00	131,25	3,25	3%
9217	59,17	138,50	138,50	0,00	0%	9836	151,74	131,00	132,25	1,25	1%
9221	27,92	132,75	133,25	0,50	2%	9836	138,93	131,00	131,00	0,00	0%
9221	275,28	131,50	133,25	1,75	1%	9838	39,12	125,25	125,25	0,00	0%
9236	206,49	138,75	139,25	0,50	0%	9838	118,14	125,50	130,75	5,25	4%
9238	161,05	138,25	138,75	0,50	0%	9843	82,68	131,50	131,50	0,00	0%
9243	148,58	133,50	136,25	2,75	2%	9862	76,48	126,75	127,00	0,25	0%
9243	220,89	136,50	137,25	0,75	0%	9862	62,69	126,25	127,00	0,75	1%
9262	144,15	137,75	138,25	0,50	0%	9864	34,90	129,25	129,50	0,25	0%
9262	172,61	137,75	138,00	0,25	0%	9864	141,39	129,75	129,75	0,00	0%
9295	26,48	137,00	137,00	0,00	0%	9889	66,47	126,00	126,00	0,00	0%
9316	391,33	132,25	138,25	6,00	2%	9889	80,22	125,25	125,75	0,50	0%
9316	160,35	133,50	137,50	4,00	2%	9896	266,70	125,25	129,00	3,75	3%
9317	254,22	133,75	136,75	3,00	1%	9896	191,94	128,50	129,00	0,50	0%
9350	155,49	136,75	138,00	1,25	1%	9898	93,75	127,50	128,25	0,75	1%
9350	173,85	136,75	136,75	0,00	0%	9898	73,61	127,25	127,25	0,00	0%
9377	131,01	137,75	139,25	1,50	1%	9904	70,80	130,00	130,75	0,75	1%
9377	308,27	137,75	138,50	0,75	0%	9904	119,24	130,00	130,25	0,25	0%
9390	159,60	136,50	137,50	1,00	1%	9911	111,62	125,75	126,00	0,25	0%
9390	39,30	136,50	136,50	0,00	0%	9932	127,33	130,50	131,25	0,75	1%
9421	165,64	133,25	134,25	1,00	1%	9959	92,44	126,25	127,25	1,00	1%
9421	128,58	133,25	136,25	3,00	2%	10013	123,77	128,25	130,25	2,00	2%
9427	175,60	131,50	132,75	1,25	1%	10013	85,58	128,00	128,00	0,00	0%
9427	137,23	131,25	131,25	0,00	0%	10020	85,99	125,25	126,00	0,75	1%
9459	284,51	133,00	136,25	3,25	1%	10020	194,67	125,25	125,25	0,00	0%
9459	177,66	133,00	133,50	0,50	0%	10024	237,86	128,25	131,25	3,00	2%
9513	124,09	132,25	133,50	1,25	1%	10024	70,84	128,00	128,00	0,00	0%
9518	159,70	135,25	136,25	1,00	1%	10024	71,80	127,50	128,00	0,50	0%
9525	275,19	131,50	135,00	3,50	1%	10034	246,75	127,50	131,25	3,75	3%
9533	177,35	136,50	137,50	1,00	1%	10072	245,72	126,25	129,75	3,50	3%
9533	57,81	136,25	136,25	0,00	0%	10072	262,27	126,25	129,00	2,75	2%
9543	220,91	128,00	131,00	3,00	1%	10073	83,87	126,75	128,00	1,25	1%
9549	177,66	131,75	132,50	0,75	0%	10073	140,66	126,25	126,50	0,25	0%
9552	123,07	131,25	131,25	0,00	0%	10075	174,33	125,25	126,00	0,75	1%
9552	267,60	128,25	131,00	2,75	1%	10085	62,15	126,75	127,25	0,50	0%
9567	251,82	134,00	136,50	2,50	1%	10123	72,96	125,50	126,50	1,00	1%
9567	103,42	133,75	133,75	0,00	0%	10123	33,13	125,25	125,25	0,00	0%
9584	122,43	131,50	132,75	1,25	1%	10123	56,22	125,25	125,25	0,00	0%
9584	165,88	131,50	131,75	0,25	0%	10126	383,98	125,25	125,25	0,00	0%
9596	190,40	127,75	129,00	1,25	1%	10178	89,95	125,25	126,50	1,25	1%
9600	248,21	133,75	136,50	2,75	1%	10313	201,91	125,25	126,00	0,75	1%

