Thesis 293

The situation for cyclists in South Africa

A study in Stellenbosch

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Abstract:

This thesis aims to evaluate the situation for cyclists in Stellenbosch, one of the leading cities in South Africa when it comes to planning for cyclists. The current situation for cyclists in Stellenbosch will be evaluated in terms of level of service, accessibility and safety. Moreover, the purpose of this study is also to investigate if there are there any official policies or plans to improve the situation for cyclists in Stellenbosch. If there are, the purpose is also to see if the content is consistent with previous studies regarding cycling. The evaluation is based on information gathered in different ways. Most information is collected during observations in Stellenbosch but other methods such as measurements, conversations and literature review was also used. The results from this study show that the current situation for cyclists in Stellenbosch is rather poor. Many factors point to the fact that the situation is even worse but some essential factors show that the town has great potential, which contributes to the overall description.

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Preface

The last step towards becoming civil engineers at Lund University is to write a master thesis, our master thesis is based on a study. The information for this study was gathered in January-March 2016 through a minor field study in Stellenbosch in the southern parts of South Africa.

First of all we would like to thank Sida for giving us the opportunity to conduct this study through the MFS scholarships. We would also like to thank everyone at the Sida Partnership Forum in Härnösand, both staff and lecturers, for providing us with useful insight in how to prepare for and conduct a study in a developing country. A special thanks is also given to Marie Brink, who has been our MFS contact at Lund University, for all your help and support considering the MFS process.

Secondly, we are grateful to everyone who helped us before and during our weeks in South Africa. Most of all we would like to thank Professor Marion Sinclair, EJ Wentzel and Tanya Fouché for your warm welcome and very valuable information. Moreover, we would like to thank everyone we have been in contact with at Stellenbosch University, both students and staff.

Thirdly, we would like to thank our supervisor Till Koglin and examiner Åse Svensson at the Department of Technology and Society, Transport and Roads at Lund University for all the help and support we got in order to fulfill this master thesis.

Last but not least, we want to thank our friends and family for supporting us in this challenging but rewarding project. A special thanks to all of you who visited us in South Africa, we had a great time!

Elina Hederberg and Helena Homle

Lund, june 2016

Summary

Cycling is a mode of transport with many advantages - a bicycle is rather inexpensive, easy to use, non-polluting, health improving and it claims less urban space than motorised vehicles (Handy et al., 2014). This is something that many countries have realized lately and nowadays policies that focus on promoting cyclists can be found in many cities worldwide (Handy et al., 2014). In order to increase cycling many countries conduct studies which aims to identify the most efficient way to promote cycling (Handy et al., 2014). One of these countries is South Africa where the priority of cyclists recently began.

Even if it is made clear that many factors contribute in making cycling attractive it is still possible to try to understand the situation for cyclists and need of improvements by evaluating only a few of them. Therefore this study aims to, through a few factors, evaluate the situation for cyclists in Stellenbosch, one of the leading cities in South Africa when it comes to planning for cyclists. The current situation for cyclists in Stellenbosch will be evaluated in terms of level of service, accessibility and safety. Moreover, the purpose of this study is also to investigate if there are there any official policies or plans to improve the situation for cyclists in Stellenbosch. If there are, the purpose is also to see if the content is consistent with previous studies regarding cycling.

The evaluation is based on information gathered in different ways. Most information is collected during observations in Stellenbosch but other methods such as measurements, conversations and literature review was also used.

The results from this study show that the current situation for cyclists in Stellenbosch is rather poor. Many factors point to the fact that the situation is even worse but some essential factors show that the town has great potential, which contributes to the overall description. Furthermore, it is according the authors' experiences from the observations definitely possible to travel by bike in Stellenbosch today. Moreover, in the literature review a big amount of plans and policies were found, both on national and municipality level. The brief evaluation of the content showed that it is accurate and consistent with previous studies in this field.

Sammanfattning

Cykling är ett transportmedel med många fördelar - cykeln är mindre kostsam, lätt att använda, miljövänlig, hälsofrämjande och kräver mindre utrymme än motorfordon (Gqaji, 2010). Detta är något som många länder nyligen har insett och numera kan politik som fokuserar på att främja cyklister hittas i många städer runt om i världen (Handy et al., 2014). För att kunna öka cykelanvändningen bedriver många länder studier som syftar till att identifiera det mest effektiva sättet att främja cykling (Handy et al., 2014). Ett av dessa länder är Sydafrika där prioriteringen av cyklister nyligen började.

Trots att oerhört många faktorer bidrar till att göra cykling attraktivt är det fortfarande möjligt att försöka förstå situationen för cyklister, och behov av förbättringar, genom att utvärdera endast ett fåtal av dem. Denna fallstudie syftar därför till att genom några faktorer utvärdera situationen för cyklister i Stellenbosch, en av de ledande städerna i Sydafrika när det gäller att planera för cyklister. Den nuvarande situationen för cyklister i Stellenbosch kommer att utvärderas med avseende på framkomlighet, tillgänglighet och säkerhet. Syftet med denna studie är också att undersöka om det finns några officiella policys eller planer för att förbättra situationen för cyklister i Stellenbosch. Om det finns är syftet också att se om innehållet överensstämmer med resultaten från tidigare studier om cykling.

Utvärderingen baseras på information som samlas in på olika sätt. Större delen av informationen samlades in under deltagande observationer i Stellenbosch, men också genom andra metoder såsom mätningar, samtal och litteratur.

Resultaten från denna studie visar att den nuvarande situationen för cyklister i Stellenbosch är relativt dålig. Många faktorer indikerar att situationen är ännu värre, men eftersom några av de viktigaste faktorerna visar att staden har en stor potential påverkas den övergripande beskrivningen av dessa. Dessutom är det utifrån författarnas erfarenheter från observationerna definitivt möjligt att cykla i Stellenbosch idag. Avslutningsvis hittades en stor mängd policys och planer, både på nationell och kommunal nivå. En översiktlig utvärdering av innehållet visade att det är välarbetat och överensstämmer med tidigare studier på området.

1 Introduction

1.1 Stellenbosch, The best cycling town in South Africa?

According to Handy et al. (2014) cycling is a mode of transport with many advantages. A bicycle is rather inexpensive, easy to use, non-polluting, health improving and it claims less urban space than motorised vehicles. This is something that many countries have realized lately and nowadays policies that focus on promoting cyclists can be found in many cities worldwide (Handy et al., 2014). However, this is not the case in South Africa today where the car is the most popular means of transportation and most of the road casualties are vulnerable road users. This indicates that improvements need to be made in the infrastructure for cyclists and pedestrians (Macozoma & Ribbens 2004). This is essential since the road safety situation is considered to be one of the worst in the world with high accident rates and many fatalities (Stellenbosch municipality, 2015b).

Buehler and Pucher (2008) state that history and culture is of importance when trying to increase cycling but it is not the only factors that influence the results. Even in successful European countries the change did not happen over a night and it is therefore important to continue working towards an improved situation for cyclists. South Africa has recently started working with the situation for cyclists but has not yet seen major improvements. Although, they should not give up due to the many advantages for cyclists such as flat terrain, the many key routes with short distances, the lack of public transportation and inability to afford private motor vehicles.

Stellenbosch is considered one of the leading municipalities in South Africa since they have recently highlighted the need of improving the situation for non-motorised road users (Stellenbosch municipality, 2015b). Actually, Stellenbosch municipality (2015b, 2016) consider the town to be very suitable for cycling. Thanks to the flat terrain, compact city centre, high university influence, need for affordable transportation options and the fact that motorists show courtesy for cyclists the town is ideal for becoming the premier cycling town in South Africa.

The situation for cyclists in Stellenbosch is therefore interesting to evaluate in this study in order to increase the understanding in planning for improved cycle infrastructure. Hopefully, the result of this study could give an insight in the possibility of Stellenbosch becoming a successful cycling town.

1.2 Purpose

The purpose of this study is to gain deeper knowledge about the situation for cyclists in the city of Stellenbosch through a minor field study. An evaluation of the current situation will be made through the perspective of traffic engineering students. Besides improving the authors' insight in the situation for cyclists in Stellenbosch this study will hopefully contribute to encourage others to continue working towards an increase of cycling.

In order to conduct this study the following underlying questions have been stated:

- What is the current status of the situation for cyclists in Stellenbosch, described from a cyclist's perspective in terms of:
    - Level of service
    - Accessibility
    - Safety

- Are there any official policies or plans to improve the situation for cyclists in Stellenbosch? If there are, is the content consistent with previous studies regarding cycling?

1.3 Limitation

A significant limitation in this study is that the situation will only be evaluated in Stellenbosch instead of the whole Republic of South Africa. The main reason for this is the time frame for this project. A more credible result would be given if different places would be evaluated. Furthermore, the information gathered in Stellenbosch cannot be generalized and applied elsewhere, not even in other South African cities. It is not possible to assume that the conclusions are representative for the entire country.

Meanwhile, it is also important to only thoroughly evaluate a reasonable part of Stellenbosch. It will also be necessary to delimit which areas in Stellenbosch to inventory due to safety issues. The northern, western and southern suburbs will not be evaluated.

As stated in section 1.2 the current situation in Stellenbosch will be evaluated in terms of level of service, accessibility and safety for cyclists. This will be done by studying different factors that indicates the level of these three terms. It is not possible to evaluate every street thoroughly, therefore the factors that require specific measuring have only been studied at a few chosen streets and intersections. Two examples of such specific measuring is car speed and travel time measuring. Nevertheless, all streets have been briefly observated since this is important for the overall understanding of the different parts of town.

Moreover, the factors will only be studied and valuated from an average cyclist's point of view. An average cyclist is in this study defined as a fairly strong and healthy adult with common sense. This will affect the outcome of this study since consideration is not given

to other kinds of cyclists, such as sport cyclists, children, elderly or cyclists with special needs.

To avoid this study from focusing too much on official plans instead of the actual traffic situation in South Africa the evaluation of current plans, policies and laws will not be too extensive. However, this will still be a part of the study, mainly because it is of importance for understanding the conditions in South Africa.

There has also been a limitation during the study of previous publications on cycling in general since this study is conducted in South Africa. Because of possible differences in for example traffic behaviour not all European outcomes may be applicable in the analysis in this study.

2 Method

The method that is used is described below.

2.1 Overall

Before arrival in Stellenbosch the situation in the city was unknown. It was not certain that there would be cyclists for whom the situation could be studied and therefore several back-up plans were discussed. Since the subject was not decided before arrival the literature review was not conducted until after the eight weeks in Stellenbosch, when the subject of this study and the conditions in Stellenbosch were better known. Due to these uncertainties no decisions were made in beforehand on which factors that would be studied during the field study.

Upon arrival in Stellenbosch it was clear that there are cyclists in the streets and that both planning and infrastructure for cyclists occur in the city. Due to this fact the purpose of this study was chosen. Although, it was still questionable which factors that could be interesting to study and therefore it was decided that the factors would be chosen after a brief inventory of the city which is further described in section 2.2.1.

To conduct a study as accurate as possible it is important that information is gathered in various ways. During the eight weeks in Stellenbosch most of the information was gathered through observations that means the result will mostly be based on qualitative information. Although, information was also collected using other methods such as measurements and conversations. An important limitation of inventorying is that the information may be influenced by the authors' experiences or personal opinions which means the results will not be fully objective (McLeod, 2008).

2.2 Data collection

As mentioned in section 2.1 the information in this study is collected in various ways, most data is quantitative but as can be seen below there is also some qualitative data collected through measurement.

2.2.1 Observations

To better understand what it is like to be a cyclist in Stellenbosch it is essential to try it, the authors therefore inventoried as many streets in the city as possible. A wide scale inventory is necessary to comprehend the bigger picture of the traffic situation. Although, this limits the outcome of the study since consideration is not taken to details in infrastructural design and network. As mentioned in section 1.3 some areas were not being further analyzed due to safety issues but otherwise all streets within the black line, marked in figure 1, were studied. Information was documented by taking notes and photographs and rental bikes were used during the observations. The situation was evaluated through the perspective of traffic engineering students in terms of accessibility, safety and level of service for cyclists. The reason to this is that these three aspects are stated to be of great importance for describing if the traffic system for cyclists is well functioning (CROW 2007, SKL 2015 & TfL 2014).

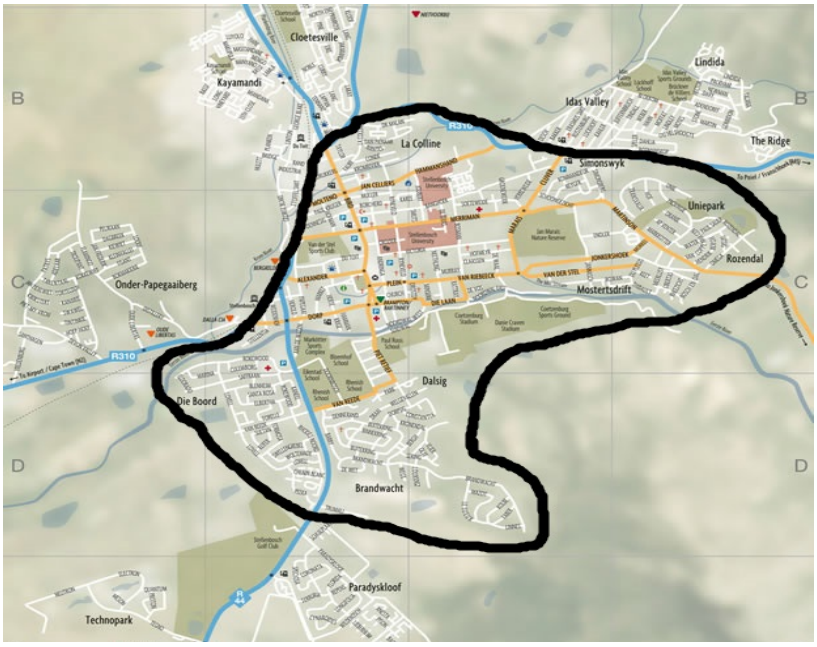

Figure 1 - The area inside the black line is the part of Stellenbosch which is evaluated in this study
Source: Stellenbosch (2016) edited by Elina Hederberg and Helena Homle

To understand the road traffic network and especially the existing cycle infrastructure in the town of Stellenbosch, all streets were briefly inventoried. During the observations the evaluation is made in the perspective of an average cyclist, which in this case study is defined as a fairly strong and healthy adult with common sense.

During the inventory of the city the authors experienced that a few distinctive factors occurred more often than others. These were therefore chosen to be the basis in the description of the situation for cyclists in Stellenbosch. Besides the observed factors there were two other factors that was considered interesting for this study, these were vehicle speed and travel time. In order to evaluate even these two the measurement described in section 2.2.2 was conducted. All chosen factors are stated below:

Level of service:

- Travel time ratio
- Coherency and continuity in the cycle traffic network
- Recurring stop signs
- Priority for cyclists in intersections
- The width of the roads
- Congestions
- Parked cars

Accessibility:

- Distance
- Guiding signs along routes
- Surface quality
- Obstacles
- Cycle parking

Safety:

- Vehicle speed
- Accident data
- Drainage channels
- Warning signs and other indications of cyclists
- Separated cycling facilities

All information regarding the above mentioned factors are collected during the inventory made by the authors except the vehicle speed and travel time that are measured. A few facts that are stated in the results are based on verbal information or emails (see section 2.2.3) or from documents studied during the literature review (see section 2.3). The importance and possible effect of the factors were studied after the time in Stellenbosch during the literature review.

2.2.2 Measurement

2.2.2.1 Vehicle speed

The vehicle speed was measured at four locations in Stellenbosch: one two-way street, one intersection and two roundabouts. These locations were chosen because they are characteristic for Stellenbosch and considered to be often used by cyclists during the inventory. The speed was measured by the authors in the afternoon before the congestions during rush hour started. The Bushnell radar gun that was used was borrowed from the Faculty of engineering at Stellenbosch University.

There are some factors that must be considered while conducting speed measurements. Due to circumstances in South Africa it was important for the authors to be visible during the measuring to make clear that it was a speed gun and no kind of weapon. During vehicle speed measurements there is always the possibility that drivers reduce speed when detecting the speed gun, of course this may affect the results. This is even more likely in this case since the authors needed to be visible due to safety reasons.

Since it is essential to stand as close to the collision course as possible it is hard to avoid being detected while using a radar gun (Bushnell, 2010). The reason for this is that the accuracy decreases with the angle from the collision course. The accuracy of the radar gun is +/- one mile-per-hour but this will be affected due to the authors' position on the pavement, perpendicular to the collision course. During the measurements made in this

study the authors' were standing on the pavement, 40 metres away from intersection and roundabouts.

The vehicle speed of 100 vehicles was measured in each direction on the road and at the intersections and roundabouts the speed of 100 vehicles was measured at every lane where traffic approach the intersection or roundabout. In case a series of cars approached the measuring point the speed was only measured of the first car in line since the following cars are affected by the speed of the first car.

