Shared mobility for less agile cyclists

The search for improvements on the current shared bicycle systems in the Netherlands.

By

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Preface

This thesis is part of the Transport & Planning track of my Civil Engineering Bachelor program. The theory is related to the research into improvements on shared bicycle systems to benefit less agile cyclists too. During this bachelor end project I got to experience and learn how to tackle a problem statement through research and then reporting. Since this was my first time to independently execute a research in a scientific strategy, it was a very educative first experience. But, of course I could not have performed as well as I did now without the help of others.

Therefore, I want to thank my supervisors Maria Salomons, Yufei Yuan and Dorine Duives who I could rely on for constructive feedback and suggestions. Maria helped me a lot with the related subject, since she has the knowledge about the context of the topic, by supporting me with useful tips and information. Yufei Yuan gave me weekly constructive feedback and tips regarding my thesis as a whole which kept my work on point. Dorine furthermore gave me good feedback and insight in my work during my mid-term presentation, this helped me to properly push through with my work. As last I want to thank all the respondents who contributed a lot to my thesis its progress.

Rania Ellounissi
Amsterdam, June 2022

Summary

With the aging population, society needs to take elderly and/or people with disabilities more into consideration. These less agile people are becoming a bigger part of society, and to give them chance to contribute freely in their community, independency is needed. As public facilities do not always provide their services for people less agile than others, a difference needs to be made. In this thesis, improvements in the current bike sharing systems are researched to improve health and independency in the lives of less athletic people. This had been done by giving answer to the sub-questions through literature research and conducting a survey.
Mostly through literature research, answer to the first four sub-questions was provided. The first inquiry was achieved through stakeholder analysis. This is to provide an overview with explanation of who is involved in this subject and why will be taken into application throughout the research. Prior research has then been made to achieve findings and research gaps, which give answer to the second sub-question. There, it has been mainly brought into being that many research project either concentrate on shared mobility or improvements on bikes for elderly and disabled people. But a connection between improvements on shared mobility systems and bikes has not been looked in to as much. The third sub-question has been resolved through influential factor identification, with the help of the formed stakeholders. The fourth sub-question has been posed to research into the one main issue in bike sharing systems that less agile people experience, so that the scope of the survey is one problem related. And this is the lack of bike options. The last sub-issue regards the difference in opinions of less agile people and agile people on posed bike solutions. This has been done through a survey that numerically measured whether the people motivated or demotivated by idea of the implementation of certain bikes. The results of the survey were then statistically analysed with the Mann-Whitney U-test, to see if there are any significant differences between sub-groups their responds. Also mean calculations of the given ratings were calculated to see if the ideas were acceptable.
After reviewing the results from the survey, it has come clear that both agile and less agile people are on the same page regarding the implementation of lighter bikes and electrical supported bikes. Both parties reacted positively on both idea's, only lighter bicycles performed better in terms of ratings and significant indifference between sub-groups. Agile people however, perceived the implementation of tricycles as a demotivating factor for them to (start) using bike sharing systems.

Contents

1. Introduction

The world is starting to get more connected and active which each other. New ways of ecological and sustainable transport systems are being sought for and studied. The shared mobility is here one of the new and striving methods of transportation in, mainly, cities (Heineke et al., 2021). It is efficient since one has no need to buy a bike or scooter, but can rent one nearby and then park the transportation element near destination. Unfortunately ableism in the transportation community is still existent and hence needs to be stopped (International Journal of Urban and Regional Research, 2021). But, how do we make sure the shared mobility systems can be used by everyone?

With the growing population, the percentage of less agile people is growing too. Since the aging among the population is increasing, the elderly citizenry is starting to become a more prominent factor in society (Fasina et al., 2020). Therefore their active contribution in the community would be important for them as for the rest of the people. These people which have lack of dexterity and also often have additional disabilities, should still have the possibility to use active transportation methods. This is good for them physically as mentally by allowing them to choose a more active and independent lifestyle (Anzilotti, 2019). It is therefore important to make as much able for the disabled by looking for improvements in the shared mobility community.