10.2.1 Pictures from the fieldtrip

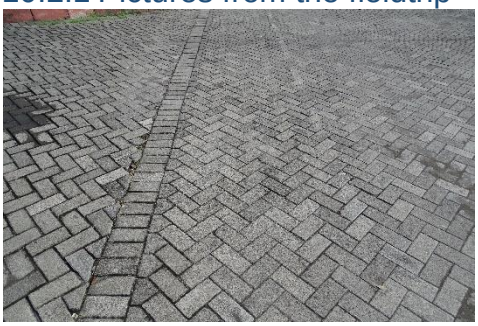

Figure 25 - State 1 - cobblestones (Evenly and flat cobblestones)

Figure 26 - State 2 - cobblestones (Evenly but not flat paved)

Figure 27 - State 3 - cobblestones (Not evenly paved, with obstacles)

Figure 28 - Sunk cobblestones

Figure 29 - State 1 - asphalt (Even and flat paved)

Figure 30 - State 2 - asphalt (Even and flat paved, with obstacles)

Figure 31 - State 3 - asphalt (Rough with holes)

Figure 32 - State 1 - concrete (Flat with some holes)

10.3 Appendix C – Final survey:

Survey Sepeda Kampus

This survey is part of a research on the 'Sepeda Kampus' (bicycle sharing system at UGM). The aim of the research is to identify factors that will help to improve the system so that more people will use it.

By filling in this survey you will help to execute this research.

Thank You in advance

General information

This information is only used for the purpose of this research and will not be distributed to any other third party.

1. Gender

O Male
O Female

2. Age

_____

3. Type of user

O I am a student of UGM
O I am a faculty member of UGM
O I am a non-academic staff of UGM
O I am a visitor of UGM

4. At which faculty do you work/study?

_____

5. Do You own a bicycle, motorbike or car?

O Yes I own a bicycle
O Yes I own a motorbike
O Yes I own a car
O Yes I own a bicycle and motorbike
O Yes I own a bicycle and car
O Yes I own a motorbike and car
O Yes I own all three
O No

Cycling behaviour general

These questions are about how often You use the Sepeda Kampus or a bicycle in general

6. How often do You use the 'Sepeda Kampus' system?

O I have never used the system *Skip to question 11*
O Once a month *Skip to question 8*
O More than once a month *Skip to question 8*
O Once a week *Skip to question 8*
O More than once a week *Skip to question 8*
O Daily *Skip to question 8*

Cycling behaviour for 'Sepeda Kampus' users

These questions are special for people who already use the 'Sepeda Kampus' system

7. For which purpose do you mainly use the 'Sepeda Kampus' system?

O To travel to my location of work
O For recreation
O To travel across the campus between UGM buildings
O To transport goods across the campus
O To go to a shop
O To meet with friends
O Other:

8. What is your most used departure station?

O Perpustakaan
O Gelanggang
O Lembah
O Agro Fauna
O Taman Biologi
O Teknik
O Kesehatan
O Vokasi
O GMC
O Bank UGM
O Farmasi
O PAU Pascasarjana
O Hotel UC
O Dinas
O Klebengan
O Bengkel

9. What is your most used arrival station?

O Perpustakaan
O Gelanggang
O Lembah
O Agro Fauna
O Taman Biologi
O Teknik
O Kesehatan
O Vokasi
O GMC
O Bank UGM
O Farmasi
O PAU Pascasarjana
O Hotel UC
O Dinas
O Klebengan
O Bengkel

Cycling behaviour general

10. How often do You cycle without using the 'Sepeda Kampus' system?

O I never cycle
O Once a month
O More than once a month
O Once a week
O More than once a week
O Daily

Attitude towards cycling

This section is about how much You agree or disagree with one of the following statements.

Infrastructure

11. The on road safety on the campus is good

1	2	3	4
O	O	O	O
Strongly agree			Strongly disagree

12. There are sufficient bicycle paths

1	2	3	4
O	O	O	O
Strongly agree			Strongly disagree

13. The bicycle paths are well signed

1	2	3	4
O	O	O	O
Strongly agree			Strongly disagree

14. There is sufficient lighting in the evening

1	2	3	4
O	O	O	O
Strongly agree			Strongly disagree

15. There are enough stations to return the bicycle

1	2	3	4
O	O	O	O
Strongly agree			Strongly disagree

16. The distance between stations is too long

1	2	3	4
O	O	O	O
Strongly agree			Strongly disagree

Attractive environment

17. The weather influences my bicycle use

1	2	3	4
O	O	O	O
Strongly agree			Strongly disagree

18. It is attractive to cycle across the UGM campus

1	2	3	4
O	O	O	O
Strongly agree			Strongly disagree

19. Seeing more bicyclists makes me want to cycle more

1	2	3	4
O	O	O	O
Strongly agree			Strongly disagree

20. I am not interested in cycling because it is unpleasant

1	2	3	4
O	O	O	O
Strongly agree			Strongly disagree

Change in behaviour

Before you answer the following question make sure you read the following things:

Infrastructure policies:

These policies include a clear dedicated lane only for bicycles. This lane is physical separated from the road for cars and motorbikes. Also a clear marking of the bicycle path will be present. This dedicated lane only for bicycles will improve the safety during a bicycle trip.