The results of the vehicle speed measurements will be shown with a cumulative speed distribution and the average speed and 85-percentile will be also be presented. Even if the results from the speed measurement are not representative for all streets in Stellenbosch it gives an indication of the current situation.

2.2.2.2 Travel time ratio

To be able to evaluate some key routes in Stellenbosch travel time ratio is calculated. The routes were chosen based on key destinations and experienced flows of cycle traffic which were detected during the inventory. In order to calculate the travel time ratio the total travel time along a specific route is required for cyclists and motorists. This was measured while using rental bikes and a rental car.

The travel time can be measured according to different methods, although in this study only a simplified method was used. The travel time along each route were measured randomly and only one time in each direction. Thereafter, the average of these two times was calculated for every route. The travel time ratio is then calculated according to the equation 1.

Equation 1 - Travel time ratio between cycling and driving

$$Travel\ time\ ratio = \frac{Travel\ time\ by\ cycle}{Travel\ time\ by\ car}$$

Since travel time is affected by the current traffic situation it was measured by cycle and car at the same time, i.e. the cyclist and motorist left the starting point at the same moment. The travel time was measured during the peak hour in the afternoon since this is the time when most people travel from school or work, regardless mode of transport. Moreover, it is also clear that cycling is faster than driving during these heavy congestions.

2.2.3 Verbal information and emails

Since this case study aims to provide a great insight in the current situation for cyclists in Stellenbosch the idea was to interview for example cyclists, city planners and professors or other employees at the university. Even if interviews had held the result would not have been representative for the entire town, although it is an efficient way to gain understanding of the opinion among people in Stellenbosch. Unfortunately, it was not possible to conduct interviews in South Africa due to local regulations. In order to hold interviews in Stellenbosch an ethics approval is required which must be applied for at the university. Since the procedure takes around six months this was not possible due to the

time frame of this case study. Luckily, some information has been gathered through verbal and email conversations with professors and professionals in Stellenbosch.

The information gathered through verbal and email conversations were spontaneously collected. Even if no expressed interviews were held the verbal information was still collected during booked meetings. Some of the asked questions were considered in beforehand while others appeared randomly during the conversation. Meetings were held with Professor Marion Sinclair at the department of civil engineering at Stellenbosch University and EJ Wentzel, former Manager of transport, roads and stormwater at the department of engineering services at Stellenbosch Municipality. Spontaneous email conversations with these two professionals also occurred in which some questions were also answered. The reason why information was gathered from prof. Sinclair and former manager Wentzel is simply that they were the ones the authors had contact with. Other professionals in Stellenbosch were contacted but they chose not to answer the questions due to the problems with the ethics approval.

2.3 Literature review

To gain deeper understanding of the different factors that affects the situation for cyclists a literature review was conducted. This also gives an insight in how these factors are analyzed in other research studies. In this study the literature review was made after the inventory in Stellenbosch. The reason for this is, as mentioned in section 2.1, which the purpose of the study was not chosen before arrival due to the unknown circumstances in Stellenbosch. Furthermore, it was important to focus on observations rather than literature while beeing in Stellenbosch since observations cannot be made afterwards.

In this study information will be gathered on cycling in general but also specifically on cycling in South Africa and Stellenbosch. The literature that has been reviewed is scientific articles, policies, plans, legislative texts, accident data, master theses, doctoral dissertations, technical reports, guidelines and manuals, school textbooks and other publications. All publications have been studied in terms of level of service, accessibility and safety focusing in an overall level rather than specific bicycle facility designs. The gathering of previous South African studies and publications where simplified since access to the library and databases at Stellenbosch University was granted.

Another reason to why the literature study was not made until after the time in Stellenbosch is because it could have an impact on the observants opinion of the situation. Knowledge about how the Municipality of Stellenbosch considers cycling in local plans and policies were in other words gained after all observations.

3 Background

The following information is mostely based on the literature review and verbal and email conversations. The only part that also consists of observations is the description of Stellenbosch today in section 3.2.2.

3.1 Cycling in general

According to Handy et al. (2014) cycling is a mode of transport with many advantages. A bicycle is rather inexpensive, easy to use, non-polluting, health improving and it claims less urban space than motorised vehicles. This is something that many countries have realized lately and nowadays policies that focus on promoting cyclists can be found in many cities worldwide (Handy et al., 2014). Although, there are some disadvantages of cycling such as difficulties due to hilly terrain, the cyclists' vulnerability in interactions with motorised vehicles and lack of existing cycling culture (SKL 2010, Ribbons 2006, TfL 2014). In order to be able to increase cycling regardless these difficulties many countries conducts studies, which aims to identify the most efficient way to promote cycling (Handy et al., 2014).

Even if many studies are already conducted in order to determine which factors have the greatest impact on how cycling can be an attractive mode of transport it is essential to further look into this topic (Bamberg et al, 2013). Previous studies imply that no specific conclusions can be made when it comes to state the key factors that promote cycling. However, a few studies indicates that the success in countries like the Netherlands and Denmark rather depends on the fact that they have prioritised cycle planning and infrastructure for a longer period of time than that they have focused on a specific factor. Although, it can still be possible to increase cycling since many factors are claimed to be of importance for improving the situation for cyclists. Some of the factors that are often mentioned to be essential to consider cycle planning and design of facilities are distance, safety, coherence, directness, speed appropriateness, level of separation from motorised vehicles, comfort, surface quality and the overall mobility (Bamberg et al 2013, CROW 2007, Heydon & Lucas-Smith 2014, Lindelöw 2009, SKL 2015, TfL 2014).

However, Buehler and Pucher (2008) claims that the key lesson to learn from the successful cycling cities in The Netherlands, Germany and Denmark is the importance of a coordinated, multi-faceted approach in the implementations. Actually, there are several studies, which agrees on the importance of a holistic approach (SKL 2009, Bamberg et al. 2013, Handy et al. 2014, Ribbens 2006,). The results of a study made by Buehler et al. (2011) confirms this theory since the study shows that cycling has only increased in cities where aggressive programmes that promote cycling on many levels were implemented. Furthermore, it was noticed that the increase in this cities seems to be concentrated to city centres and university districts while suburbs and some other residential areas are not affected in the same extent. However, Ribbens (2006) points to the fact that it is important to be patience while trying to improve the situation for cyclists, changes of planning or infrastructure do not create an increase in cycling over a night.

Even if it is made clear that many factors contribute in making cycling attractive it is still possible to try to understand the situation for cyclists and need of improvements by

evaluating only a few of them. This is possible as long as the importance of a holistic approach in terms of level of service, accessibility and safety is understood. Due to the limited time frame of this study only a few of the important are evaluated, these are divided in terms of level of service, accessibility and safety and further described below in sections 3.1.1-3.1.3.

3.1.1 Level of service

3.1.1.1 Travel time ratio

Travel time ratio is the ratio between the measured travel time by cycle and by car, it is calculated as described in equation 2 (Svensson 2008).

Equation 2 - Travel time ratio between cycling and driving

$$Travel\ time\ ratio = \frac{Travel\ time\ by\ cycle}{Travel\ time\ by\ car}$$

SKL (2009) and Svensson (2008) state that travel time ratio is a useful measurement to evaluate the quality of the cycle infrastructure. According to Bamberg et al. (2013) many studies suggest that travel time ratio might even be the most important factor to study in order to determine whether cycling is an attractive alternative to driving. In order to have a situation where cyclists can compete with motorists, in terms of time consumption, the travel time ratio should be less than 1,5 according to Aretun & Robertson (2013) and Svensson (2008) and less than 2 according to SKL (2015).

3.1.1.2 Coherency and continuity in the cycle traffic network

According to TfL (2014), Trafikverket (2014) and Lindelöw (2009) coherence is regarded one of the most important factors that affects the level of service, to consider when forming an attractive cycle network.

Continuity in cycling facilities implies that no gaps or interruptions occur along the cycle path (TfL, 2014). Buehler & Dill (2015), and TfL (2014) suggest that the level of service is poor along discontinuous cycle paths. Heydon & Lucas-Smith (2014) states that cycling facilities therefore must be planned in a way that does not delay or force cyclists to make detours.

3.1.1.3 Recurring stop signs

The regulation of intersections affects the level of service for all road users, for example it is in a cyclist's point of view considered to be inefficient to stop at stop signs (Heydon & Lucas-Smith 2014, SKL 2009). It is therefore common that cyclists ignore the rules and proceed through the intersections without stopping. According to Buehler and Dill (2015) this fact has lead to some cities allowing cyclists to proceed through minor intersections without stopping, however the effect of this option is not yet confirmed by any research.

3.1.1.4 Priority for cyclists in existing infrastructure

According to SKL (2009) efficient planning and designing of intersections is essential to ensure an acceptable level of service for all road users. If cyclists and pedestrians are not prioritised in any way it can be very difficult for them to claim their space in the interaction with motorists, which may decrease the safety and level of service a lot since it creates delays along their route (TfL, 2014). According to Buehler and Dill (2015) there

are studies indicating that cyclists appreciate prioritizing facilities, however more research is considered to be needed in this field.

3.1.1.5 The width of the roads

The width of the roads is an important factor for the quality of the cycle network. The width combined with other factors such as traffic volume and vehicle speed is according to TfL (2014) of great importance for cyclists' level of service and ability to compete for road space. It is necessary for cyclists to have enough space if wobbling and it is of extra importance at low speed (SKL, 2010 & TfL, 2008).

3.1.1.6 Congestion

The queue length and delays are often used to determine whether the level of service is good or not (Trafikverket, 2013). Long queue lengths that are caused by heavy congestions affects the level of service in the traffic network, for motorists as well as cyclists. According to Heydon & Lucas-Smith (2014) and TfL (2014) it is preferred among cyclists to travel on the most direct and quickest route, since delays are unwanted.

3.1.1.7 Parked cars

For cyclists that are traveling in the roadway while being mixed with other motorised vehicles, parked cars may create difficulties (Buehler and Dill, 2015). Traveling on roads where cars are parked along the way have an impact on the visibility for both cars and vulnerable road users. Therefore cyclists tend to prefer cycling on roads without parked cars interfering. According to Heydon & Lucas-Smith (2014) it is even more important to avoid car parking near intersections to maintain good visibility.

3.1.2 Accessibility

Accessibility is according to SKL (2015) and TfL (2014) important to consider when planning and designing non-motorised transportation facilities. These facilities should be accessible to all users, regardless of age and abilities.

3.1.2.1 Distance

The most important factor when it comes to accessibility for cyclists is distance and it is directly associated with the bicycle use (Bamberg et al, 2013). The accessibility in a city is affected by the distance between key destinations (SKL, 2015). According to SKL (2010) cycle trips should not be longer than 5 km for cycling to be considered an attractive mode of transport. Lindelöw (2009) states that cities with short distances are more likely to become successful cycling cities.

3.1.2.2 Guiding signs

SKL (2015) states that guidance along a route is of great importance for the quality in the transport network since it is essential that cyclists are able to find their way without difficulties. Even if the cycling facilities are well designed it is essential that these are supplemented by amenities such as guidance and information signs in order to improve the level of service for cyclist (Heydon & Lucas-Smith, 2014 and Ribbens, 2006).

3.1.2.3 Surface quality

According to SKL (2010, 2015) irregularities due to the surface quality highly affects the accessibility for cyclists. It is important to maintain a good surface quality in to prevent

accidents from happening to cyclists and pedestrians (Heydon & Lucas-Smith 2014, TfL 2014).

3.1.2.4 Obstacles

To create attractive streets and environments for cyclists various kinds of street furniture and amenities are essential. According to Trafikverket (2014) and SKL (2010) it is highly recommended to thoroughly plan the location of these to avoid creating obstacles that affects the accessibility for cyclists.

3.1.2.5 Cycle parking

The accessibility for cyclists is highly affected by the possibility to park the bicycle close to the destination (SKL 2010, TfL 2014 & Heydon & Lucas-Smith 2014). It is also necessary that parking opportunities are designed in a safe and efficient way. According to Svensson (2008) some studies actually show that secure parking is considered to be very important since many people choose not to cycle due to the risk of theft.

3.1.3 Safety

The safety for cyclists is according to CROW (2007) one of the most important factors when planning and developing cycle infrastructure.

3.1.3.1 Vehicle speed

The speed of motorised vehicles may be the most important factor in terms of traffic safety (Hydén, 2008). This is explained by its great impact on the probability of accidents occurring and the severeness of injuries when accidents do happen (Kröyer 2015, Almqvist & Hydén 1994). Hydén (2008) & SKL (2015) state that road traffic safety is directly dependent on speed among motorised vehicles. According to Hydén (2008) the severity of accidents increases heavily when motorised vehicles travel above 30 km/h. The risk of accidents with fatal outcome increases heavily if the collision speed increases from 30 km/h to 50 km/h.

According to Buehler and Pucher (2008), SKL (2015) and Ribbens (2006) the overall traffic safety can be improved by implementing traffic calming in smaller roads and suitable separated cycling facilities along heavily travelled roads. This is also supported in Elvik (2012) where it is shown that the number of accidents decreases with lower speeds.

The results of vehicle speed measurements are often shown with a cumulative speed distribution and the average speed and 85-percentile is presented. The 85-percentile is according to Elvik et al (2009) defined as:

> *"The speed below which 85 % of vehicles drive"*

The 85-percentile presents the actual speed limit rather than the regulated speed limit.

3.1.3.2 Accident data

In order to make cycling an attractive mode of transport it is essential to increase the safety among cyclists, i.e. the number of accidents must decrease (Buehler & Pucher, 2008). It is often assumed interesting to study accident data to understand the current safety situation in the traffic network. However, it is important to remember that a low accident number among cyclists does not necessarily mean that cyclists feel safe while travelling on the roads (Bester & Pretorius, 2004). Additionally, it is also important to understand that accident data often is inaccurate (Várhelyi et al. 2010).

3.1.3.3 Drainage channels

Roadways lined with drainage channels may affect the safety situation for cyclists. This is one example of where it is important to thoroughly plan the design and location of street amenities to prevent accidents from happening (SKL 2010, Heydon & Lucas-Smith 2014 & TfL 2014).

3.1.3.4 Warning signs

According to Ribbens (2006) warning signs are important for the safety of cyclists. In situations where cyclists interact with motorised it is essential to use supplements in order to alert motorists about the possible upcoming interaction.

3.1.3.5 Separated cycling facilities

Traffic safety is of great importance for non-motorised road users since they are the most vulnerable road users (CROW 2007, SKL 2010). Conflicts often occur when pedestrians and cyclists interact with motorised vehicles, especially where the speed limit is high and the visibility is poor (Ribbens, 2006). Pedestrians and cyclists should therefore, where it is needed, be separated from motorised traffic. This is not only essential in order to increase safety but also to improve the level of service and overall comfort (SKL 2015, TfL 2014). It is in some cases also necessary to separate cyclists from pedestrians in order to ensure the safety for pedestrians and the level of service for cyclists (Svensson 2008, Heydon & Lucas-Smith 2014). According to Heydon & Lucas-Smith (2014) there are different ways of separating road users from each other. Facilities like pavements, bicycle lanes and bicycle roads could help improve the traffic safety for cyclists and pedestrians. According to Vanderschuren and Phayane (2015) it is very important to always consider the actual vehicle speed when designing these facilities.

3.2 Stellenbosch

South Africa is a country with over 53 million inhabitants located in the most southern part of Africa, see figure 2 (Svenska FN-förbundet, 2016).

Figure 2 - The location of South Africa in the world
Source: WPClipart (2016) edited by Elina Hederberg and Helena Homle

In the southwestern parts of South Africa, in the Western Cape Province, is the town Stellenbosch situated (see figure 3). Stellenbosch is located about 50 km from Cape Town in a valley surrounded by mountains (South Africa Tourism, 2016).

Figure 3 - The location of Stellenbosch in South Africa
Source: Google Maps (2016) edited by Elina Hederberg and Helena Homle

Stellenbosch is strongly characterized by South Africa's unstable past and the political situation is still turbulent and accusations of corruption still occur. The heritage from the decades of apartheid is also still present in South Africa. Moreover, the poverty, crime and unemployment rates are high and not everyone has access to fundamental rights such as piped water, sewerage and electricity. The unemployment rate in the country is 25 % and therefore considered one of the biggest challenges today. South Africa also struggles with severe diseases such as malaria and HIV/AIDS, the HIV epidemic is actually the highest in the in the world (Avert, 2016). In the past years South Africa has therefore financed major treatment programmes, poverty reducing initiatives and projects that provides piped water and sewerage to more households instead of infrastructural projects (Wentzel, 2016).