In this thesis I concentrate on improving shared bike mobility for the less agile (them being the elderly and/or disabled persons) cyclists in the Netherlands. This chapter will firstly share some theoretical background about the stakeholders and transportation elements for the target group. Then in the motivation, the sub-questions and the societal and scientific benefits will be discussed. In chapter 2 the prior research will be assessed and discussed, this will give an idea about the research gaps and findings, which are interesting to include in this research. The third chapter investigates in detail and categorizes the factors influencing the existing system; then shows the methods of data collection before finally explaining the procedure of the data analysis. After the methodology the results, discussion & conclusion and recommendations will respectively be treated in separate chapters.

In the following the stakeholders, which is a list of parties who are involved with the progress of the research, and an explanation about tricycles and supported bicycles are to be found.

1.1 Academical background

1.1.1 Stakeholders

In the following the stakeholders, which have input into the research and problem, will be listed and discussed.

- Cyclists
  These are the average civilians that make use of the bike lanes. This is quite a large target group since it could consist of different kinds of people with different age groups etc.. It is more interesting to see how they experience the shared bike mobility for the less agile or how they would experience an increase in this type of mobility. It would be good to learn in what extent the cyclists feel positive or negative about possible innovations for the less agile in the existing shared bike mobility systems. Besides, this stakeholder group could give a nice view of the existent context of the target group. This group could in addition also contain the elderly (which are defined as the people over the year of 65 according to Singh and Bajorek (2014)) and/or disabled people, which are the target group of this thesis. By directly focusing on this group of people in this category, one can attain, among other things, specific information on what makes them not use the shared bike mobility.

- Pedestrians (non-cyclists)
  Also pedestrians, the people that do not use a bicycle too often, could give more context by sharing their opinions on the more shared tricycles and/or supported bicycles in their living area. Pedestrians could give an insight on shared bike mobility that cyclists do not necessarily experience. For example, regarding the potentially needed parking spaces or those that already exist but need improvement. This way occurring problems could be minimalized and/or avoided. Also, the pedestrians could give more insight about the problems regarding the cycle lanes etc. The elderly and/or disabled are in this category again interesting to concentrate on. Since they do not use the cycle, they could give more input for example on what they would like to change or not change in the shared bike mobility system for it to be useful for them.

- Shared bike companies
  The shared bike companies are eventually the providers for the less agile, so it is inevitable to include them as stakeholders too. In the Netherlands one of the most used shared bike companies are: ov-fiets, Obike, Mobike, Flickbike & Donkey Republic (Steens, 2018). Most of them are active in big cities, except the ov-fiets of NS which is national. With the use of for example interviews, the shortcomings from their perspective can be assessed. But on the other hand, some of these shortcoming could only be further handled by other parties, like the government for instance, which are out of our scope for this research project. But it is nevertheless a wasted effort to bring these specific shortcomings and parties to light, since one can always learn and innovate from this on.

- Tricycle & supported bicycle companies
  This party is to be taken in consideration since in the research, it is the goal to combine tricycle and supported bicycle companies with the shared bicycle companies. So, besides the shared bicycle companies it is necessary to assess the tricycle & supported bicycle companies too for comparison reasons. It is needed to know how willingly tricycle & supported bicycle companies would like to cooperate with shared mobility companies and what complications they might experience. Few examples of these companies are: Stella & Victoria (Consumentenbond, 2022)

- Government / municipality
  The government and municipality have big say regarding the funding and management of infrastructure. The government funds municipalities and the municipalities subsequently fund their companies and systems. In other words, the two stakeholders work together. So they indirectly could have a big influence on the operation of not only infrastructure but also for example bike companies in any sense.

1.1.2 Tricycles & Supported bicycles

In this section is a brief explanation of what (the use of) tricycles and supported bicycles nowadays are. This is to give a better background understanding of these elements which will be taken into further studies.