21. What will happen when only infrastructure policies will be introduced?

1	2	3	4	5
O	O	O	O	O
Certainly I will use the 'Sepeda Kampus' system	Probably I will use the 'Sepeda Kampus' system	Doubtful	Probably I will not use the 'Sepeda Kampus' system	Certainly I will not use the 'Sepeda Kampus' system

Supporting facilities:

These policies include the introduction of more stations where the bicycle can be picked up or returned. This introduction of new stations will result in an average shorter walking distance to a station. Also the station will provide a detailed description of how to get to the other stations on the campus. This will be done by hanging up a big map of the UGM campus.

22. What will happen when only supporting policies will be introduced?

1	2	3	4	5
O	O	O	O	O
Certainly I will use the 'Sepeda Kampus' system	Probably I will use the 'Sepeda Kampus' system	Doubtful	Probably I will not use the 'Sepeda Kampus' system	Certainly I will not use the 'Sepeda Kampus' system

Service facilities:

These policies include that the opening times of the system will be extended so that people can use the system longer. The introduction of an easier borrowing procedure is also part of these policies, the easier procedure will allow people to borrow and returning a bike using their student card.

23. What will happen when only service policies will be introduced?

1	2	3	4	5
O	O	O	O	O
Certainly I will use the 'Sepeda Kampus' system	Probably I will use the 'Sepeda Kampus system	Doubtful	Probably I will not use the 'Sepeda Kampus' system	Certainly I will not use the 'Sepeda Kampus' system

24. What will happen when infrastructure and supporting policies will be introduced?

1	2	3	4	5
O	O	O	O	O
Certainly I will use the 'Sepeda Kampus' system	Probably I will use the 'Sepeda Kampus' system	Doubtful	Probably I will not use the 'Sepeda Kampus' system	Certainly I will not use the 'Sepeda Kampus' system

25. What will happen when infrastructure and service policies will be introduced?

1	2	3	4	5
O	O	O	O	O
Certainly I will use the 'Sepeda Kampus' system	Probably I will use the 'Sepeda Kampus' system	Doubtful	Probably I will not use the 'Sepeda Kampus' system	Certainly I will not use the 'Sepeda Kampus' system

26. What will happen when supporting and service policies will be introduced?

1	2	3	4	5
O	O	O	O	O
Certainly I will use the 'Sepeda Kampus' system	Probably I will use the 'Sepeda Kampus' system	Doubtful	Probably I will not use the 'Sepeda Kampus' system	Certainly I will not use the 'Sepeda Kampus' system

27. What will happen when all three policies will be introduced?

1	2	3	4	5
O	O	O	O	O
Certainly I will use the 'Sepeda Kampus' system	Probably I will use the 'Sepeda Kampus 'system	Doubtful	Probably I will not use the 'Sepeda Kampus' system	Certainly I will not use the 'Sepeda Kampus' system