However, the need of infrastructural improvements is essential since the road safety situation is considered to be one of the worst in the world with high accident rates and many fatalities (Stellenbosch municipality, 2015b). This is even more important due to the fact that the UN have currently proclaimed "Decade of Action", the goal of this initiative is to reduce the road traffic fatalities in the world until 2020 (FIA Foundation, 2016). In South Africa today the car is the most popular means of transportation but most of the road casualties are vulnerable road users, this indicates that improvements need to be made in the infrastructure for vulnerable road users such as cyclists and pedestrians (Macozoma & Ribbens 2004).

It is stated that there are not enough resources to reduce poverty and improve the infrastructure at the same time, therefore it is of great importance to consider the fact that studies suggest that poverty can be reduced if the situation for vulnerable road users is improved (Gqaji 2010, Ribbens 2006). This is explained by the fact that the bicycle is a low-cost mode of transport that makes it possible to travel longer distances and thereby place job opportunities within reach (Gwala 2007, Gqaji 2010). In other words the overall commitment to improve the situation for cyclists could result in major decrease of the poverty levels and unemployment rate (Ribbens, 2006). The Department of Transport

seems to be aware of this since they state “Transport is the heartbeat of South Africa’s growth and social development!” (Department of Transport, 2016).

3.2.1 The history of Stellenbosch

One of the reasons why the Dutch chose to settle here in the late 17th century was that the valley is ideal for farming, especially for wine making. This is because the Eerste River flows through and provides the area with water (ShowMe, 2009). To be able to use the water supply more efficiently canals and channels that lead the water from the river to farms and houses were constructed throughout Stellenbosch. In the 19th century oak trees were planted along the streets to provide shadow and make oak barrels for the wine making. Many of these trees are still seen along the streets and this is why Stellenbosch is sometimes called the city of oaks.

Even today it is possible to see this heritage from the olden days. Stellenbosch is known for the oak-lined streets, water channels and the Cape Dutch styled houses seen in figure 4. The street in figure 4, Dorp Street, is actually announced to be a national monument in South Africa because of its great historical value (Travel Directory Sàrl, 2016).

Figure 4 - Dorp street in Stellenbosch
Source: Elina Hederberg and Helena Homle

Besides being a centre of the old Cape winelands Stellenbosch is also known for the University that is considered to be one of the top universities in the world (Stellenbosch University, 2016). Since there are currently almost 30 000 students in Stellenbosch and campus is located in the middle of town it really affects the everyday life. Students are seen walking, cycling or driving around town alongside other residents and tourists. Restaurants and cafés among the oaks are popular meeting places that make Stellenbosch a picturesque, bustling town.

3.2.2 Stellenbosch today

In 2011 the population in the urban area of Stellenbosch was 155 733 people, excluding students (Statistics South Africa, 2011). The urban area is about 21 km^2 which can be compared to the urban area of Lund that is 25 km^2 (SCB, 2013) with a population of 84 442 people. The parts of Lund are centered around the city centre while the parts of Stellenbosch are more irregularly spread in different directions, this is shown in figure 5.

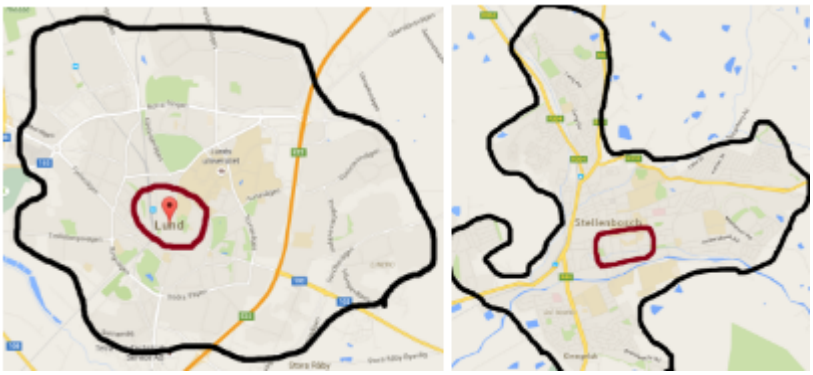

Figure 5 - The urban areas of Lund and Stellenbosch marked in black and the city centers marked in red. Source: Google Maps (2016) edited by Elina Hederberg and Helena Homle

Many of the key destinations in Stellenbosch are located in the central parts of town. Some of them are shown in figure 6. These central parts are from now on called the city centre and university area. In this area one can find the typical streets that Stellenbosch are known for, with many Cape dutch styled houses, oak trees and open-air cafés and restaurants. Since key destinations like the mall, campus, hospital and sport center is located in this area it is very vibrant. Most shops, museums, restaurants and other tourist attractions are located in the city centre, while there are lots of student accommodations to the north and northeast of the campus. The residential neighbourhoods outside the city center and university area are more widespread. Some of the biggest ones that are a part of this study are marked with black in figure 6 and further described in the sections below. More detailed maps of Stellenbosch can be found in appendix 1 and 2.

Figure 6 - Some of the neighbourhoods, in black, and important key destinations, in red, in Stellenbosch Source: Stellenbosch (2016) edited by Elina Hederberg and Helena Homle

As shown in figure 6 Stellenbosch is divided into many residential areas. There are huge differences between these areas when it comes to population density, education and

unemployment rates, housing conditions and access to fundamental rights such as piped water, sewerage and electricity (Statistics South Africa, 2011). Some of the areas that are often mentioned but not further analyzed in this report, such as the northern suburbs Kayamandi, Cloetesville and Idas Valley, are in general characterized by higher population density, lower education and higher unemployment rates. Kayamandi (se figure 7) has a population of almost 25 000 people in a little more than 8 500 households (Statistics South Africa, 2011). The higher education rate for people over 20 years old is only 4,3 % and around 30 % of the households have no income. In 2011 a car could only be found in 9,9 % of the households.

Figure 7 - The residential area of Kayamandi
Source: MegMoggington (2012)

In most other residential areas in Stellenbosch the population density is much lower, the education rate is higher and the unemployment rate is lower (Statistics South Africa, 2011). The area south of the city centre includes the neighbourhoods Brandwacht, Dalsig and Die Boord. The area east of the city centre includes Mostertsdrift, Rozendal, Uniepark and Simonswyk. All these residential areas are similar in many ways. Most households have fenced off yards around their houses and the streets are wide and paved but still verdant. Usually there are no pathways for pedestrians or cyclists. Some streets are shown in figure 8.

Figure 8 - Typical streets in the neighbourhoods south and east of Stellenbosch city center, Linnes road in Brandwacht to the left and Trengove road in Uniepark to the right
Source: Elina Hederberg and Helena Homle

As mentioned earlier the areas south and east of the city centre are different from the northern suburbs. In Brandwacht, for example, there are only 265 inhabitants living in 91 households (Statistics South Africa, 2011). 73 % of the people older than 20 years are higher educated, only 7,9 % of the households have no income and all households have at least one car.

The area north of the city centre, La Colline, is similar to the neighbourhoods in the south and the east but there are a few differences. There is around 1 500 inhabitants in 505 households in La Colline but cars are only found in 73 % of the households (Statistics South Africa, 2011). The streets in La Colline looks a lot like the ones in for example Brandwacht but many of the houses are a bit different. Not all yards are fenced off and various types of housing cooperative are common, see figure 9. Among people older than 20 years 28 % are higher educated and almost 40 % of the households have no income.

Figure 9 - La Colline road and Dan Pienaar road in La Colline
Source: Elina Hederberg and Helena Homle

3.2.3 Cycling in Stellenbosch

Three or four decades ago Stellenbosch was a completely different city, public transportation was available for the citizens and the cycling culture was widespread (Wenzel, 2016). One reason for this was that the university did not allow students to have cars. Unfortunately, the politicians decided to stop providing public transport and the cycling decreased due to safety reasons, such as increased crime and accident rates (Vanderschuren, 2004). Because of these circumstances the university allowed students to have cars and therefore the amount of cars have increased heavily which have led to major problems with lack of parking, congestions and a more unsafe traffic environment. Actually, the main reason to why people choose not to cycle is according to a survey made by Stellenbosch municipality (2016) is poor traffic safety, lack of cycling infrastructure and personal safety concerns.

Before the year of 2001 no government programmes, policies or plans, in which a wanted increase of the modal share for non-motorised transports was discussed, existed in South Africa (Gwala, 2007). However, today the situation is different and planning of cycle and pedestrian infrastructure is part of both governmental and municipality plans and policies (Gwala 2007, Ribbens 2006, Stellenbosch municipality 2015b). According to Ribbens (2006) South Africa has developed a detailed facility guidelines manual for pedestrians and bicyclists and it is clear that the Department of Transport is highly committed to prioritise cyclist and pedestrian planning all over the country. Stellenbosch has developed many plans and policies and is therefore one of leading municipalities in South Africa (Stellenbosch municipality, 2016). Gwala (2007) states that many provinces and municipalities has not yet decided to address the challenges concerning non-motorised road users.

According to Wentzel (2016) the municipality of Stellenbosch has developed several policies and plans regarding increased planning for non-motorised road users. The

"Comprehensive integrated transport plan" is a document that thoroughly describes the current traffic network, situation and plans in Stellenbosch, in this document bigger priority has been given to non-motorised transportation. To ensure that the municipality is committed to improve the situation for non-motorised vehicles an "NMT policy" is created, this document describes the political commitment in terms of what they intend to achieve in order to improve the situation for vulnerable road users. Moreover, an "NMT Plan" has thereafter been developed in order to more thoroughly describe why, where and how they intend to achieve the goals stated in the "NMT policy". Additionally, a specific "Cycle plan" has recently been created as well. This document is even more detailed and focuses only on improving the situation for cyclists.

According to Professor Sinclair (2016) there are existing regulations regarding the cycle traffic in Stellenbosch and South Africa. These laws regulate where and how cyclists are allowed to ride and how they are suppose to behave among other road users. There are some important rules when it comes to cycling that cyclists should be aware of. One rule is that cyclists are expected to ride in the roadway if nothing else is described. Another important rule is that cyclists, as well as motorists, are supposed to stop at intersections regulated by stop signs. However, these rules are norms rather than laws but they are still important in order to maintain a functional traffic system. Moreover, the speed limit in Stellenbosch is 60 km/h in urban areas (Brand South Africa, 2015). Cyclists in urban areas or often forced to mix with cars where the speed limit is 60 km/h (Brand South Africa, 2015).

Today, 50 % of all trips made in South Africa are according to Vanderschuren and Phayane (2015) made on foot, although only 1 % chose to cycle (Gwala, 2007). In Stellenbosch cycling is a bit more popular, even if the car still is the most popular mode of transport today (Stellenbosch municipality, 2016). This seems to especially apply for high-income areas, since Table 1 shows that cycling and walking are less popular in these areas compared to low and middle-income areas. In low-income areas it is also popular to travel with the local minibus taxis but otherwise there are no public transportation in Stellenbosch.

Table 1 - Non-motorised transport modal share in the residential areas in Stellenbosch
Source: Stellenbosch municipality (2016)

Residential Area	Income Group	% Walk	% Cycle
Dalsig	High	0	4
Die Boord	High	2	2
Onder Papegaai	High	3	2
Paradyskloof	High	2	0
Krigeville	High	5	0
Uniepark/ Karindal/ Simonswyk	High	2	4
Central Stellenbosch	Middle-High	11	15
La Colline	Middle-High	16	0
Idas Valley	Lower-Middle	14	2
Cloetesville	Lower-Middle	13	1
Jamestown	Lower-Middle	12	1
Kayamandi	Low	26	1

Stellenbosch municipality (2016) has noticed that even people that own a cycle choose not use it for transportation. In order to understand why, a survey was conducted and the results is shown in diagram 1. According to this the three most important factors that discourage people from cycling are traffic dangers, lack of facilities and personal safety.

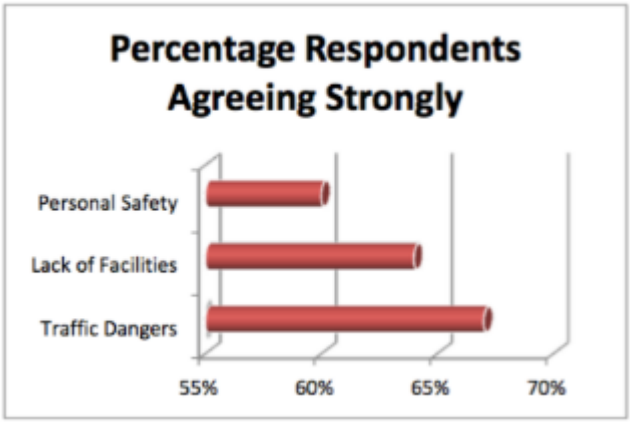

Diagram 1 - Factors preventing more widespread use of currently owned bicycles
Source: Stellenbosch municipality (2016)

In 2009 Stellenbosch University conducted a study among students and personnel considering cycling habits and modal splits (Stellenbosch municipality, 2016). The study shows that 60 % of the participants had access to at least one bicycle and that 85 % strongly agreed on the need of improving cycle networks and facilities. The ones who owned a bicycle even indicated that they would cycle more if conditions improved. It also shows that most of the daily trips to work and school are shorter than 4 km (Stellenbosch municipality, 2016), which is advantageous since cycling is considered faster during rush hour and more attractive than driving shorter distances (Gqaji 2010, Svensson 2008). The modal split among the participants is shown in table 2, where it can be seen that only 3 % of students and 4 % of the personnel travel by bicycle (Stellenbosch municipality, 2016).

Table 2 - Main mode of travel for students and personnel of the University of Stellenbosch
Source: Stellenbosch municipality (2016)

Main mode of Travel to/ from University	Students	Personnel
Car	51%	86%
Motor Cycle	1%	1%
Combination (Mainly Public Transport & Walk)	24%	3%
Public Transport	1%	3%
Bicycle	3%	4%
Walk	19%	3%
Total	100%	100%

Stellenbosch municipality (2016) is committed to improve the situation for cyclists and increase the modal split for cycling. The overall vision for the traffic situation in Stellenbosch is according to Stellenbosch municipality (2016):

> *"A sustainable transport system that provides for the basic mobility needs of individuals, supports a vibrant economy and operates seamlessly within and across the municipal boundaries"*

In the Cycle plan (Stellenbosch, 2015b) where more focus is given to cycling in specific is another vision stated:

> *"By 2030, cycling within and around Stellenbosch has become a popular form of mobility that is safe, convenient and is accepted and promoted by all."*

Stellenbosch municipality (2015b) aims to be the best cycling town in South Africa and one of the best cycling tourism destinations in the world. To accomplish this the focus will be on allowing people to easily move by bike from origins to destinations, regardless age and abilities. The goal is also to reach a 15 % modal share and zero fatalities. It is stated that all planning should be according to the national guidelines developed by the Department as Transport as well as international guidelines through a multi-faceted approach. The plan is to improve the situation in three different stages, from short-term implementations to medium and long term. In order to get an idea of what could be done in Stellenbosch the municipality has made a report in which all streets have been inventoried and action proposals for all three stages have been suggested. An example from this report is shown in figure 10.

Current Situation
Bird Street connects Stellenbosch north with the urban centre. Improved walking links through NMT investments in 2009/10 between Du Toit Station and town centre. Cycling on pathway is problematic, often too busy and narrow for shared use. The roadway is busy and cars travel up to and above 60km/h.

Short Term Pathway widening
a) Given the high current traffic speeds, and narrow road width the short term recommended improvement would be to create a continuous cycle link as best possible through widening the pathway were space exists, marking for separation between walking and cycling where this is feasible.

Medium to Longer Term

Road speed limit reduced to 40kmh with necessary traffic calming measures. Full cross section review of road to provide for Class 3 or ideally Class 2 Cycleway on both carriageways (consider use of "Armadillos" or similar See Box 5.1 Class 2 example).

Will require carriageway narrowing in places. Probably cater for by placing one cycle lane (southbound) in the roadway, the other (northbound) on the flanking pavement.

Figure 10 - Proposal for improvements on the cycle infrastructure on Bird street in three stages
Source: Stellenbosch municipality (2015b)

It is of importance to point out that the suggestions stated in the report are only recommendations and not accepted implementation plans (Stellenbosch municipality, 2015b). However, it has been stated that the future cycle network should be safe, secure, comfortable, direct, convenient, and attractive in order to be successful. Moreover, the following factors are some of the ones required to achieve this:

- Traffic calming
- Localised infrastructure improvements in intersections and along key route
- Separation of non-motorised road users from motorised vehicles
- Bicycle parking and end of trip facilities
- Guiding and warning signage
- Promotion and education
- Initiatives that give everyone the opportunity to access a bicycle, regardless income level

Stellenbosch municipality (2015b) consider to have recent success in increasing motorists' tolerance for non-motorised road users. Considering their recent success many new projects are planned to further increase the situation. However, the total investment in non-motorised transportation improvements for the three upcoming years is only 5,6 million rand, or 3 million SEK (Stellenbosch municipality (2015a).