Because of the rise in elderly people in our society, the rise in electrical and special bikes has increased accordingly. But this comes with a rise in bike accidents too. In general almost more than three quarters of the fatal bicycle victims come from the people older than 60 years. While the fatal accidents of the other remaining percentage, people under the age of 60, is decreasing(swov, 2020). This is due to the imbalance the victims experience while cycling. Therefore a tricycle (see figure 1) has become a popular replacement of regular electric bikes. As one can derive from the name, a tricycle is a bicycle that contains 3 wheels, often one frontal and two parallel dorsal wheels, and sometimes the opposite (Fietsersbond, n.d.). Nowadays the bikes are also included with electrical pedal assistance to reduce the physical forces that should be exerted by the cyclist (Senzup, n.d.).

Figure 1: The tricycle (Van Raam, n.d.)

Another option to reduce the accidents of for example falling and/or shooting out of the corner, is an adaption of the electrical bike. While electrical bikes reduce the physical efforts of the user, the supported bikes (see figure 2) take care of also the security of the user. These bikes have the appearance of a normal (electrical) bike, but are specially made for the less skilful. The supported bicycles are an alternative of the tricycle with the same goal of keeping balance (though not as strong as a tricycle), however the users have now the choice to use a bike with also only 2 wheels. There has been done research, by the TU Delft in association with Gazelle, in the use of a wheel supported bike, with a motor built inside that tracks the movements of the user and accordingly takes the measurements in need. This way the bike and its user stay upright in risky situations (TU Delft, 2019).

Figure 2: The supported bicycle (TU Delft, 2019)

1.2 Structure & Motivation

As mentioned in the prior research, there has been made great investigation into different aspects of the mobility of elderly and less agile. For example: the means of mobility possible for elderly has been mentioned; the designs for developing elements of transportation for elderly or less agile; the shared mobility for the less agile etc. But what takes the interest the most is that, according to the prior research chapter, there has not been made sufficient examination of the shared *bicycle* mobility for the elderly and disabled. So a combination of all the aspect that have been researched, and researching the effects of that further on would be interesting to look into. Therefore the following research question was formulated:

"How can the use of shared bicycle systems in the life of less agile people be improved?"

To give proper answer to the research question above, a few sub-questions are formulated which are answered in this report.

1. *"Who are involved with the shared bicycle systems, and why are they important?"*
2. *"What can be learned from previous investigations and what are the research gaps?"*
3. *"What factors influence the successfulness of the shared bicycle systems and how?"*
4. *"What factor forms the problem aspect which less agile people struggle the most with when wanting to use shared bicycles."*
5. *"How will the less agile in comparison with agile people react on different improvements on this problem aspect in the shared bicycle systems?"*

The first sub-question has been answered in the "stakeholders" section of this introduction. That is where the different important groups of people are introduced and explained in terms of how they are involved in the shared bicycle systems. The second sub-question has been assessed in chapter 2: "Prior Research", where different articles and research papers have been discussed that are relevant to this subject. From these references, past mistakes (together with the found research gaps) can be found and taken into further investigation. Sub-question 3 is part of the methodology and is processed in the "Influential Factor Identification" section. In that section it is necessary to calendar who has a say and why they have a hold on the achievements of the shared bike mobility systems. Besides, with successfulness it is mean the extensiveness of the companies of shared bicycle mobility that succeed in satisfying a larger group of cyclists, so including the elderly and disabled, without dissatisfying the non-users. The fourth sub-question is answered in the "Scope" section in the Methodology chapter of this thesis. In the "Scope" section some literature review has been done to identify the most problematic aspect for less agile cyclists when wanting to use shared bicycles. Sub-question 5 is part of the Methodology's "survey" section. The survey is an element to achieve data, from the people mentioned in the "Influential Factor Identification" section. This is regarding their opinions about different improvements, concerning the problem aspect which is identified in sub-question 4, in the shared bicycle systems. This way it will be more clear what innovation can be successful and what cannot. The results will then be examined in the 4th chapter: "Results" with the help of the data analysis methods introduced in the methodology chapter.