Thank You for your time and filling in this survey

10.4 Appendix D – Analysis:

10.4.1 Graphs:

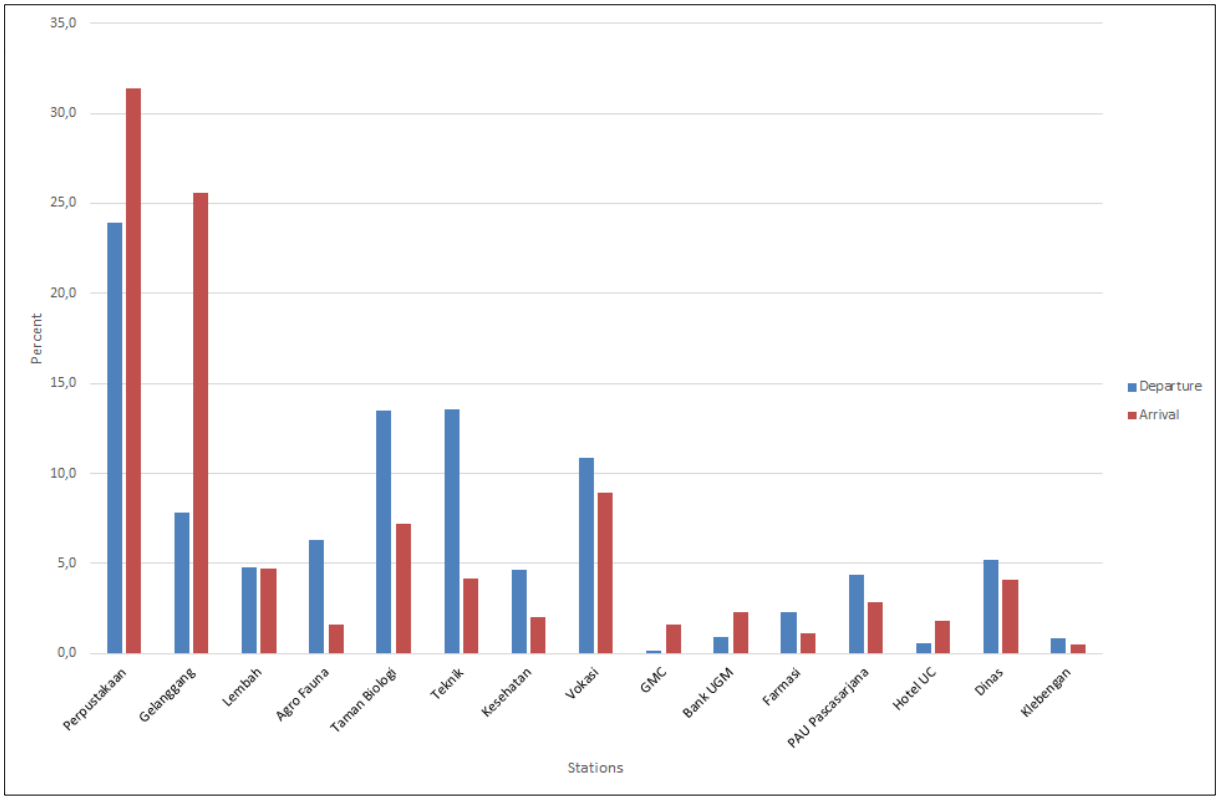

Figure 33 - Portion of trips arriving and departing from each station

10.4.2 Summaries

Table 14 - Numerical values for each answer

Type of user	
I am a student of UGM	1
I am a faculty member of UGM	2
I am a non-academic staff of UGM	3
I am a visitor of UGM	4

Use of system	
I have never used the system	1
Once a month	2
More than once a month	3
Once a week	4
More than once a week	5
Daily	6

Cycle without system	
I never cycle	1
Once a month	2
More than once a month	3
Once a week	4
More than once a week	5
Daily	6

Policies	
Certainly I will use the 'Sepeda Kampus' system	1
Probably I will use the 'Sepeda Kampus' system	2
Doubtful	3
Probably I will not use the 'Sepeda Kampus' system	4
Certainly I will not use the 'Sepeda Kampus' system	5

Purpose of use	
To travel to my location of work	1
For recreation	2
To travel across the campus between UGM building	3
To transport goods across the campus	4
To go to a shop	5
To meet with friends	6
Sport	7
More than one purpose	8

Ownership	
Yes I own a bicycle	1
Yes I own a motorbike	2
Yes I own a car	3
Yes I own a bicycle and motorbike	4
Yes I own a bicycle and car	5
Yes I own a motorbike and car	6
Yes I own all three	7
No	8

Departure/Arrival	
Perpustakaan	1
Gelanggang	2
Lembah	3
Agro Fauna	4
Taman Biologi	5
Teknik	6
Kesehatan	7
Vokasi	8
GMC	9
Bank UGM	10
Farmasi	11
PAU Pascasarjana	12
Hotel UC	13
Dinas	14
Klebengan	15
Bengkel	2

Faculty	
Cultural science	1
Economics and business	2
Engineering	3
Law	4
Social and politics	5
Psychology	6
Religious studies	6
Dentistry	7
Mathematics	8
MIPA	8
Pustral	9
Agro Fauna	10
Biology	11
Central office	12
Library	12
Geography	13
International affairs	14
Post graduate school	15
Medical	16
Pharmacy	17
Philosophy	18
PPB	19
System and Information Resources	20
Testing Laboratory	21
Veterinary Medicine	22
Vokasi	23

Gender	
Male	1
Female	0

Table 15 - Social economic characteristics of users and possible users

Gender		Possible user	User	Total
Female	n	*263*	*527*	*790*
	%	37,46%	42,71%	40,81%
Male	n	*439*	*707*	*1146*
	%	62,54%	57,29%	59,19%

Type of user		Possible user	User	Total
Student	n	*507*	*900*	*1407*
	%	72,22%	72,93%	72,68%
Academic	n	*109*	*160*	*269*
	%	15,53%	12,97%	13,89%
Staff	n	*78*	*157*	*235*
	%	11,11%	12,72%	12,14%
Visitor	n	*8*	*17*	*25*
	%	1,14%	1,38%	1,29%