Two of the planned action proposals is to reduce speed limits and develop the cycle infrastructure (Stellenbosch, 2015b). As can be seen in table 3 the proposed speed limit is 40 km/h within the urban area of Stellenbosch and 30 km/h in the most central parts. Table 4 shows that cyclists on local streets are suggested to stay mixed with motorised vehicles in the roadway while different degrees of separation from motorised vehicles is considered on the bigger roads.

Table 3 - Proposed Speed Limits for Roads in the Town of Stellenbosch
Source: Stellenbosch municipality (2015b)

Road Class	Function	Examples	Speed Limit km/h	
			Typical Current	Proposed
Major arterial	Mobility	R44, Adam Tas,	80 / 60	80 / 60
Minor arterial		Cluver, Merriman	60	60 / 40 (depending on section)
Collector / Distributor	Accessibility	Bird, Marais, Rustenburg, Van Riebeeck, Dorp, Piet Retief	60	40
Local streets (Town Centre & Residential Areas)		Curry, Banhoek, Ryneveld,	60	30

Table 4 - Guideline for Cycleway Development in Stellenbosch
Source: Stellenbosch municipality (2015b)

Road Class	Function	Examples of Stellenbosch roadways	Typical Appropriate Cycleway Class	Description
Principal arterial	Mobility	R44, R310	Class 1	Separate cycleway (away from road)
Major arterial		R304, Helshoogte Rd		
Minor arterial		Bird, Martinson, Merriman, Cluver	Class 2	Cycleway connected to road (hard infrastructure separation)
Collectors	Accessibility	Marais, Van Riebeeck, Piet Retief, Lang, Dorpsig, Jonkershoek	Class 3 (& Class 2)	In roadways – separation by paint
Local street		Much of CBD & Most residential streets	Class 4	Shared space on street

The longterm plan in Stellenbosch is to create a well-functioning cycle network with primary routes for high volumes of cyclists, secondary feeder routes between the primary links and other smaller routes suitable for short, local trips (Stellenbosch municipality, 2015b). The idea of this network is shown in figure 11. Worth mentioning is that this is only a suggestion made by Stellenbosch municipality to explain what is planned in the city, however this map was never used during the inventorying and has therefore no impact on this study.

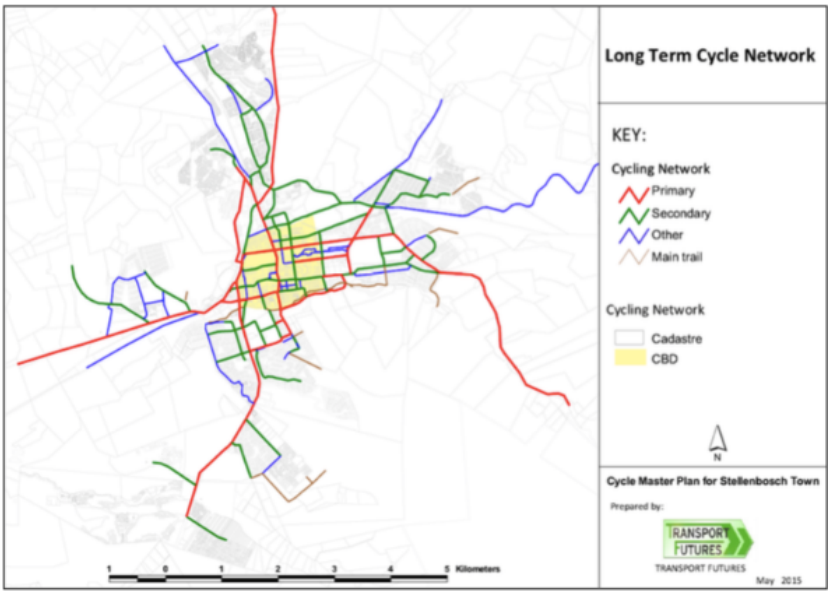

Figure 11 - A long term proposed cycle network in Stellenbosch
Source: Stellenbosch municipality (2015b)

In conclusion, Stellenbosch municipality (2015b, 2016) consider Stellenbosch to be a town that is very suitable for cycling. Thanks to the flat terrain, compact city centre, high university influence and the need for affordable transportation options and the fact that motorists show courtesy for cyclists the town is ideal for becoming the premier cycling town in South Africa.

4 Result and analysis

4.1 Level of service

4.1.1 Travel time ratio

In order to calculate the travel time ratio the travel time along seven key routes in Stellenbosch have been measured, these are found in appendix 3. Seven important routes are chosen; these are shown in figure 12 and further described below.

Figure 12 - A map showing the seven chosen routes
Source: Stellenbosch (2016) edited by Elina Hederberg and Helena Homle

- Yellow route: Student accommodations - Coetzenburg sport centre. 1,3 km.
- Green route: Student accommodations - Campus. 0,9 km.
- Red route: Student accommodations - Eikestad mall. 1,3 km.
- Blue route: Eikestad mall - the residential area of Kayamandi. 1,4 km.
- Pink route: Eikestad mall - the residential area of Brandwacht. 3,7 km.
- Dark blue route: Eikestad mall - the residential area of Idas Valley. 2,1 km.
- Purple route: Eikestad mall - the residential area of Uniepark. 2,6 km.

The travel time ratio between bicycle and car for all seven routes is measured and the result is shown in table 5.

Table 5 - Measured travel time ratio for the seven chosen routes

Travel time ratio	
Route	Bicycle/Car
Student accommodation-Sport centre	0,5
Student accommodation-Campus	0,4
Student accommodation-Eikestad Mall	0,8
Eikestad Mall-Kayamandi	0,7
Eikestad Mall-Brandwacht	3,2
Eikestad Mall-Idas Valley	1,7
Eikestad Mall-Uniepark	1,9

4.1.1.1 Analysis

In section 3.1.1.1 it is described why it is unlikely to choose cycling along a path where the travel time ratio is more than 1,5 (Aretun & Robertson 2013; Svensson 2008) or according to SKL (2015) more than 2. If the acceptable limit is 1,5 cycling is attractive along four of the seven routes but if the acceptable limit is 2 cycling is attractive along six out of seven routes. This suggests that the level of service for cyclists, in terms of travel time, is good at most of the important key routes in Stellenbosch.

Worth mentioning is that the path to Brandwacht, which got the highest travel time ratio, is not only the longest route but also the one with the biggest difference in altitude. SKL (2010) and TfL (2014) state that hilly terrain is one disadvantage that definitely should be avoided in cycling routes. According to the contour map the grade is approximately 8 % (Google maps, 2016), which affects the travel time for cyclists. Some of the roads with high grade in Brandwacht are shown in figure 13. Ribbens (2006) states that cyclists do not appreciate grades above 5 % and therefore the criterias of an attractive route is not fulfilled. According to Svensson (2008) it is always recommended to avoid big differences in altitude when planning for cycle infrastructure.

Figure 13 - Some of the roads with high grade in Brandwacht
Source: Elina Hederberg and Helena Homle

4.1.2 Coherency and continuity in the cycle traffic network

Cyclists in Stellenbosch are generally supposed to mix with other vehicles in the streets but in some places there are separate cycling facilities. These facilities have different shapes and various designs and can only be found along a few streets. In figure 14 the existing bicycle infrastructure is marked to easier describe the present situation and its lack of connections.

Figure 14 - A map of Stellenbosch in which existing cycle paths are marked
Source: Stellenbosch (2016) edited by Elina Hederberg and Helena Homle

During the planning of the existing cycle infrastructure in Stellenbosch it did not always seem like the importance of continuity was considered. Some distinctive examples of questionable continuity were found during the observations. Firstly, some parts of the cycle path along Van Reede road are debatable. The path on the south side of the road is a one metre wide path with pavers, this can be seen in figure 15.

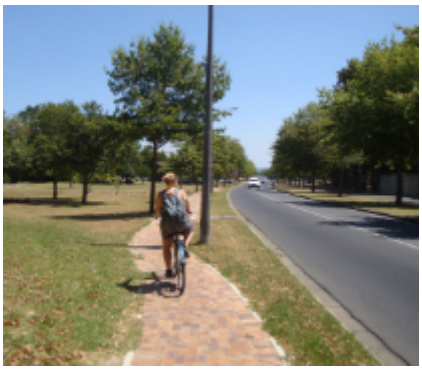

Figure 15 - The cycle path on the south side of Van Reede road
Source: Elina Hederberg and Helena Homle

Later on the cyclists are lead down onto a small cul-de-sac road without any warning signs or further directions on where to go. Further ahead it becomes even more unclear where to go, since the paved road ends and cyclists were seen proceeding across the big gravelyard shown in figure 16.

Figure 16 - To the left: When cyclists on the path along Van Reede road are lead down on a cul-de-sac. To the right: The gravelyard along Van Reede road
Source: Elina Hederberg and Helena Homle

Secondly, there is a cycle path on Marais road where it also is unclear for cyclists how to proceed. In the beginning of the path cyclists are lead up on the pavement as shown in figure 17. The pathway crosses several connecting streets and exits, at these places the curb is ramped which can also be seen in figure 17.

Figure 17 - To the left: The beginning of the path along Marais road. To the right: An example where the curb is ramped along the pathway on Marais road
Source: Elina Hederberg and Helena Homle

Further down the road there is an intersection where suddenly the ramp is not curbed, this can in a cyclist's point of view be confusing since all previous curbs have been ramped and this may indicate that the path ends here. To continue cycling along Marais road the cyclists, as seen in figure 18, seem forced to proceed in the roadway among the cars. However, there is a new sign indicating that the pathway is reserved for cyclists south of Victoria road after all.

Figure 18 - To the left: The intersection between Marais road and Victoria street where the curb is not ramped and cyclists are forced to continue along the road. To the right: A sign indicating that the unramped pavement is a shared cycle path. Source: Elina Hederberg and Helena Homle

A third example of a confusing situation is where the cycle path along Suidwal road ends at Coetzenburg sport centre. The path ends abruptly in a t-junction and the pavers indicate that the cyclist is supposed to continue straight into a fence, which is seen in figure 19. The bollard and the fact that the curb is ramped are the only things indicating that users are supposed to proceed through the intersection.

Figure 19 - The abrupt end of the cycle path at the intersection between Coetzenburg road and Suidwal road. Source: Elina Hederberg and Helena Homle

4.1.2.1 Analysis

According to TfL (2014), Lindelöw (2009), Trafikverket (2014) and SKL (2009) coherence is regarded one of the most important factors to consider when forming an attractive cycle network. As can be seen in figure 14 the existing cycle infrastructure is far from coherent. This is a disadvantage since planning of cycle facilities should, according to Heydon & Lucas-Smith (2014) ensure that facilities are well integrated and unregulated sprawl is avoided. This generates difficulties for cyclists because it affects the level of service, i.e. the simplicity for a cyclist to move from one point to another. In general, the bicycle infrastructure in Stellenbosch could therefore be improved, as currently there are only a few existing cycling paths which are connected.

It is also suggested that discontinuous cycle paths are less popular among cyclists than the ones that are continuous (TfL 2014, Heydon & Lucas-Smith 2014 and Buehler & Dill 2015). This means that the second example from Marais road in Stellenbosch is a typical example of when the level of service for cyclists is reduced due to defects in the infrastructure. Since it is also said that cycle paths should be of consistent standard (SKL, 2010) the level of service along the cycle path at Van Reede road is problematic as well. The fact that cyclists on their way to the sport centre are not able to follow a continuous cycle path all the way to this destination is another example of discontinuous routes in Stellenbosch. TfL (2014) says that cycling facilities must be planned in a way that does not delay or force cyclists to make detours, therefore the current facilities in Stellenbosch is not always well-planned in terms of level of service for cyclists.

4.1.3 Recurring stop signs

Stop signs is a common way to regulate traffic junctions in Stellenbosch, almost every junction in the urban area is controlled with all-way stop (see figure 20). This means that traffic approaching an intersection from all directions is required to stop before continuing through the junction.

Figure 20 - A typical all-way stop that often appears in Stellenbosch
Source: SKL (2009)

As mentioned, Stellenbosch has a high density of all-way stops regardless if it is an intersection between smaller streets in residential areas or intersections with bigger roads. Moreover, the all-way stops often seem to generate congestions during rush hour.

4.1.3.1 Analysis

To regulate intersections with all-way stop is relatively safe since it reduces the speed in the intersection (SKL, 2009). Although, in a cyclist's point of view it is considered to be inefficient to stop at every stop sign. Therefore it is common that cyclists tend to ignore the rules and proceed through the intersections without stopping. Another problem that seem to exist in Stellenbosch is that cars at various times ignore the stop signs as well. The fact that both cyclists and motor vehicles neglect the rules of the stop signs does not only affect the level of service but it also creates a hazard for all road users in the intersection.

The fact that the many all-way stops seems to worsen the congestions at some roads in Stellenbosch also affects the cyclists. Heavy congestions makes it even harder for cyclists to get around in the narrow streets. Consequently, recurring stop signs decreases the level

of service for cyclists both by forcing them to stop at all intersections and by leading to worse congestions. One option the might increase the level of service for cyclists is according to Buehler and Dill (2015) to allow cyclists to proceed through minor intersections without stopping. Although there is no research evaluating the effects of this option.

4.1.4 Priority for cyclists in intersections

Prioritised cycle facilities and devices are rare in Stellenbosch. Although at the biggest roundabout in the city, between Merriman Avenue, Cluver road and Marais road big priority has been given to cyclists. The cycle path is separated from the motorised traffic through the entire intersection, besides from the zebra crossings where the cyclists are forced to interact with motorists. Except from the roundabout there are no other priority facilities, such things as bike boxes or bike traffic signals that automatically activates when cyclists approach the intersection. A difficulty for vulnerable road users at most intersections, controlled by traffic lights, is that the green time for them is a lot shorter than for motorists. Not even an average person will in most cases make it cross the road before the traffic lights turn red again.

An example where cyclists are not prioritised is along Cluver road where the road and the lined cycle path approach the intersection with Banghoek road. The pathway ends abruptly just before the intersection on Banghoek road, see figure 21. The path ends where the roadway divides into several lanes and therefore cyclists are forced to either cross the left lane or mix with the motorised vehicles turning left. Since this is a busy intersection cyclists easily gets unnoticed.

Figure 21 - The cycle path along Cluver road when approaching the intersection with Banghoek road
Source: Elina Hederberg and Helena Homle

4.1.4.1 Analysis

According to SKL (2009) efficient planning and designing of intersections is essential to ensure an acceptable level of level of service for all road users. If cyclists and pedestrians are not prioritised in any way it can be very difficult for them to claim their space in the interaction with motorists, which may decrease the level of service a lot since it creates delays along their route. One example on how to make the crossing a bit easier for vulnerable road users is to construct refuge islands that are wide enough for cyclists and pedestrians to be able to wait for another green light (Ribbens, 2006). According to Buehler and Dill (2015) there are studies indicating that cyclists appreciate devices such as bike boxes, bike traffic signals and bicycle signal activation at intersections. All these are

typical examples of how to prioritize cyclists. However, more research is considered to be needed in this field.

4.1.5 The width of the roads

Lack of space for cyclists is a general issue on most of the streets in Stellenbosch. In most cases the idea for cyclists is to be mixed with other vehicles and therefore cyclists easily gets pushed aside since motorists tend to take up their space. In busy and narrow streets lack of space becomes a big problem, mostly because of the width of the roadway but sometimes due to the speed of the motor vehicles. When cyclists are not given enough space the speed among the vehicles passing by has a significant influence on the feeling of insecurity. To get an idea of how comprehensive this problem is the narrow streets are marked in figure 22.

Figure 22 - A map of Stellenbosch in which streets with lack of space are marked
Source: Stellenbosch (2016) edited by Elina Hederberg and Helena Homle

As shown in the figure 22 this is a problem in many parts of Stellenbosch. Except for some residential areas lack of space is common in the majority of the streets.

One narrow road in Stellenbosch is the most turbulent part of Bosman road, between the intersection with Banghoek road and the intersection with Merriman Avenue. The cross section of this street is shown in figure 23 and the street is also shown in figure 24. Cyclists and cars in both directions are supposed to share a roadway of only 5,5 metres, even if it is lined with shallow drainage ditches and pedestrians often uses the roadway because of the narrow pavement.