1.2.1 Societal relevance

As the population is aging, society needs to start taking this growing age group of people more into consideration. Aging also often comes with physical limitations, these categories of elderly and the disabled all makeup of the less agile target group (Fasina et al., 2020). Unfortunately many societal facilities are still not reachable for this target group. If we take public transportation as an example, elderly and disabled people often cannot find the chance to make use of the full potential of the services (International Journal of Urban and Regional Research, 2021). That is because shared bicycle companies often only provide necessities like normal bicycles that can only be used by agile people. Therefore, we need to enable the independency of this target group by making improvement in mainly transport facilities. In this case we look for improvements in the shared bicycle systems.

By thus enabling a more independent lifestyle for less agile people, we enable this aging society to still be as active as it should be. This way not only benefits regarding the mental and physical health of the individual would occur, but also benefits of the society economically and socially (Fasina et al., 2020).

1.2.2 Scientific relevance

As will be assessed in the next chapter, there are some research gaps and helpful findings that have been found in the literature research of prior investigations regarding this topic. The most addressed topics regarding the context of this thesis are related to either only shared mobility in general for less agile people or innovations on personal bicycles for the less agile. This thesis is an attempt to seek improvements on shared *bicycle* mobility for less agile people. Also by directly involving the people in question into the corresponding survey part of this research, it is relevant to see if that gives even more significant gains in data. Since the survey addresses only a smaller scope of the potential stated problems in the current bicycle sharing systems, it could be an inspiration for future researchers to try to treat a bigger scope with a larger research than this thesis can reach.

2. Prior Research

To be able to have a nice overview of what has been done in terms of this subject, and in what depth and categories the researchers analysed this, prior research has been done. It is to be expected that there are no such projects already available that cover the most of what this project will handle, but a fair amount of information regarding different smaller comparable topics is useful nonetheless. So in the following the similar researches will be described and assessed. The first section addresses the negative consequences in the lack of mobility for the elderly and disabled. The second section thereafter focuses on the development of efficient transportation elements that elderly could use. The third section zooms out and focuses on the shared mobility for elderly and disabled people. The fourth section focuses again on the transportation elements for the elderly and disabled; the safety and usefulness of the bikes is discussed there. At the end you can find the summary where the important aspects of these researches are highlighted.

2.1 Mobility of elderly and the disabled in Nigeria

Fasina et al. (2020) made research in Nigeria about the mobility of elderly and the disabled. As they, among other things, mentioned in their paper; the number of elderly is growing and takes each year a bigger percentage of the 'less agile' category of people. This counts for Nigeria as for the rest of the world and is therefore to be considered for future plans. It is important for the less agile to keep an independent and active lifestyle. The elderly should be able to have the chance of using public transport. Such simple tasks, as going to the grocery store on their own, being restricted by their physical abilities, can negatively affect their mental health as well as their physical health. This could subsequently also have economic draw backs, since more special and individual care for this target group will be necessary. Also misunderstanding the behaviour of the target group, the kinds of vehicles that are used, regarding their mobility around city's, and inefficient planning of this, create big drawbacks in the mobile independence of the less agile. Besides, it has been discovered that a good integration of this kind of mobility into different transport modes, create a great upsurge in the overall use and efficiency of the city its transport system. It has become clear that the government therefore has a big say in the operation of all these factors.

2.2 New transportation element for elderly

In another article of Wallisch et al., research was done to develop a functional transportation element for the elderly. With the help of smart and flexible transportation designs; overall mobility of the elderly can be enhanced and integrated into the existing modes of transportation. What the researchers furthermore have noticed, is that not only functionality but also emotional and social aspects are to be considered greatly into the design of basically all objects. An object that could be very functional but has great downsides emotionally and socially etc., can still poorly preform in the market (Wallisch et al., 2018). Therefore it is important in the making of designs (whether they are physical or abstract), to take context into account. And with context is meant all other factors like economy, social, emotion and more that could have effect on the use of the end product.

Therefore, in this research, a case study was performed of the design and its social aspects. In the end the scholars based their end conclusions and products on the non-functional needs, being the needs of how the users want to feel emotionally and socially when using the product. The elderly had more preference to those needs than the functional needs. This is interesting, since most researchers tend to look at functionality and efficiency first. The end product was a kit that can be adjustable to normal bikes, and make a tricycle. That way the product can be used and shared between multiple people who are close to the main user (an elderly). It is furthermore interesting to subsequently to think about how this can potentially implemented into shared bicycle mobility systems and what effect it would have. In the next section therefore more about general shared mobility for less agile.