Ownership		Possible user	User	Total
Bike	n	*48*	*147*	*195*
	%	6,84%	11,91%	10,07%
Scooter	n	*314*	*469*	*783*
	%	44,73%	38,01%	40,44%
Car	n	*21*	*17*	*38*
	%	2,99%	1,38%	1,96%
Bike+Scooter	n	*107*	*214*	*321*
	%	15,24%	17,34%	16,58%
Bike+Car	n	*14*	*13*	*27*
	%	1,99%	1,05%	1,39%
Scooter+Car	n	*44*	*41*	*85*
	%	6,27%	3,32%	4,39%
All	n	*116*	*152*	*268*
	%	16,52%	12,32%	13,84%
No	n	*38*	*181*	*219*
	%	5,41%	14,67%	11,31%

Age categories		Possible user	User	Total
17 ≤ 18 (1st year)	n	*36*	*126*	*162*
	%	5,13%	10,21%	8,37%
19 ≤ 20 (2nd year)	n	*134*	*301*	*435*
	%	19,09%	24,39%	22,47%
21 ≤ 22 (3rd year)	n	*90*	*250*	*340*
	%	12,82%	20,26%	17,56%
23 ≤ 25	n	*130*	*170*	*300*
	%	18,52%	13,78%	15,50%
26 ≤ 30	n	*101*	*117*	*218*
	%	14,39%	9,48%	11,26%
31 ≤ 40	n	*124*	*129*	*253*
	%	17,66%	10,45%	13,07%
41 ≤ 50	n	*61*	*106*	*167*
	%	8,69%	8,59%	8,63%
> 50	n	*26*	*35*	*61*
	%	3,70%	2,84%	3,15%

Faculty		Possible user	User	Total
Cultural	n	*26*	*92*	*118*
	%	3,70%	7,46%	6,10%
Economic	n	*64*	*89*	*153*
	%	9,12%	7,21%	7,90%
Engineering	n	*215*	*236*	*451*
	%	30,63%	19,12%	23,30%
Law	n	*34*	*37*	*71*
	%	4,84%	3,00%	3,67%
Social	n	*22*	*52*	*74*
	%	3,13%	4,21%	3,82%
Psychology	n	*10*	*18*	*28*
	%	1,42%	1,46%	1,45%
Dentist	n	*6*	*10*	*16*
	%	0,85%	0,81%	0,83%
Mathematics	n	*71*	*177*	*248*
	%	10,11%	14,34%	12,81%
Pustral	n	*1*	*4*	*5*
	%	0,14%	0,32%	0,26%
Agro Fauna	n	*43*	*105*	*148*
	%	6,13%	8,51%	7,64%
Biology	n	*14*	*33*	*47*
	%	1,99%	2,67%	2,43%
Central office/Library	n	*21*	*62*	*83*
	%	2,99%	5,02%	4,29%
Geography	n	*18*	*40*	*58*
	%	2,56%	3,24%	3,00%
International affairs	n	*2*	*4*	*6*
	%	0,28%	0,32%	0,31%
Post graduate school	n	*11*	*13*	*24*
	%	1,57%	1,05%	1,24%
Medical	n	91	113	204
	%	12,96%	9,16%	10,54%
Pharmacy	n	*3*	*20*	*23*
	%	0,43%	1,62%	1,19%
Philosophy	n	*3*	*9*	*12*
	%	0,43%	0,73%	0,62%
PPB	n	*0*	*2*	*2*
	%	0,00%	0,16%	0,10%
System and Information Resources	n	*1*	*7*	*8*
	%	0,14%	0,57%	0,41%
Testing Laboratory	n	*5*	*3*	*8*
	%	0,71%	0,24%	0,41%
Veterinary Medicine	n	*2*	*11*	*13*
	%	0,28%	0,89%	0,67%
Vokasi	n	*39*	*97*	*136*
	%	5,56%	7,86%	7,02%

Table 16 - Frequencies per statement per user category

On-road safety		Possible user	User	Total
Agree +	n	*61*	*123*	*184*
	%	9,4%	10,9%	10,4%
Agree	n	*255*	*452*	*707*
	%	39,4%	40,1%	39,8%
Disagree	n	*237*	*433*	*670*
	%	36,6%	38,4%	37,7%
Disagree +	n	*94*	*120*	*214*
	%	14,5%	10,6%	12,1%

Distance between		No user	User	Total
Agree +	n	*148*	*211*	*359*
	%	23,1%	18,7%	20,3%
Agree	n	*253*	*361*	*614*
	%	39,4%	32,1%	34,7%
Disagree	n	*205*	*448*	*653*
	%	31,9%	39,8%	36,9%
Disagree +	n	*36*	*106*	*142*
	%	5,6%	9,4%	8,0%