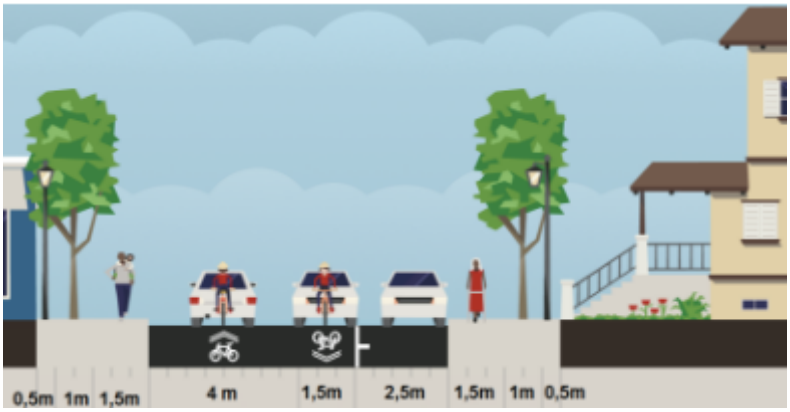

Figure 23 - The cross section of Bosman road, between Banghoek road and Merriman Avenue. Source: Streetmix (2016) edited by Elina Hederberg and Helena Homle

Figure 24 - Bosman road between Banghoek road and Merriman Avenue, with congestion in the right lane. Source: Elina Hederberg and Helena Homle

Another example of a street in Stellenbosch where the lack of space for cyclists is significant is along Merriman Avenue, west of Bosman road where cyclists are supposed to mix with motor vehicles. Merriman Avenue is one of the most important roads in Stellenbosch for both cyclists and motorists and it is therefore very busy it is not unusual to see heavy traffic on this road. In figure 25 it is shown that cyclists cannot travel alongside motor vehicles due to lack of space in the roadway. Additionally, motorists tend to travel at relatively high speed, which as mentioned above also affects the feeling of security while cycling.

Figure 25 - Lack of space for cyclists on Merriman Avenue
Source: Elina Hederberg and Helena Homle

Dorp Street is also a great example of a typical street in Stellenbosch, a narrow street lined with drainage channels that often is busy with traffic. As shown in figure 26 there is not much space left for cyclists between the cars and the relatively deep drainage channels.

Figure 26 - Lack of space for cyclists on Dorp street
Source: Elina Hederberg and Helena Homle

4.1.5.1 Analysis

According to SKL (2010) and TfL (2014) it is possible for cyclists to compete with motorists for space in the roadway if traffic volume and vehicle speed is low and the street design is well planned. This imply cyclists are not prioritised in many of the streets in Stellenbosch since they are mixed with motor traffic relatively narrow streets even though the speed limit is 60 km/h and traffic volumes are high. The level of service for cyclists in Stellenbosch is in other words fairly poor due to lack of space where cyclists are forced to mix with motorists.

4.1.6 Congestions

In section 3.2.3 it is discussed that Stellenbosch is more and more troubled with traffic congestions. According to Stellenbosch Municipality (2016) Dorp street, Merriman avenue and Piet Retief street are some of the most congested roads. In figure 27 the situation on Dorp street and Piet Retief street during rush hour is shown.

Figure 27 - Cycling along Dorp street, to the left, and Piet Retief street, to the right, during rush hour
Source: Elina Hederberg and Helena Homle

However, there are also delays at some places during other times of the day. It is noticed that the queue length on Merriman Avenue, in the intersection with Bosman road, is often more than five cars even when the traffic volume is considered low. An example of this is shown in figure 28.

Figure 28 - Merriman Avenue, the queue length is seven vehicles in this moment
Source: Elina Hederberg and Helena Homle

4.1.6.1 Analysis

Cyclists want to travel along the quickest and most direct route between their origin and destination to avoid detours and delays (TfL, 2014). According to Trafikverket (2013) the queue length is often used to determine whether the level of service is good or not. Heavy congestions in Stellenbosch cause long queue lengths that affect the level of service in the traffic network. Naturally, congestions do not only result in delays for motorists but for cyclists as well due to the lack of space in the streets that is described in section 4.1.6. Although, when streets are wide enough it is possible for cyclists to pass by cars in the queue and the level of service is therefore better for cyclists than cars in that case. However, cyclists still have to be aware of unforeseen and dangerous interactions due to stressed motorists that are trying to find the fastest way through traffic.

4.1.7 Parked cars

In Stellenbosch cars parked at inconvenient places is a common sight. In all pictures in figure 29 cars are parked blocking the entire cycle facility. Pay attention to the parked car in the figure to the right, where the vehicle chose to park in the painted cycle lane instead of in the parking lot right next to the lane.

Figure 29 - To the left: Parked cars along the pathway on Marais road. In the middle and to the right: Car blocking the cycle path along Merriman avenue
Source: Elina Hederberg and Helena Homle

Besides forcing cyclists to make detours parked cars may also narrow the roadway, decreasing the possible space for cyclists to use. This is shown in figure 30.

Figure 30 - Cycling north along Bird street from the roundabout with Alexander road
Source: Elina Hederberg and Helena Homle

Another example of inconvenient parking in Stellenbosch is found in the intersection between Bosman road and Soeteweide road where a permanent parking lot is located in the middle of the intersection, see figure 31.

Figure 31 - The permanent parking lot in the intersection with Bosman and Soeteweide road. The painting to the right is not to scale. Source: Elina Hederberg and Helena Homle

4.1.7.1 Analysis

Lack of space due to parked cars is an issue for cyclists since it creates a complicated traffic situation with poor visibility and narrowed streets. According to Heydon & Lucas-Smith (2014) and Buehler & Dill (2015) cyclists that are mixed with motorised vehicles prefer roadways without parked cars in the way. The traffic situation is difficult to grasp when attention must be given to parked cars and possible interactions with people who enter or exit their cars. As can be seen in some of the pictures cars are often parked on existing cycle paths even if there are signs that clearly indicate that parking is prohibited. One reason why motorists often obey this parking signs is according to Wentzel (2016) that the system for collecting fines is inadequate. Most people are aware of this, which leads to the situation shown in the examples above.

The parking lot in the middle of the intersection is an interesting example of questionable traffic planning. In intersections it is important that both cars and cyclists gets extra space and good visibility while turning or looking out for other turning vehicles. Therefore it is important to avoid placing objects in or near intersections (Heydon & Lucas-Smith, 2014). Having a parking lot in the middle of the t-junction does not only affect the level of service in a bad way but it also draws attention to the parked car instead of the surroundings.

4.2 Accessability

4.2.1 Distance

The figure 32 below shows how far from the mall in Stellenbosch city centre one can get in 2 and 5 km respectively.

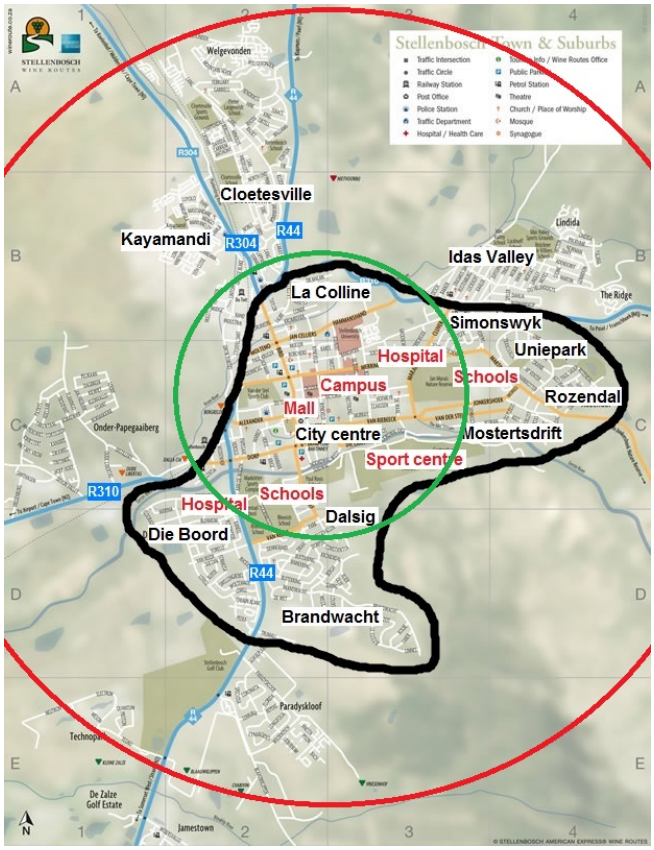

Figure 32 - A map of Stellenbosch where the green circle illustrates a distance of 2 km from the mall and the red circle illustrates a distance of 5 km from the mall.
Source: Stellenbosch (2016) edited by Elina Hederberg and Helena Homle

4.2.1.1 Analysis

The accessibility in a city is affected by the distance between key destinations (SKL, 2015). As can be seen in figure 32 almost all key destinations are located within 2 km from the mall in the city centre. In 5 km it is possible to reach all residential areas and also some of the suburbs. In other words almost all possible key destinations are within short distances in Stellenbosch and it is therefore suitable for cycling, according to SKL (2010).

4.2.2 Guiding signs along routes

Guiding signs showing cyclists the way to different key destinations are not found in Stellenbosch. Although, at some locations there are signs, like the one in figure 33, which are posted by the university to guide students, employees and visitors around the campus.

Cyclists may use these as well but since they are not placed consistently along the entire route it is not always possible to use them as guidance all the way. Moreover, some of the signs are in Afrikaans.

Figure 33 - A sign showing the way to key destinations found at the campus
Source: Elina Hederberg and Helena Homle

4.2.2.1 Analysis

People should easily find routes to their destinations, therefore route signing and guiding is important. SKL (2015) states that guidance along a route is of great importance for the quality in the transport network. Even if the cycling facilities are well designed it is essential that these are supplemented by amenities such as guidance and information signs in order to improve the accessibility for cyclist (Ribbens, 2006). The university signs in Stellenbosch can be used as guidance in some cases. However, the fact that the information sometimes is in Afrikaans means that the information is not accessible for everyone, since Afrikaans is not the only official language in South Africa.

4.2.3 Surface quality

The streets in Stellenbosch are generally paved, small-scale streets with one lane in each direction. The surface quality is acceptable in the majority of the streets but irregularities occur. There are often irregularities like cracking and rutting due to distress in the asphalt but greater obstacles are also common, an example is shown in figure 34.

Figure 34 - Major irregularities on the pavement along Bosman road, to the left, and on the cycle path along Suidwal road, in the middle. To the right: Irregularities on the Bird street cycle path.
Source: Elina Hederberg and Helena Homle

The surface material is paver on many of the existing cycle paths in Stellenbosch. It is common that the pavers are broken and disordered, as shown in figure 35.

Figure 35 - Disordered pavers on the cycle path along Suidwal road Soure: Elina Hederberg och Helena Homle

On the cycle path on Jonkershoek road the sign indicates that cyclists and pedestrians are supposed to have separated lanes on the pathway even though it is narrow. The sign seen in figure 36 indicates that the path is supposed to be divided with pedestrians walking closest to the roadway on the paved lane while cyclists seems to be forced to continue on the gravel.

Figure 36 - The pathway along Jonkershoek road where cyclists are shown to ride in the gravelyard Source: Elina Hederberg and Helena Homle

An interesting example of bad surface quality is the one shown in figure 37. On the pathway for pedestrians and cyclists along Suidwal road there is a sudden change in surface material due to a wooden deck by the river.

Figure 37 - The wooden deck found along Suidwal road
Source: Elina Hederberg and Helena Homle

4.2.3.1 Analysis

According to SKL (2015) irregularities due to the surface quality highly affects the accessibility for cyclists. As shown in all examples above the surface quality is poor which has a negative effect to the accessibility. The design of the pathway in figure 36 where the cyclists are separated from pedestrians on the pavement and are supposed to ride in the gravel on the left side is questionable. Although, changing the side of the cycle and pedestrian lane would not solve the problem since it in terms of accessibility is not desirable among pedestrians either. The planning of the example from the cycle path along Suidwal road is also questionable. The wooden deck becomes a quite big obstacle, which may be hard to detect for cyclists approaching at relatively high speed. To avoid cyclists from slipping or falling it is important to keep the surface of cycle facilities at level and well maintained (TfL 2014, Heydon & Lucas-Smith 2014).

4.2.4 Obstacles

The existing cycle paths in Stellenbosch are often blocked. A large number of examples of mobile obstacles like trashcans, garbage, cars or people and permanent obstacles such as trees, fences, lampposts or street signs are shown below. In addition to these obstacles the curbs are rarely ramped which makes it difficult for pedestrians and cyclists at intersections, see figure 38. Pay attention to the signpost in the left picture, it is placed so that cyclists must ride under it even though it is quite low.

Figure 38 - Some examples of curbs at intersections along Bird street
Source: Elina Hederberg and Helena Homle

The cycle path, which leads cyclists through the local taxi and bus station on Bird Street, is a very busy and crowded area, which makes it difficult for cyclists to pass. The cycle path is supposed to be a shared facility for pedestrians and cyclists but it is mostly used by pedestrians. Except for the crowd there are plenty of trees, bollards, garbage bins and other boxes blocking the way for cyclists (see figure 39).

Figure 39 - The crowded area around Stellenbosch/Kayamandi taxi/bus station
Source: Elina Hederberg and Helena Homle

The cycle path on the opposite side of Bird street, seen from the local taxi and bus station, is even more difficult to pass since it is narrow, crowded and blocked by signs and shop entrances, as shown in figure 40.

Figure 40 - The southbound pathway along Bird street, south of Merriman avenue
Source: Elina Hederberg and Helena Homle

Obstacles on the cycle path along Bird street are common not only around the station area but all along the pathway. Besides being a crowded and busy path there are also mobile obstacles such as garbage bins, advertising signs and parked cars, as shown in figure 41. Even though Bird street is a very busy street with a relatively high car speed, lined with deep drainage channels, it is observed that people chose to cycle in the street due to all above mentioned obstacles on the pathway.

Figure 41 - Some of the mobile obstacles on the cycle path along Bird street
Source: Elina Hederberg and Helena Homle

There are also many permanent obstacles along the path. The most distinctive obstacles are found where the path crosses connecting streets. At these points there are always bollards blocking the pathway to prevent cars from entering, as shown in figure 42. The bollards are often placed in a way that makes it difficult even for cyclists to pass by. Except from the bollards it is also common that electrical cabinets are standing in the way.

Figure 42 - Bollards and electrical cabinets blocking the pathway at intersections along Bird street
Source: Elina Hederberg and Helena Homle

Obstacles are not only found on Bird Street but in several places in Stellenbosch. It is common along many cycle paths that trees or lamp poles are placed in the middle of the pathway forcing the cyclists to yield. Examples of this are shown in figure 43.

Figure 43 - Obstacles on the cycle path on Suidwal road, Marais road and Jannasch road respectively.
Source: Elina Hederberg and Helena Homle

Some obstacles on cycle paths in Stellenbosch seems to occur due to poor maintenance, one example of this is the common problem with branches blocking the way as can be seen in figure 44.

Figure 44 - Branches blocking the way on the cycle path along Marais road to the left and the cycle path along Van Reede road to the right. Source: Elina Hederberg and Helena Homle

It is not rare that it is difficult for motorists to detect vulnerable road users due to bad visibility. One example of this is when the cycle path along Suidwal road crosses Die Laan, this is shown in figure 45. Since the crossing is very close to the bridge it can be difficult for motorists to detect cyclists that are about to cross. Additionally, there are no signs or markings on the pavement warning for cyclists and there is a large tree blocking the entire path, which makes the situation even worse.

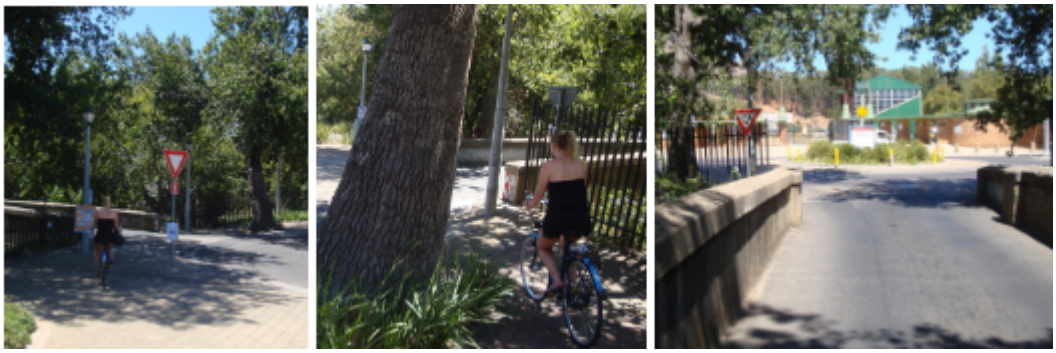

Figure 45 - The bridge seen from different angles
Source: Elina Hederberg and Helena Homle

Another example of when it may be difficult for motorists to detect vulnerable road users is found in the intersection between Merriman Avenue and Bosman road. As can be seen in figure 46 the stop sign is placed in a bad way since the pedestrian behind the sign clearly is difficult to detect.

Figure 46 - Poor visibility at the intersection, where vulnerable road users are easily hidden behind the sign. Source: Elina Hederberg and Helena Homle

4.2.4.1 Analysis

Obstacles are, as can be seen in the numerous examples above, a common problem for cyclists in Stellenbosch. Street furniture and other amenities is essential to create an attractive environment for pedestrians and cyclists, although it is important to thoroughly plan where to locate it (Trafikverket 2014, SKL 2010). This is important to consider in order to not interfering with the normal flow of cyclists and pedestrians since that would heavily decrease the accessibility for cyclists and pedestrians.