2.3 Shared mobility for the disabled and elderly

Another research paper has addressed the shared mobility of the disabled and elderly. MacArthur et al. (2020) looked into how existing systems are approaching the use of shared mobility for elderly and the disabled, with their specific needs. By the use of surveys in low income communities of colour and bike share operators, the needs, contexts and opinions of the target group and civilians became more clear. Also interviews with bike share participants have been made, these were necessary to have a view of what the needs and situations of the participants in that system were. In the end a few gaps regarding this problem were noticed and mentioned in the paper.

First, there is a shortage in the knowledge and research about the needs of the users. This results in the bike sharing companies having not sufficient options for les agile participants. Secondly, there is a big gap in the structure funding and management of these adaptive bike sharing programs. It was mentioned that it is therefore very important to keep making further research about the people and their context by utilizing more direct involvement of the elderly and disabled. The following section will therefore go in more depth of what the needs of elderly and the disabled are regarding a successful transport element.

2.4 Safety & success of tricycles and bikes

Another important aspect that should be taken into account is the safety of the target group, since they are more vulnerable than the average civilian. But often, if given the option between tricycles and bicycles, the tricycle is often neglected. For a product like the tricycle to fully succeed in the market, a five aspects are important to take into consideration. The lifestyle of the target group should be understood so that the product can fit in and its costs should therefore also be taken into account. Also the comprehensibility and usefulness of the product should be good, with the last aspect being the most important one. Also, riding a tricycle does not seem to be as straight forward as it sounds since keeping your balance is not necessary anymore. One therefore needs some practise to get used to the ways of riding a tricycle (Fietsersbond, z.d.). People also tend to use a bicycle more than a tricycle because of the better overview on the road. Besides these aspects other problems were: the heaviness and bulkiness of the bikes, standing out and blending in with the existing infrastructure. Regarding parking's: small garages specifically for these bikes could be a nice solution (Krause et al., 2013).

2.5 Summary/Conclusion

The importance of including less agile people in the transport system is, both for economical as ethical reasons, is significant. Especially with the rise of old age, there is (and should be) no room for ableism. But with making room for the disabled and elderly one must understand more about them before taking measurements. For example: to learn more about their lifestyle and context, the target group should be involved more directly into researches (MacArthur et al., 2020). This way integration of their needs into the existing systems would have no complications. Also, the government has much say in this since they provide the main funding an management (Fasina et al., 2020). Regarding the transportation product, companies tend to look more into functionality and usefulness, but forget about emotional and social appeal. From research it is deducted that the emotional appeal (how a person feels about a product before considering to buy) and social appeal (how a person feels about the product in a social sense) have more influence on the success rate of the product (Wallisch et al., 2018). For example, investigation of use of tricycles and bicycles has shown that tricycles are far not chosen as an option as much as the bicycle. This is mainly because of the social appeal the tricycle gives off. Elderly state to have the feeling of standing out too much with the use of a tricycle. Also not only socially but in community, the bikes stand out because of the lack of good integration in the transportation systems. People do not really know what to do with them, yet (Krause et al., 2013). Therefore this thesis has its goal to find an answer as to how we can identify and improve these kind of lacks existing in the current shared bike mobility networks.

3. Methodology

In this chapter the methodology will be explained. This will be done by firstly identifying and explaining the factors that can influent the shared bike mobility for less agile cyclists. Further on are two other sections: Survey & Data analysis. In the "Survey" section, the set-up an questions put in the survey are induced. In the last section, the "Data analysis", several data analysis methods that will be used for processing the results will be explained.

3.1 Influential Factor Identification

With the help of the stakeholders assessed in chapter 1, a derivation can be made to achieve the specific factors influencing the research. These more specific factors are needed to be identified, categorized and then efficiently narrowed down to be implemented in the questions of the survey.

3.1.1 Factors

The main factors are divided into 4 groups: "User", "Context", "Providers" & "Operator". Each of them will be explained and further divided into smaller factors that are part of their corresponding main factor.