Sufficient bicycle		No user	User	Total
Agree +	n	*50*	*93*	*143*
	%	7,7%	8,3%	8,1%
Agree	n	*199*	*421*	*620*
	%	30,8%	37,4%	35,0%
Disagree	n	*256*	*433*	*689*
	%	39,6%	38,4%	38,9%
Disagree +	n	*141*	*180*	*321*
	%	21,8%	16,0%	18,1%

Weather		No user	User	Total
Agree +	n	*377*	*596*	*973*
	%	58,6%	53,3%	55,2%
Agree	n	*172*	*360*	*532*
	%	26,7%	32,2%	30,2%
Disagree	n	*60*	*110*	*170*
	%	9,3%	9,8%	9,6%
Disagree +	n	*34*	*53*	*87*
	%	5,3%	4,7%	4,9%

Well signed pathes		No user	User	Total
Agree +	n	*75*	*140*	*215*
	%	11,6%	12,4%	12,1%
Agree	n	*201*	*429*	*630*
	%	31,2%	38,1%	35,6%
Disagree	n	*266*	*428*	*694*
	%	41,2%	38,0%	39,2%
Disagree +	n	*103*	*130*	*233*
	%	16,0%	11,5%	13,1%

Attractive to cycle		No user	User	Total
Agree +	n	*152*	*371*	*523*
	%	23,8%	33,0%	29,7%
Agree	n	*299*	*523*	*822*
	%	46,7%	46,6%	46,6%
Disagree	n	*146*	*185*	*331*
	%	22,8%	16,5%	18,8%
Disagree +	n	*43*	*44*	*87*
	%	6,7%	3,9%	4,9%

Sufficient lighting		No user	User	Total
Agree +	n	*38*	*54*	*92*
	%	6,0%	4,8%	5,2%
Agree	n	*173*	*279*	*452*
	%	27,1%	24,9%	25,7%
Disagree	n	*266*	*506*	*772*
	%	41,7%	45,2%	43,9%
Disagree +	n	*161*	*281*	*442*
	%	25,2%	25,1%	25,1%

Seeing more		No user	User	Total
Agree +	n	*301*	*516*	*817*
	%	46,7%	45,8%	46,1%
Agree	n	*224*	*420*	*644*
	%	34,7%	37,3%	36,3%
Disagree	n	*89*	*145*	*234*
	%	13,8%	12,9%	13,2%
Disagree +	n	*31*	*46*	*77*
	%	4,8%	4,1%	4,3%

Enough stations		No user	User	Total
Agree +	n	*48*	*102*	*150*
	%	7,4%	9,1%	8,5%
Agree	n	*247*	*430*	*677*
	%	38,3%	38,4%	38,4%
Disagree	n	*254*	*387*	*641*
	%	39,4%	34,6%	36,3%
Disagree +	n	*96*	*201*	*297*
	%	14,9%	17,9%	16,8%

Cycling is unpleasant		No user	User	Total
Agree +	n	*36*	*31*	*67*
	%	5,6%	2,7%	3,8%
Agree	n	*58*	*52*	*110*
	%	9,0%	4,6%	6,2%
Disagree	n	*184*	*282*	*466*
	%	28,5%	25,0%	26,3%
Disagree +	n	*368*	*764*	*1132*
	%	57,0%	67,7%	63,8%

Table 17 - Summary policies – Answers

Infra		No user	User	Total
Certainly use	n	140	512	652
	%	20,00%	41,56%	33,75%
Probably use	n	400	584	984
	%	57,14%	47,40%	50,93%
Doubtful	n	116	111	227
	%	16,57%	9,01%	11,75%
Probably not	n	27	21	48
	%	3,86%	1,70%	2,48%
Certainly not	n	17	4	21
	%	2,43%	0,32%	1,09%
Total	n	700	1232	1932
	%	100,00%	100,00%	100,00%

Infra&Supp		No user	User	Total
Certainly use	n	201	615	816
	%	28,96%	50,29%	42,57%
Probably use	n	403	536	939
	%	58,07%	43,83%	48,98%
Doubtful	n	62	58	120
	%	8,93%	4,74%	6,26%
Probably not	n	17	10	27
	%	2,45%	0,82%	1,41%
Certainly not	n	11	4	15
	%	1,59%	0,33%	0,78%
Total	n	694	1223	1917
	%	100,00%	100,00%	100,00%