4.2.5 Cycle parking

It is not always easy to find cycle parking in Stellenbosch even if bike stands are found in some places. It is shown in figure 47 that the parking facilities have different standards and that the location is more or less well planned. Quite many bike stands can be found on campus but otherwise it is not certain that any can be found close to key destinations since they are often placed at odd locations.

Figure 47 - Examples of cycle parking in Stellenbosch. To the left: Church street. To the right: Plein street. Source: Elina Hederberg and Helena Homle

4.2.5.1 Analysis

Considering how many people that actually do cycle in Stellenbosch it is debatable how few cycle stands there are in the city. Obviously, it is not attractive to travel to a destination where it is not possible to safely park the bicycle. The present situation is not sustainable since the accessibility according to SKL (2015) depends on the possibility to

park the bicycle in an efficient and safe way. In order to increase cycling in Stellenbosch it is essential to create more and better parking opportunities, due to the safety situation in South Africa it is also of great importance to focus on planning secure parking to prevent thefts. According to Svensson (2008) some studies show that secure parking is considered to be very important in order to increase cycling since many people choose not to cycle due to the risk of theft.

4.3 Safety

4.3.1 Speed

4.3.1.1 Overall

As mentioned in section 3.2 the speed limit on most streets in the urban area in Stellenbosch is 60 km/h, regardless the width of the street and the surroundings. There are a few streets where the speed limit is lower, one interesting example of this is shown in figure 48. This part of Jonkershoek road is considered a walking pace area with a speed limit of 35 km/h according to signposts found along the road.

Figure 48 - Sign posts indicating speed limits on Jonkershoek road
Source: Elina Hederberg and Helena Homle

To get an idea of whether motorists tend to respect the speed limits in Stellenbosch or not measurements have been made in four characteristic locations, the places are further described and the results is shown below.

4.3.1.2 Brief introduction of chosen locations for vehicle speed measurements

Dorp Street

Dorp Street is an important street in Stellenbosch, besides being a national monument it is also one of the major roads that lead traffic from Stellenbosch city centre further out to the highways and rural routes. The location of the street is shown in figure 49. Since it is such an important link in the traffic system it is busy all through the day but mostly during rush hour when there are heavy congestions (Stellenbosch municipality, 2016).

Figure 49 - A map showing the location of Dorp street and the location for where the speed measurements were done. Source: Stellenbosch (2016) edited by Elina Hederberg and Helena Homle

As shown in figure 50 and 51 the roadway is only six metres in total and supposed to be shared by cars and cyclists in both directions. The street appears to be even narrower than it actually is since it is lined with deep drainage channels. This is what makes it interesting to measure vehicle speed in this road since drainage channels are common along many streets throughout Stellenbosch.

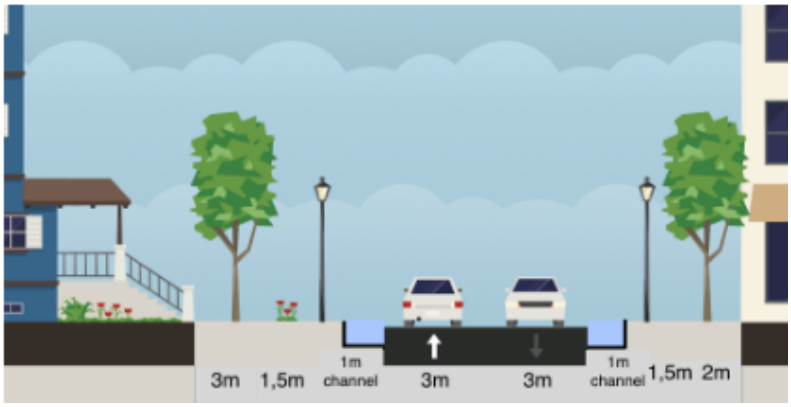

Figure 50 - The cross section of Dorp street
Source: Streetmix (2016) edited by Elina Hederberg and Helena Homle

Figure 51 - Dorp street
Source: Elina Hederberg and Helena Homle

Intersection Bosman road/Merriman avenue

The intersection between Bosman road and Merriman Avenue is one of the busiest intersections in Stellenbosch. As can be seen in figure 52 it is a relatively big intersection with one lane in each direction on Bosman road and with one lane on Merriman avenue approaching from the east respectively two lanes approaching from the west.

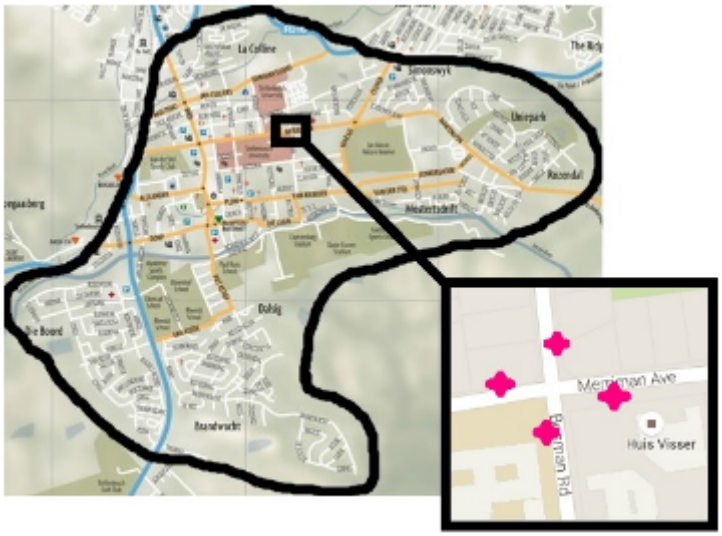

Figure 52 - A map showing the location of the intersection between Bosman road and Merriman Avenue and the location for where the speed measurements were done
Source: Stellenbosch (2016) and Google Maps (2016) edited by Elina Hederberg and Helena Homle

The intersection is also one of the heaviest congested ones in Stellenbosch during rush hour. It is regulated with all-way stop and cyclists that are crossing are forced to cross the relatively wide intersection while claiming their space among the motorists. In addition to this there are no signs or markings in the road that indicates cyclists may pass through. It is interesting to measure the vehicle speed at this location since it is part of the route from the student accommodations to many key destinations in Stellenbosch, in other words lots of cyclists pass through here daily. The intersection is shown in figure 53.

Figure 53 - The intersection shown from different angles Source: Elina Hederberg and Helena Homle

Roundabout Merriman avenue/Cluver road

The roundabout with Merriman Avenue, Cluver road and Marais road is the biggest roundabout in Stellenbosch. This traffic solution is of interest since the roundabout was recently reconstructed and big priority was given to cyclists. As can be seen in figure 54

the cycle path is separated from the motor traffic through the intersection, except from the zebra crossings where the cyclists are forced to interact with motorists.

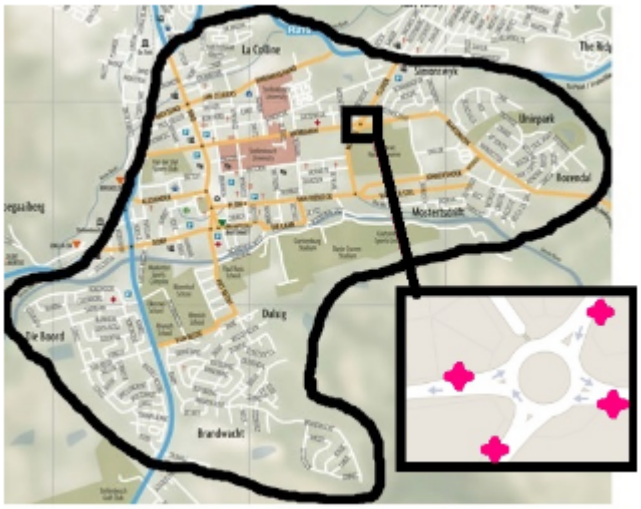

Figure 54 - A map showing the location of the roundabout with Merriman Avenue and Cluver road and the location for where the speed measurements were done
Source: Stellenbosch (2016) and Google Maps (2016) edited by Elina Hederberg and Helena Homle

The cycle path is clearly marked with green paint, as can be seen in figure 55. According to Professor Sinclair (2016) a Smart car have been seen using the cycle path during rush hour since it is very wide. It is interesting to measure vehicle speed at this location because of the existing cycle infrastructure and the fact that cyclists are still interacting with approaching cars.

Figure 55 - The roundabout between Merriman avenue/Cluver road seen from two different angles
Source: Elina Hederberg and Helena Homle

Roundabout Plein Street/Ryneveld Street

The roundabout between Plein Street and Ryneveld Street is a smaller roundabout without any special facilities for cyclists, i.e. cyclists are integrated with motorised vehicles. Since there are a few roundabouts like this in Stellenbosch, which are used by many cyclists, this is a characteristic location that cyclists are exposed to every day. The design of this roundabout, with the various numbers of lanes approaching and exiting, is shown in figure 56.

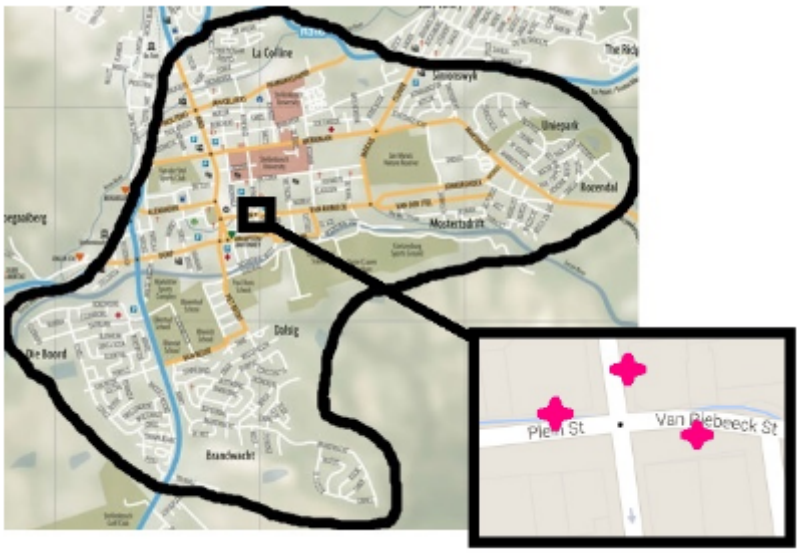

Figure 56 - A map showing the location of the roundabout with Plein street and Ryneveld street and the location for where the speed measurements were done
Source: Stellenbosch (2016) and Google maps (2016) edited by Elina Hederberg and Helena Homle

The circle in this roundabout is quite small and cars are therefore often seen driving straight through or over this. Examples of this traffic solution are shown in figure 57. It is interesting to measure the vehicle speed in this roundabout since a few smaller roundabouts are found in Stellenbosch in which cyclists are integrated with motorised traffic.

Figure 57 - The roundabout between Plein Street and Ryneveld Street seen from different angles. The picture at the bottom right shows the situation when a car drives straight through the circle
Source: Elina Hederberg and Helena Homle

4.3.1.3 Results from speed measurements

Dorp Street

The result of the speed measurements on Dorp Street is described with a cumulative speed distribution, as shown in diagram 2.

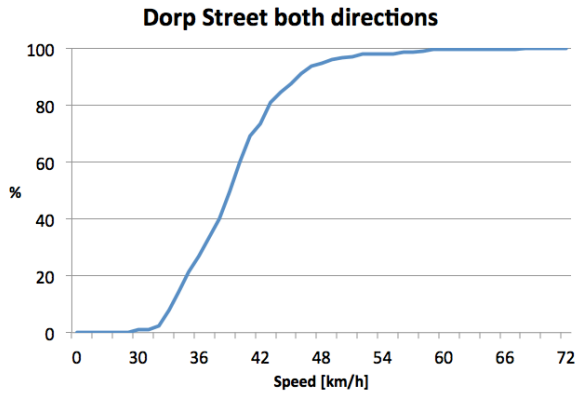

Diagram 2 - Results from vehicle speed measurements on Dorp street

The average speed is 40 km/h in both directions and the 85-percentile is 45 km/h.

Intersection Merriman avenue/Bosman road

The result of the speed measurements in the intersection between Merriman Avenue and Bosman road is described with a cumulative speed distribution, as shown in diagram 3.

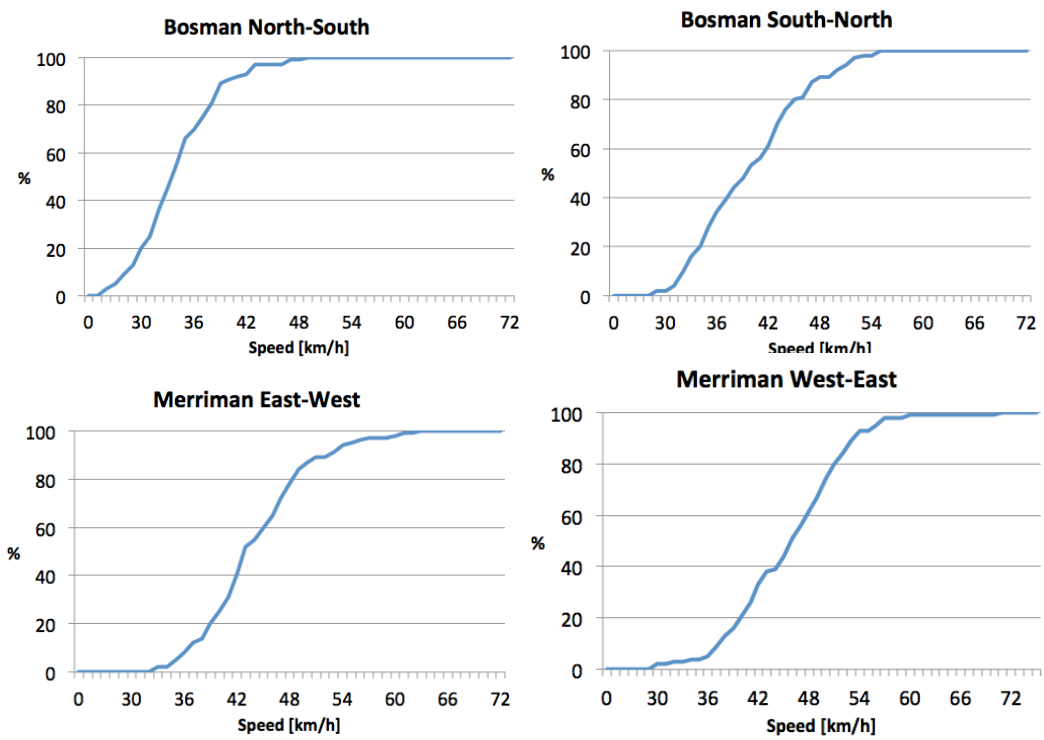

Diagram 3 - Results from vehicle speed measurements in the intersection between Merriman Avenue and Bosman road

The average speed on Bosman road 34 km/h and 40 km/h in north-south direction and south-north direction, respectively. The average speed on Merriman Avenue is 44 km/h and 46 km/h in east-west direction and west-east direction, respectively. The 85-percentile on Bosman is 39 km/h and 47 km/h in north-south direction and south-north direction, respectively. The 85-percentile on Merriman Avenue is 50 km/h and 53 km/h in east-west direction and west-east direction, respectively.

Roundabout Merriman avenue/Cluver road

The result of the speed measurements in the roundabout between Merriman Avenue and Cluver road is described with a cumulative speed distribution, as shown in diagram 4.