The "User"

With the term "User" is meant all of the people that will be or are using the bike sharing system. These could be elderly people, disabled, young adults etc. All of these have an influence on the successfulness of a bike sharing company/system. To be even more specific, other aspects that part of this category are mentioned and explained in the table below:

Table 1: Aspects of the user

Aspect	**Explanation**
Emotional aspect	These are the feelings the user has when using elements (i.e., bikes and tricycles) provided by the bike sharing companies (Wallisch et al., 2018).
Social aspect	This is how the user may feel when using the shared mobility system in a social sense (Wallisch et al., 2018).
Age	The age group of the user.
Gender	Gender of the user.
Living area	What kind of living area the user lives in. This could be an interesting aspect to explore and see if there is a difference in needs for shared bike mobility in villages and cities for example.

The "Context"

With the term "Context" is meant all of the people and things around the users of the bike sharing system. In the following a description of the aspects that are part of the context of shared mobility for the less agile.

Table 2: Aspects of the context

Aspect	**Explanation**
Infrastructure	Mainly the bike lanes.
Image	With image is meant the ideas and opinions that people could have on tricycle users. For example elderly rather use a bicycle than tricycle as they do not want to be viewed as outsiders (Krause et al., 2013). So tricycles need to portray a more positive and less emphatic image for the users.
Pedestrians	People in the area that use the walking paths nearby.
Agile cyclists	All other cyclists except the cyclists that are considered part of the less agile people.

The "Providers"

The providers are the ones that provide the users of the elements needed to have a bike sharing system. These are the bike sharing companies themselves and indirectly bicycle companies.

Table 3: Aspects of the provider

Aspect	**Explanation**
Bike quality	How well the bike performs in all aspects(i.e., functionality & usefulness)
Parking facilities	The kind of parking areas that are utilised to store the bikes (i.e., stalls and/or garages)
Costs	The costs of bike rental.
Parking locations	The locations where one can find the bikes to rent and return.

The “Operators”

The operators are the ones that have the bigger say over these companies and systems. The providers, which is the government and municipalities, choose how and in what extent the providers can fulfil their tasks. The aspects mentioned below are the main tasks the operators complete.

Table 4: Aspects of the operator

Aspect	**Explanation**
Funding	This is the amount of money that goes into the investment of the bike sharing companies.
Management	This is the management, in bigger sense for example, in how far the companies can make use of existing infrastructure for their needs. Management of keeping the bike lanes and public spaces providable for all without complications.
Integration public transport	Allowing the different companies to work and intertwine with other similar systems/companies existing in the same municipality and/or country. This could, for example, provide for a better transition from regional to national transportation.

Figure 3: Diagram of the influential factors

3.1.2 Categorization & Selection

In the following table are all of the identified factors judged on significance in the research. Also is explained why they are or are not included into the survey.

Table 5: Elimination & selection of factors

Factor	Included?	Explanation
Emotional aspects	Yes	This factor is indirectly the most important and used aspect in the survey, as one is constantly seeking to learn how the respondents feel about the proposed ideas and scenarios regarding the bicycle sharing systems.
Social aspects	No	This aspect is not necessary as we do not go in depth regarding the social interactions users could experience when using shared bicycles.
Age	Yes	For demographic reasons this is necessary in the survey. This is necessary to define the elderly group. In the survey it is chosen that people older than the age of 65 are considered to be in the elderly group (elizz, n.d.)
Gender	Yes	Also for demographic reasons necessary.
Living area	Yes	This is necessary to learn if there is a difference in the needs of shared mobility in different living areas.
Infrastructure	No	Infrastructure is not included since there will not be any focused concerning the innovation ideas regarding infrastructure.
Image	No	This is a broad and subjective element to properly include in the survey.
Pedestrians	Yes	This is to identify the respondents using the survey and to achieve their opinions on the shared mobility system as bystanders (also identified as non-cyclists).
Agile cyclists	Yes	Also these are for identification purposes and getting information from them as bystanders around the target group. These are the cyclists who are under the age of 65 with no physical limitations.
Bike quality	Yes	It is needed to know whether different bikes and their qualities have positive influence on the usage of bike sharing systems by less agile people.
Parking facilities	No	Getting opinions on the current parking systems of bikes and potential solutions makes the survey too broad and falls out of the scope (as described in the “Scope” section).
Costs	No	This aspect is also not as necessary as the other included aspects. This is also explained in the “Scope” section of this chapter.
Locations	No	Improvement in bike locations is a too broad subject which falls out of the scope of the survey. This is therefore not included.
Funding	No	This depends on the government and municipality, which cannot be reached with the survey.
Management	No	This depends on the government and municipality, which cannot be reached with the survey.
Integration public transport	No	This depends on the government and municipality, which cannot be reached with the survey.