Supp		No user	User	Total
Certainly use	n	156	549	705
	%	22,38%	45,15%	36,85%
Probably use	n	393	529	922
	%	56,38%	43,50%	48,20%
Doubtful	n	116	103	219
	%	16,64%	8,47%	11,45%
Probably not	n	18	27	45
	%	2,58%	2,22%	2,35%
Certainly not	n	14	8	22
	%	2,01%	0,66%	1,15%
Total	n	697	1216	1913
	%	100,00%	100,00%	100,00%

Infra&Serv		No user	User	Total
Certainly use	n	184	597	781
	%	27,54%	49,67%	41,76%
Probably use	n	390	537	927
	%	58,38%	44,68%	49,57%
Doubtful	n	63	57	120
	%	9,43%	4,74%	6,42%
Probably not	n	20	8	28
	%	2,99%	0,67%	1,50%
Certainly not	n	11	3	14
	%	1,65%	0,25%	0,75%
Total	n	668	1202	1870
	%	100,00%	100,00%	100,00%

Serv		No user	User	Total
Certainly use	n	190	616	806
	%	27,30%	50,78%	42,22%
Probably use	n	369	493	862
	%	53,02%	40,64%	45,15%
Doubtful	n	96	72	168
	%	13,79%	5,94%	8,80%
Probably not	n	27	27	54
	%	3,88%	2,23%	2,83%
Certainly not	n	14	5	19
	%	2,01%	0,41%	1,00%
Total	n	696	1213	1909
	%	100,00%	100,00%	100,00%

Supp&Serv		No user	User	Total
Certainly use	n	171	572	743
	%	25,04%	47,23%	39,23%
Probably use	n	404	551	955
	%	59,15%	45,50%	50,42%
Doubtful	n	80	75	155
	%	11,71%	6,19%	8,18%
Probably not	n	17	11	28
	%	2,49%	0,91%	1,48%
Certainly not	n	11	2	13
	%	1,61%	0,17%	0,69%
Total	n	683	1211	1894
	%	100,00%	100,00%	100,00%

All three		No user	User	Total
Certainly use	n	237	692	929
	%	34,30%	57,28%	48,92%
Probably use	n	370	448	818
	%	53,55%	37,09%	43,08%
Doubtful	n	57	58	115
	%	8,25%	4,80%	6,06%
Probably not	n	17	9	26
	%	2,46%	0,75%	1,37%
Certainly not	n	10	1	11
	%	1,45%	0,08%	0,58%
Total	n	691	1208	1899
	%	100,00%	100,00%	100,00%

Table 18 - Summary policies (Possible users)

Paired Samples Statistics	Mean	N	Std. Deviation	Std. Error Mean
Infrastructure	2,12	696	,853	,032
Supporting	2,05	696	,821	,031
Service	2,00	694	,865	,033
Infrastructure and supporting	1,89	662	,776	,030
Infrastructure and service	1,93	662	,798	,031
Supporting and service	1,96	678	,782	,030
All three	1,83	690	,792	,030

Table 19 - Summary policies (Users)

Paired Samples Statistics	Mean	N	Std. Deviation	Std. Error Mean
Infrastructure	1,72	1214	,726	,021
Supporting	1,70	1214	,770	,022
Service	1,61	1197	,738	,021
Infrastructure and supporting	1,57	1195	,656	,019
Infrastructure and service	1,57	1195	,640	,019
Supporting and service	1,61	1187	,662	,019
All three	1,49	1191	,635	,018

Table 20 - Correlation between policy combinations (Possible users)

Paired Samples Correlations	N	Correlation	Sig.
Infrastructure & Supporting	696	,688	,000
Infrastructure & Service	694	,564	,000
Supporting & Service	692	,712	,000
Infrastructure and supporting & Infrastructure and service	662	,901	,000
Infrastructure and supporting & Supporting and service	678	,851	,000
Infrastructure and service & Supporting and service	658	,847	,000
Infrastructure & All three	690	,635	,000
Supporting & All three	687	,619	,000
Service & All three	685	,600	,000
Infrastructure and supporting & All three	683	,842	,000
Infrastructure and service & All three	664	,831	,000
Supporting and service & All three	680	,809	,000

Table 21 - Correlation between policy combinations (Users)

Paired Samples Correlations	N	Correlation	Sig.
Infrastructure & Supporting	1214	,483	,000
Infrastructure & Service	1211	,468	,000
Supporting & Service	1197	,690	,000
Infrastructure and supporting & Infrastructure and service	1195	,838	,000
Infrastructure and supporting & Supporting and service	1203	,735	,000
Infrastructure and service & Supporting and service	1187	,816	,000
Infrastructure & All three	1206	,482	,000
Supporting & All three	1191	,440	,000
Service & All three	1189	,433	,000
Infrastructure and supporting & All three	1200	,760	,000
Infrastructure and service & All three	1181	,763	,000
Supporting and service & All three	1191	,721	,000