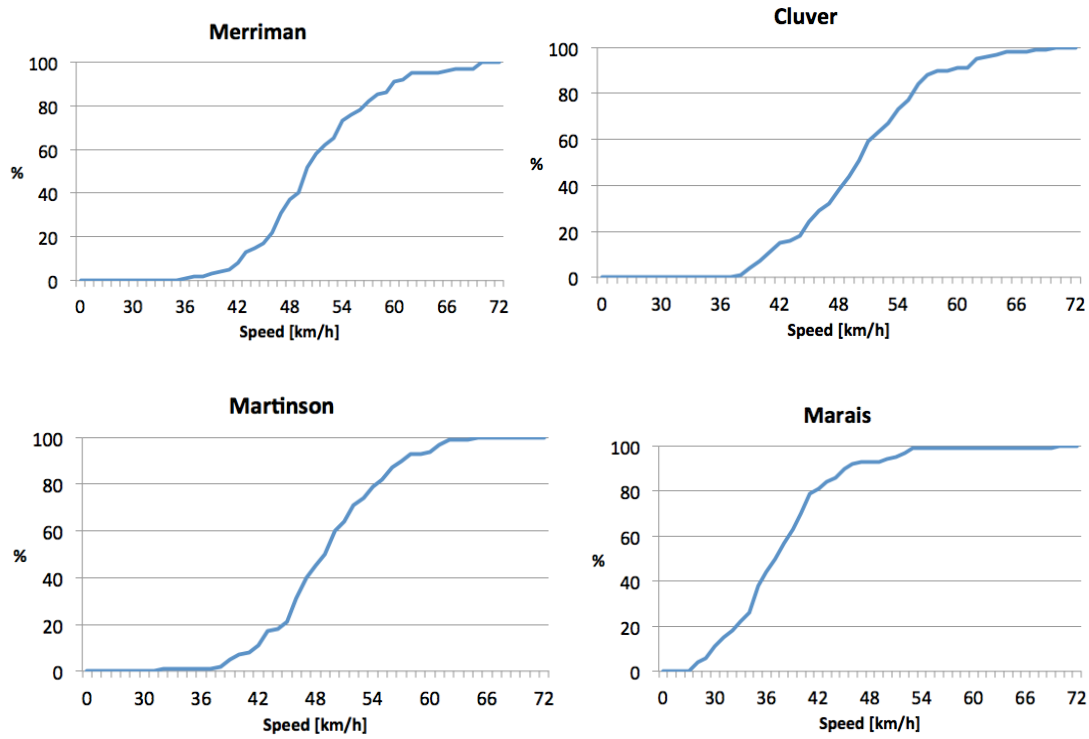

Diagram 4 - Results from vehicle speed measurements in the roundabout between Merriman Avenue and Cluver road

The average speed is 52 km/h on Merriman Avenue, 51 km/h on Cluver road, 50 km/h on Martinson road and 38 km/h on Marais road. The 85-percentile is 58 km/h on Merriman Avenue, 57 km/h on Cluver road, 56 km/h on Martinson road and 44 km/h on Marais road.

Roundabout Plein Street/Ryneveld Street

The result of the speed measurements in the roundabout between Plein street and Ryneveld street is described with a cumulative speed distribution, as shown in diagram 5.

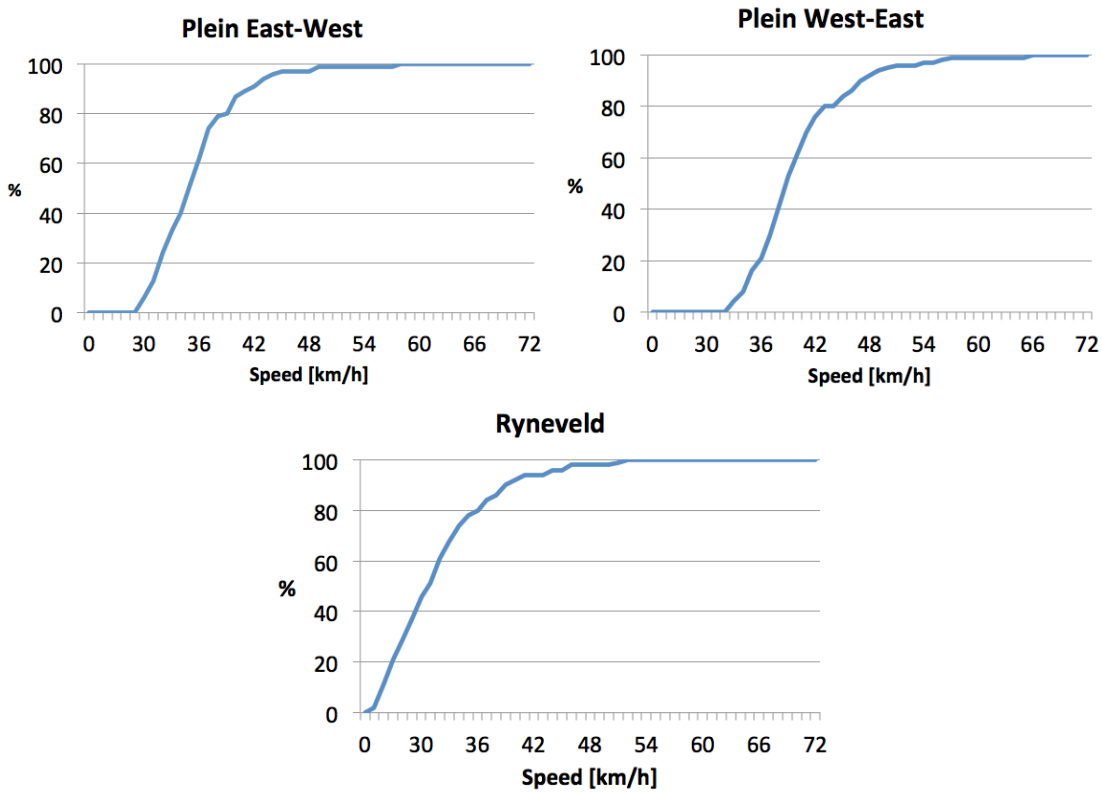

Diagram 5 - Results from vehicle speed measurements in the roundabout between Plein Street and Ryneveld Street

The average speed is 36 km/h on Plein Street in east-west direction, 40 km/h on Plein street in west-east direction and 32 km/h on Ryneveld street. The 85-percentile is 40 km/h on Plein street in east-west direction, 46 km/h on Plein street in west-east direction and 38 km/h on Ryneveld street.

The assembled results for all four locations

To get a clearer picture of the result from all measured locations the information of the average speed and 85-percentile is gathered into one table. This is shown below, in table 6.

Table 6 - The average speeds and 85-percentiles from all four locations

	Average speed [km/h]	85-Percentile [km/h]
Dorp street		
Both directions	40	45
Intersection Bosman-Merriman		
Bosman North-South	34	39
Bosman South-North	40	47
Merriman East-West	44	50
Merriman West-East	46	53
Roundabout Merriman-Cluver		
Merriman	52	58
Cluver	51	57
Martinson	50	56
Marais	38	44
Roundabout Plein-Ryneveld		
Plein East-West	36	40
Plein West-East	40	46
Ryneveld	32	38

4.3.1.4 Analysis

As mentioned in section 3.1.3.1 the road traffic safety is directly dependent on speed among motorised vehicles (Hydén 2008 & SKL 2015). In table 6 it is shown that the 85-percentile never exceeds the speed limit of 60 km/h, however the measured speeds are still relatively high in terms of traffic safety. According to Hydén (2008) the severity of accidents increases heavily when motorised vehicles travel above 30 km/h and in this case both the average speed and the 85-percentile are all above 30 km/h. The fact that the speed limit is 60 km/h and all measured speeds are high is even more questionable considering the circumstances in Stellenbosch with many narrow streets and lots of vulnerable road users.

The roundabout with Merriman avenue and Cluver road is according to the measurements the traffic facility with highest speeds, regarding both average speed and 85-percentile. This is expected since these roads are wider and more heavily travelled than the others. The higher speed at this roundabout is a disadvantage for cyclists and pedestrians although it is an advantage that the vulnerable road users are mostly separated from the motorised vehicles in this location (Heydon & Lucas-Smith, 2014)

As mentioned above having a speed limit of 60 km/h in the urban area in Stellenbosch is highly questionable due to safety issues. According to Heydon & Lucas-Smith (2014), SKL (2010) and TfL (2014) the overall traffic safety can be improved by implementing traffic calming in smaller roads and suitable separated cycling facilities along heavily travelled roads. The measurements of vehicle speed that are made in Stellenbosch indicate

that traffic calming amenities is needed to improve the overall safety for vulnerable road users.

Moreover, It is also interesting to highlight the example from Jonkershoek road where a home zone with the speed limit 35 km/h can be found. According to SKL (2010) it can be a good solution to integrate cyclists with motorised traffic, although this requires low speeds and flows of motorised vehicles. The speed limit is 35 km/h, which is considered to be a bit too high since the speed limit in a home zone should not be above 7 km/h due to safety issues (Buehler and Pucher, 2008).

4.3.2 Accident data

The accident data received from Stellenbosch traffic department states that during a period of six years, between 2010-2016, 172 accidents that involved cyclists occurred. The accident data describes collisions between all kinds of road users, everything from accidents involving only one cyclist to accidents between a cyclist and a heavy vehicle. 17 of these accidents lead to serious injuries and two of the accidents were fatal. Worth mentioning is that the two collisions with a fatal outcome occurred on the bigger roads outside the city centre. The accident data is based on police reports.

4.3.2.1 Analysis

It is considered interesting to look into accident data in order to evaluate the safety in the current traffic situation. However, it is important to remember that a low accident number among cyclists does not necessarily mean that cyclists feel safe while travelling on the roads (Bester & Pretorius, 2004). Besides, it is most likely that the estimated number of unknown accidents is high and that the accident data therefore is incomplete. One reason for this is that the system of collecting accident data is inadequate since many accidents are not reported and also because there is no standardisation in how to report accidents. This means that the information in many cases is inaccurate (Várhelyi et al. 2010). Whether the accidents are reported or not depends on various factors such as the type and severity of the accident, the location of the crash site and which vehicles it involves. In conclusion, it seems difficult to rely on accident data when trying to describe the current safety situation due to the many uncertainties.

According to Macozoma & Ribbens (2004) it is important to remember that the reason why many accidents do occur is due to several factors. The undisciplined behaviour of both motorised and non-motorised road users is one important factor, inefficient traffic law enforcement and inadequate design of road traffic facilities is another. It is therefore desirable to try to prevent accidents through different means.

4.3.3 Drainage channels

The historical drainage channels that are mentioned in section 3.2 are common along the streets of Stellenbosch. Some examples of the design of drainage channels are shown in figure 58. The unique design of these explains parts of the city's history and is therefore an important part of the urban design. The design of the channels is angular and the depth as well as the width is usually a few decimeter.

Figure 58 - The typical design of the historical drainage channels
Source: Elina Hederberg and Helena Homle

These drainage channels occur on several streets in Stellenbosch, which is shown in figure 59. Most of the channels appear close to the river in the city center along some of the busiest streets used by both cars and cyclists.

Figure 59 - A map of Stellenbosch in which streets that are lined with drainage channels are marked
Source: Stellenbosch (2016) edited by Elina Hederberg and Helena Homle

4.3.3.1 Analysis

The historical value of the drainage channels is according to Professor Marion Sinclair (2016) prioritised by the city of Stellenbosch, which provides difficulties for cyclists and pedestrians when it comes to traffic safety. The shape and location of the drainage channels can be dangerous for vulnerable road users and cause severe accidents since it is

easy to fall or stumble into them. In a cyclist's point of view these drainage channels are problematic in terms of traffic safety since they reduce the road space and thereby the possibility for cyclists to wobble to the roadside in order to avoid motor vehicles. Even if these channels are of high historical value it is debatable whether their design could be altered in order to improve the situation for cyclists. According to TfL (2014) and Heydon & Lucas-Smith (2014) it is very important to thoroughly plan the design and location of street amenities and the drainage channels is a typical example of where this fact should be more considered.

4.3.4 Warning signs and other indications of cyclists

Generally it is not common with warning signs and other indications of cyclists in Stellenbosch, motorists are rarely alerted that they are about to interact with vulnerable road users. When paths for pedestrians and cyclists cross roadways it is common that the warning signs only show motorists to look out for pedestrians but not cyclists, as shown in figure 60.

Figure 60 - The warning sign before the cycle path along Suidwal road crosses the street Source: Elina Hederberg and Helena Homle

Although, there are some examples of locations in Stellenbosch where motorists are warned about cyclists crossing the road or cycle lanes starting. A few good examples are shown in figure 61.

Figure 61 - To the left: markings in the roadway on Barry road warning for cyclists crossing. To the right: A sign indicating that a cycle lane begins at this location in the intersection between Merriman avenue and Bosman road. Source: Elina Hederberg and Helena Homle

4.3.4.1 Analysis

According to Ribbens (2006) it is important to supplement cycle facilities with appropriate warning signs and other indications of cyclists approaching. As mentioned above there are generally no special markings or signs warning motorists for cyclists in Stellenbosch. Moreover, it is important to implement warning amenities with a consistent standard in order to create the desired safety situation.

4.3.5 Separated cycling facilities

In most streets in Stellenbosch cyclists are supposed to share the roadway with motorised traffic. However, there are also some existing cycling paths and these have various degrees of separation. In the first kind cyclists are only separated from motorised traffic with markings on the ground, i.e. the cycle lane is still integrated in the roadway. The paths are marked either with painted lines or with a different colour in the roadway. The cycle paths along Merriman Avenue and Cluver road are examples of integrated cycle paths, which are marked with green paint. These lanes are shown in figure 62.

Figure 62 - The green painted cycle lane on Merriman Avenue and in the right picture on Cluver road Source: Elina Hederberg and Helena Homle

In figure 63 the other kind of integrated cycle path is shown, this example can be found along Martinson road. Along one part of Martinson road there are a few parking lots in the street, which could have blocked the path, but since the lane is quite wide and drawn to the right of the parked cars it does not affect cyclists notably.

Figure 63 - The cycle lane along Martinson road, to the right is the part where the cycle lane avoids the parking lots. Source: Elina Hederberg and Helena Homle

Besides the cycle lanes that are integrated in the roadway there are also three different types of cycling paths that are separated from the roadway. In the first one both pedestrians

and cyclists have right of way but there is a painted line that indicates a segregated facility, which implies that the path is divided into one side for pedestrians and one side for cyclists. One example of this is found along Suidwal road, where the bollards divide the traffic users into two different sides. As shown in figure 64 there is a two-way cycle lane on the left and pedestrian lane on the right. The bollards and the different surface materials indicate the segregation. According to Professor Marion Sinclair (2016) it seems odd that the pedestrians are not given the inside section of the path since it is more common to place the cycle lane closer to the street. Another example of a cycle path that is completely separated from the roadway and also separates cyclists from pedestrians is found along Van Reede road, this path is also shown in figure 64.

Figure 64 - The separated path on Suidwal road to the left and to the right the separated path on Van Reede road. Source: Elina Hederberg and Helena Homle

The second kind is an integrated lane where pedestrians and cyclists must share the facility. One example of this is found along Bird street where the cycle path is separated from the motorised traffic but shared between pedestrians and cyclists. Some parts of the cycle path is only separated from the roadway by the curb while some parts are further away from the road and surrounded by gravel and trees. Different sections of the cycle path along Bird street are shown in figure 65, as can be seen in the pictures the path is often very busy and crowded with pedestrians which makes it difficult for cyclists to pass.

Figure 65 - The shared facility along Bird street, where vulnerable road users are separated from motorised vehicles. Source: Elina Hederberg and Helena Homle

The third type of separated cycle path is where cyclists are completely separated from all other road users, including pedestrians. The only example of this found in Stellenbosch is found on Endler road and shown in figure 66.

Figure 66 - The beginning of the cycle path along Endler road, where the sign indicates that the path is for cyclists only. Source: Elina Hederberg and Helena Homle

4.3.5.1 Analysis

In most streets in Stellenbosch cyclists have to mix with motorised vehicles where the operating speed is 60 km/h, this is not recommended due to safety reasons (SKL 2010, TfL 2014 & Heydon & Lucas-Smith, 2014). On streets with a speed of 60 km/h cyclists should be partly separated by a curb, or with a clearly marked cycle lane if there is not enough space. In other words are the green painted lanes on Merriman Avenue and Cluver road a relatively good solution in comparison to other streets in Stellenbosch. According to SKL (2010), TfL (2014) and Vanderschuren & Phayane (2015) it is acceptable to have cyclists integrated with motor vehicles as long as the speeds and traffic volumes are low so that cyclists are able to compete for their space on the road. However, it is also important to implement traffic calming solutions to make sure the circumstances are maintained in the smaller streets.

According to Buehler and Pucher (2008) one of the most successful methods to increase cycling is to build separated cycling facilities. This is also important for the traffic safety since the safety is affected by the level of interactions and exposures between vulnerable road users and motorists (Ribbens 2006). The degree of separation is not only important to improve the traffic safety but also the entire comfort on the journey (SKL, 2007). Although, it is sometime also necessary to separate cyclists from pedestrians in order to ensure the safety for pedestrians and the level of service for cyclists (Heydon & Lucas-Smith 2014, Svensson 2008).

Special facilities separating vulnerable road users from motorised traffic is important to ensure and improve road traffic safety (Macozuma and Ribbens, 2004). As mentioned above it is acknowledged to mix cyclists with motorised traffic if the speed is held low. Although, since conflict severity increases with the speed differential it is also important to separate vulnerable road users from motorised traffic on streets with higher speed (Vanderschuren and Phayane, 2015). Except the consideration of avoiding potential conflicts when planning for separated facilities for pedestrians and cyclists it is important

not to forget to also make the facilities attractive in terms of direct routes and safe surroundings.

4.4 Own reflections and experiences

During the observations we experienced many situations that were very different from what we are used to. None of us are used to driving in left-hand traffic and therefore we experienced major differences in the infrastructure. However, we adjusted to this new traffic system rather quickly. Although, it became clear to us that very few infrastructural priorities are implemented for cyclists, the overall motorised vehicle speed is perceived high and the streets are relatively narrow which rarely provides enough room for cyclist to wobble.

Two great examples of the safety issues due to the lack of priority for cyclists were experienced during the observations. The first incident occurred while travelling on the cycle path along Suidwal road. At the intersection on Die Laan road there is a bridge across the river. This bridge is relatively narrow and lined with thick concrete walls that negatively affect the visibility, which is shown in figure 67. While crossing the road one of the participants got hit by a car at this specific site since the car approaching from the bridge failed to see the cyclist in time. The path crossing is very close to the bridge and it can therefore be difficult for motorists to detect cyclists that are about to cross. Additionally, there are no signs or markings on the pavement warning for cyclists and there is also a large tree blocking the entire path, which makes the situation even worse.

Figure 67 - The bridge seen from different angles
Source: Elina Hederberg and Helena Homle

Another difficulty that was experienced at most intersections, controlled by traffic lights, is that the green time for vulnerable road users is a lot shorter than for motorists. Not even an average person will in most cases make it cross the road before the traffic lights turn red again. It was due to this we experienced the other incident when a car in the intersection between R44 and Bird Street almost hit us. The car came and approached the intersection from the north on the R44 and turned left towards Bird Street, where we were crossing four lanes in total. When the lights switched back to red we were only halfway cross the street and the car approached at high speed. We tried to hurry across the street to get out of the way but the motorist did not reduce the speed and therefore we had to stop right in the middle of the street when many other cars were approaching the intersection. This is shown in figure 68.

Figure 68 - The moment when the car chose not to yield and the participants had to make an immediate stop. Source: Elina Hederberg and Helena Homle

When we arrived in Stellenbosch we were thoroughly informed about the safety risks in town. Even if the streets are lively due to the student activities the risk of being exposed to crime is considered relatively high. Regardless, we did feel safe at most times during the observations and in our spare time. Although, we did not go to the areas that we were strongly advised against visiting and this may have affected our impression of Stellenbosch. However, we did also avoid cycling and walking during nighttime due to the announced safety risk in town. In the few cases where we did go out at night we kept to the streets, which are patrolled by guards.

Besides the safety risks and the two dangerous situations described above we felt safe in the streets of Stellenbosch at most times. In our opinion motorists generally showed more respect to vulnerable road users than we had thought before arriving in South Africa. Our overall impression was better than expected even if the infrastructure and traffic situation was not considered ideal for cycling. Even if we are used to the widespread cycling culture in Lund we still felt comfortable cycling around in Stellenbosch.

5 Discussion and conclusion

5.1 Discussion

5.1.1 Results

The study aims to describe the situation for cyclists in Stellenbosch in terms of level of service, accessibility and safety. It also aims to investigate if there are there any official policies or plans to improve the situation for cyclists in Stellenbosch and if these are consistent with the results of previous studies. The summarised results of the current situation are described below.

5.1.1.1 Level of service

The overall level of service for cyclists in Stellenbosch is according to the results of this study poor. This is mostly caused by the incoherent cycle network, discontinuous and inconsistent cycle paths, parked cars and lack of space and prioritising facilities. Furthermore, recurring stop signs is often a significant problem since it both affects the level of service and safety for cyclists in intersections. It decreases the level of service for cyclists due to many undesired stops and since it often leads to both cyclists and motorists neglecting the rules it also decreases the traffic safety. However, if all road users obey the rules it is a good solution for lowering the speed in intersections and thereby increasing the traffic safety. The same applies for congestions since it also decreases the overall level of service in the traffic system. Although, if it is possible for cyclists to proceed past the queues it highly increases their level of service in comparison to motorists while it also contributes to increase the traffic safety due to the lower speeds of motorised vehicles.

As has already been said, the overall level of service is rather poor in Stellenbosch. However, since the travel time often is considered to be the most important factor when it comes to describing the level of service the situation need to be further discussed. The travel time ratio measured in this study indicates that cycling is more attractive than driving on most key routes in central Stellenbosch. This has a positive impact on the overall level of service even if the above-mentioned factors suggest otherwise. In this case it seems legit to consider the travel time ratio as the most important factor due to the overall conditions in Stellenbosch. The short distances, flat terrain, compact city centre and high university influence are ideal qualities for creating coherent and continuous cycle paths that connects key destinations by short trips. This is exactly what is needed in order to heavily increase the level of service for cyclists in the town. In other words, the current infrastructure seems to have potential for improvements even if it is far from coherent and continuous today.

5.1.1.2 Accessibility

The overall accessibility for cyclists in Stellenbosch is according to the results of this study fairly poor. The reason for this is the extreme amount of obstacles, the poor surface quality and the lack of amenities such as guiding signs and cycle parking. Street furniture and other amenities are essential to create an attractive environment for pedestrians and cyclists, although it is important to thoroughly plan where to locate it. However, many obstacles that are found in Stellenbosch are not contributing to an attractive or well-functioning cycle infrastructure, which in other words decreases both the accessibility and the overall impression of cycling. Obstacles are not only affecting the accessibility for

cyclists but they also highly affect the overall safety for roadusers due to the risk of injuries caused by falling etc. However, it is important to remember that Stellenbosch has very short distances between all key destinations and that distance actually is the most important factor when choosing mode of transport. Unfortunately, it is rarely possible to park the bicycle in a safe and efficient way. This is also claimed to be of high importance when people choose whether to cycle or not and it is possibly even more essential in South Africa where the crime rate is high.

It is important to remember that not everyone has access to a bicycle, simply because many people cannot afford it. The affordability is therefore an important factor when choosing the mode of transport since many people in South Africa today do not have any other option than walking. When the car is not an option and public transportations do not exist a bicycle could help increase the accessibility and level of service and thereby the possible distance one can travel daily. Studies show that this could put job opportunities within reach and hopefully reduce the unemployment rate in a long-term perspective. Many studies actually suggest that poverty can be reduced if cycling increases.

As it has already been said, the overall accessibility is fairly poor in Stellenbosch. It is still possible to access the city's key destinations by bike although it is far from attractive and efficient.

5.1.1.3 Safety

The overall safety for cyclists in Stellenbosch is according to the results of this study very poor. The main reason for this is the high vehicle speed, the hazardous drainage channels and the lack of separating facilities and warning signs. It is also stated that the high accident and crime rates creates an overall sense of insecureness which has lead to the fact that people rather choose other means of transport.

Vehicle speed is proven to be crucial for road traffic safety, which is explained by its great impact on the probability of accidents occurring and the severeness of injuries when accidents do happen. The results of this study and the overall impression indicate that the operating speed in Stellenbosch is generally high. In addition to this most roads are relatively narrow and lined with the hazardous drainage channels which worsen the situation for cyclists additionally since they normally are mixed with motorised vehicles in the roadway. As mentioned it is not recommended to mix cyclists with motorised vehicles unless the speeds and traffic flows are held low. Actually, it is stated that appropriate separations of cyclists from motorised vehicles, due to speed limits and available space, is essential in order to increase the road traffic safety.

As has already been said, the overall safety is very poor in Stellenbosch. Although, this is expected since the road traffic safety in South Africa is said to be one of the worst in the world. However, it is assumed that the road traffic safety situation in Stellenbosch could increase drastically if traffic calming and facilities that separates cyclists from motorised vehicles was correctly implemented. This assumption considers the fact that Stellenbosch is a relatively small town with mostly narrow streets and comparatively low traffic flows.

5.1.1.4 Existing plans and policies

Another purpose of this study was to investigate if there are any official plans or policies on how to improve the situation for cyclists in Stellenbosch. If such documents were found the study also aims to briefly evaluate the content to see if it is consistent with previous studies regarding cycling. A surprisingly big amount of plans and policies were found, both on national and municipality level. The brief evaluation of the content showed that it is accurate and consistent with the previous studies in this field. Actually, the content was thoroughly describing why and how the situation for cyclists could be improved. If the implementations of these plans were highly addressed and the financial priority was given to infrastructural improvements it is expected that it could result in a well functioning traffic situation.

5.1.1.5 Overall opinion

It is impressing that Stellenbosch has come this far in both planning and implementing cycle infrastructure even though the focus on non-motorised road users is fairly new and deprioritized financially. The fact that Stellenbosch has implemented cycle facilities in various places and that the tolerance for cyclists among motorists has increased recently indicates a good will for improving the situation. This engagement together with the mentioned ideal cycling conditions is a promising start. One of the major engagements announced by the municipality of Stellenbosch is to reduce the currently high speed limits in the urban area and to implement traffic calming facilities. This is considered a great step in the right direction since the high vehicle speed in Stellenbosch was experienced to have great impact on the safety situation for cyclists.

It seems like it may be challenging for Stellenbosch to implement proper cycle infrastructure improvements since they in many cases highly prioritise the historical value. One example of where this could be problematic is on the streets lined with historical drainage channels or oak trees. However, it should be possible to find solutions even in these troubled streets, actually ideas of how can also be seen in the planning of the improvements.

The fact that infrastructural improvements have not been prioritised in the recent years is a major obstacle. However, this is highly understandable due to the current situation in South Africa with high unemployment rates and the fact that not everyone has access to fundamental rights such as piped water and sewerage. Although, this makes it even more important to remember that improved infrastructure with focus on non-motorised road users is claimed to improve the overall situation in the country and thereby reduce poverty. The commitment in Stellenbosch is even more impressive since many South African households have a difficult economic situation and the bicycle is an affordable mode of transport that may improve this situation.

5.1.2 Methods

Due to the limited time frame of this study limitations have been made which affects the result of the report. It is therefore of importance to discuss the effect of the chosen method and limitation and suggest improvements that could have been made.

5.1.2.1 Overall

This report is based on a study conducted in Stellenbosch, South Africa. As mentioned in section 2 it is an advantage to conduct an inventory in order to understand the situation in Stellenbosch. However, it is also a weakness since the information cannot be generalized and applied elsewhere, not even in other South African cities. This is a necessary limitation considering the purpose of this study.

Moreover, in this study the level of service, accessibility and safety have only been evaluated through a few chosen factors. This is clearly a disadvantage since it is well known that a numerous amount of factors affects the level of level of service, accessibility and safety. However, due to the time frame and resources in this project it would not have been possible to conduct a more thorough investigation. The fact that only a few factors are considered affects the reliability of the results in this study. Although, this study gives a brief indication of the situation for cyclists in Stellenbosch and is therefore still interesting to conduct.

5.1.2.2 Literature review

Since the study is conducted abroad in a developing country it was essential to review both Swedish, international and local South African documents. Since this study did not focus on evaluating plans or policies it was important to limitate the extension of which information to comprehend. Furthermore, much focus where on determining which information was applicable to the situation in Stellenbosch since many studies are conducted in European countries with other conditions than in South Africa. In order for the participants to create an objective opinion of the local situation the literature review of the local documents was made after the on-site observations so that the content would not influence their evaluation.

Another aspect to have in mind is the possibility that the collected information about the vision and plans for improvements in Stellenbosch is partial. Most of the local documents were developed by the municipality, which certainly could affect the outcome. However, it is still of importance to get an idea of what they know about improving the situation for cyclists and what they intend to do to achieve it.

5.1.2.3 Data collections

Observations

Most of the information that leads to the results of this study was gathered during observations in Stellenbosch. This is an important part of realizing the situation for cyclists. However, the evaluation is easily influenced by the participants' experiences and personal opinions, which affects the results. Furthermore, the evaluation was made in the perspective of an average cyclist which means the results of this study is therefore not applicable to everyone.

An important limitation during the observations was the fact that it was not safe to visit all areas in Stellenbosch. This is a major disadvantage since it would have been of great interest to better understand the situation in these areas in order to determine the situation for the entire town. However, it was not an option due to the security risks.

Another important factor to have in mind is that the evaluation in this study is only based on information that is collected during a short period of time. Temporary factors such as on-going constructions on for example Van Reede road and Marais road will affect the results since these roads were partly blocked. This may have affected the traffic flow on the surrounding streets at the moment and thereby the results of this study. It is also important to remember that this study was conducted during the late summer in Stellenbosch, while the university was open. Since a large number of the inhabitants in Stellenbosch are students the results would probably have been different if the situation had been studied during for example summer break. The fact that it was late summer did presumably not affect the results extensively since the climate during different seasons is not changing drastically.

Measurements

The vehicle speed was measured in four different places in Stellenbosch, these were chosen since they are characteristic and commonly used by cyclists. This is an important factor to consider in order to evaluate the situation for cyclists and it is therefore an advantage conducting these measurements since it indicates the overall, operating vehicle speed. However, measuring only 100 vehicles at four locations in the afternoon is not enough to get results that are representative for Stellenbosch. To get more representative results it would have been necessary to measure speed at more than four locations and during a longer period of time. It could also be discussed if other methods than using the radar gun could have given more reliable results since the accuracy of the gun is affected by the circumstances during the measurements, which are further described in section 2.

Measuring travel time and thereafter calculating travel time ratio gives a good indication on whether the cycle is an attractive mode of transport compared to the car. Since the measured travel time is affected by the current traffic situation the cyclist and motorist in this measurement left the starting point at the same moment. However, even if the travel time was measured at the same time it is not representative since it was only measured one time. To get a more accurate result, measurements should have been done several times during different weekdays and various times of the day. Furthermore, specified methods could be used in order to get more reliable results.

Verbal information and emails

Interviews would have given this study a much greater insight in the situation for cyclists in Stellenbosch, but as was described in section 2 it was not possible to conduct any interviews. Although, some information was gathered through emails and verbal conversations with professors and professionals in Stellenbosch. Even if this information cannot be considered as a representative opinion for the entire town it was still very helpful in this study.

5.2 Conclusions

The study aims to describe the situation for cyclists in Stellenbosch in terms of level of service, accessibility and safety. The current situation for cyclists in Stellenbosch has been determined with consideration of the above-mentioned limitations and effects of chosen methods. In conclusion the situation in terms of level of service, accessibility and safety is considered poor. The reason why the summarized situation is considered poor even if it according to many factors is worse than that depends on the results of the important travel

time ratio measurements. The fact that it in our personal opinion definitely is possible to travel by bike without experiencing difficult situations also contributes to the overall description of the situation.

Moreover, the purpose of the study is also to investigate if there are there any official policies or plans to improve the situation for cyclists in Stellenbosch. If there are, the purpose is also to see if the content is consistent with previous studies regarding cycling. In the literature review a big amount of plans and policies were found, both on national and municipality level. The brief evaluation of the content showed that it is accurate and consistent with previous studies in this field.

The results of this study show that the situation for cyclists in Stellenbosch is rather poor. However, it is important to remember that the evaluation is based on knowledge and results from successful European countries such as the Netherlands and Denmark. In other words, countries with completely different circumstances. If Stellenbosch would be compared to other South African cities instead it would be considered a leading city when it comes to cycle planning and infrastructure. Stellenbosch municipality claims that Stellenbosch has the potential of becoming a well-functioning cycling town, their commitment together with the found ideal conditions indicates that this is possible.

5.3 Recommendations

The general recommendation for Stellenbosch municipality is to continue implementing the action proposals stated in the current plans. In order to improve the situation as efficient as possible it is of importance to observe the results of other on-going studies and to follow-up on local implementations. It is also important to remember that the increase of cycling probably will not happen immediately, therefore it is essential to plan and design infrastructure that focus on the needs of people that will use it in the long run.

In order to better understand local circumstances and results of implementations it would be interesting to conduct more studies regarding cyclists in South Africa. In Stellenbosch it would be interesting to further look into the opinion of cycling among road users, the situation for cyclists along the key routes and also how other cyclists than the average cyclists experience the situation. In South Africa in general it would be of great interest to evaluate if results from foreign studies are applicable and whether new legislation or national campaigns could be efficient improvements for changing travel behaviours and improving cycling conditions.

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Appendix

1. Map of Stellenbosch (Stellenbosch, 2016)

2. Map of central Stellenbosch (Stellenbosch, 2016)

3. Travel time ratio

	Means of transport				Travel time ratio	
Route	Car	Bicycle	Walkning	Distance	Route	Bicycle/Car
Oss-Sport	00:11:55	00:06:05	00:18:25	1,3 km	Student accommodation-Sport centre	0,5
Oss-Cashier	00:11:50	00:04:10	00:10:15	0,9 km	Student accommodation-Campus	0,4
Oss-Mall	00:07:15	00:05:55	00:16:45	1,3 km	Student accommodation-Eikestad Mall	0,8
Mall-Kayamandi	00:15:10	00:10:35	00:20:55	1,4 km	Eikestad Mall-Kayamandi	0,7
Mall-Brandwacht	00:08:20	00:26:50	00:49:15	3,7 km	Eikestad Mall-Brandwacht	3,2
Mall-Idas valley	00:05:30	00:09:05	00:26:25	2,1 km	Eikestad Mall-Idas Valley	1,7
Mall-Uniepark	00:06:20	00:12:15	00:33:05	2,6 km	Eikestad Mall-Uniepark	1,9