10.4.3 Statistical tests

Table 22 - Social economic characteristics t-test (user vs possible user)

		t-test for Equality of Means		
		df	Sig. (2-tailed)	Mean Difference
Gender	Equal variances assumed	1934	,024	,052
	Equal variances not	1483,282	,023	,052
Type of user	Equal variances assumed	1934	,698	-,014
	Equal variances not	1510,312	,695	-,014
Ownership	Equal variances assumed	1934	,125	-,174
	Equal variances not	1590,303	,114	-,174
Age categories	Equal variances assumed	1934	,000	,564
	Equal variances not	1492,802	,000	,564
Faculty	Equal variances assumed	1934	,004	-,891
	Equal variances not	1500,138	,003	-,891

Table 23 - Statements t-test (user vs possible user)

		t-test for Equality of Means		
		df	Sig. (2-tailed)	Mean Difference
On-road safety	Equal variances	1773	,069	,075
	Equal variances not	1310,646	,071	,075
Sufficient bicycle paths	Equal variances	1771	,002	,134
	Equal variances not	1301,906	,002	,134
Well signed pathes	Equal variances	1770	,003	,129
	Equal variances not	1297,524	,003	,129
Sufficient lighting	Equal variances	1756	,299	-,043
	Equal variances not	1279,662	,305	-,043
Enough stations	Equal variances	1763	,932	,004
	Equal variances not	1415,433	,930	,004
Distance between stations	Equal variances	1766	,000	-,198
	Equal variances not	1383,043	,000	-,198
Weather	Equal variances	1760	,256	-,048
	Equal variances not	1310,420	,260	-,048
Attractive to cycle	Equal variances	1761	,000	,212
	Equal variances not	1269,477	,000	,212
Seeing more bicyclists	Equal variances	1770	,718	,015
	Equal variances not	1298,979	,721	,015
Cycling is unpleasant	Equal variances	1773	,000	-,207
	Equal variances not	1139,158	,000	-,207

Table 24 - Paired sample t-test (Possible users)

Paired Samples Test	Paired Differences					t	df	Sig. (2-tailed)
	Mean	Std. Deviation	Std. Error Mean	CI Lower	CI Upper			
Infrastructure - Supporting	,062	,662	,025	,013	,111	2,463	695	,014
Infrastructure - Service	,110	,802	,030	,050	,169	3,597	693	,000
Supporting - Service	,052	,641	,024	,004	,100	2,134	691	,033
Infrastructure and supporting - Infrastructure and service	-,036	,350	,014	-,063	-,010	-2,663	661	,008
Infrastructure and supporting - Supporting and service	-,059	,427	,016	-,091	-,027	-3,595	677	,000
Infrastructure and service - Supporting and service	-,026	,435	,017	-,059	,007	-1,522	657	,128
Infrastructure - All three	,286	,705	,027	,233	,338	10,633	689	,000
Supporting - All three	,226	,704	,027	,173	,278	8,400	686	,000
Service - All three	,177	,745	,028	,121	,233	6,206	684	,000
Infrastructure and supporting - All three	,069	,443	,017	,036	,102	4,061	682	,000
Infrastructure and service - All three	,107	,459	,018	,072	,142	6,009	663	,000
Supporting and service - All three	,134	,487	,019	,097	,170	7,170	679	,000

Table 25 - Paired sample t-test (Users)

Paired Samples Test	Paired Differences					t	df	Sig. (2-tailed)
	Mean	Std. Deviation	Std. Error Mean	CI Lower	CI Upper			
Infrastructure - Supporting	,020	,762	,022	-,037	,076	0,904	1213	,366
Infrastructure - Service	,108	,755	,022	,052	,164	4,989	1210	,000
Supporting - Service	,084	,594	,017	,039	,128	4,868	1196	,000
Infrastructure and supporting - Infrastructure and service	-,003	,369	,011	-,030	,025	-0,235	1194	,814
Infrastructure and supporting - Supporting and service	-,039	,478	,014	-,075	-,003	-2,832	1202	,005
Infrastructure and service - Supporting and service	-,040	,395	,011	-,069	-,010	-3,453	1186	,001
Infrastructure - All three	,227	,696	,020	,175	,279	11,336	1205	,000
Supporting - All three	,206	,754	,022	,149	,262	9,415	1190	,000
Service - All three	,123	,736	,021	,068	,178	5,750	1188	,000
Infrastructure and supporting - All three	,077	,446	,013	,043	,110	5,949	1199	,000
Infrastructure and service - All three	,082	,439	,013	,049	,115	6,435	1180	,000
Supporting and service - All three	,120	,485	,014	,084	,156	8,545	1190	,000