3.2 Scope of survey

Before setting up a survey, the scope of the problem should also be narrowed down to one aspect that the less agile group struggles the most with when wanting to make use of the shared bicycles systems. Multiple possible problem-aspects and factors, that are an influence on the shared bicycle mobility systems, have been introduced in the previous chapters. But it is more efficient to filter out the most crucial one. This way a survey can be developed that can collect specifically targeted data. In the following paragraph, literature research has been done to identify the problem aspect that hinders the less agile people the most when wanting to use shared bicycles.

As safety for elderly, for example, is taken more seriously in to consideration, the need for better bicycles is starting to rise (Li et al., 2019). Regarding public bicycle sharing for less agile cyclists, most of the research concludes to innovations regarding the bikes themselves. Bike locations and the amount of locations are then more relevant for the schedule tight, work related, travellers. But, regarding the less agile users who are not as time and place tight as younger workers, they don't see the locations of where they get their bikes as the biggest struggle. But the choice in bikes is for them the most crucial. Solutions regarding lightness, quality, technology etc. are already the most beneficial for the less agile to be able to start using shared bikes (Chen et al., 2017). And since most of the accidents with bicycles are among the geriatric, there is therefore more pressure on better and more accessible bicycles (Ikpeze et al., 2018). Besides, cost related issues are also not significant issues regarding this target group since financial status is not necessarily age related (UNDESA, n.d.). Therefore money related issues cannot be considered as an issue relating to only elderly or disabled people.

So, the lack of bike quality and bike choice is being an issue for the less agile that want to make use of bike sharing systems. Therefore, the solutions for this struggle have to be introduced and reviewed by less agile cyclists but also agile cyclists who want or are using the bike sharing systems. This way it is feasible to judge whether these solutions will get positive reactions when they are performed in practise.

3.3 Survey

With the help of a survey, the attitude of the involved people regarding shared bicycle systems can be achieved.

In this case it is profitable to know whether improvements on bike qualities and introducing diverse bikes in the system are beneficial for the users. What the people think of the stated solutions ideas, is a useful gain the survey can provide. The survey is made in MS Forms and consists of 3 parts. MS Forms is chosen as the survey tool to be used in recommendation of the Advisory Committee Educational Tooling for TU education (Teaching Support, n.d.). The first part is the introduction to give a brief impression what the survey is about and what it wants to accomplish. The second part consists of the questions regarding the demographic. The third and last part consists of the questions that want to achieve the motivation or demotivation in shared bike use of the respondents regarding different improvements on bike qualities. The survey ends with a question to rate the survey. In total there are 10 questions posed in this survey. And in addition the respondents can choose to take the survey in either English or Dutch.

3.3.1 Introduction

Since the survey will be sent out through my own socials (via WhatsApp & Instagram for example) which consist of my friends, their and my relatives and organisations which specifically include the target group of this thesis. It is moreover important to enlighten them about why and what for the survey is made and shared. So, a not too long but informative and understandable introduction is required. In the following is an introduction to be seen that will be included in at the beginning of the survey:

*"**Research on shared bicycle mobility for less agile cyclists***

Research on shared bicycles are nowadays a popular mode of transportation. You can rent a bike nearby and park it at a location near destiny. But unfortunately a group of people is neglected into this activity: the less agile. Elderly and the disabled find themselves often in need of simple transportation as mentioned before, but do not see sufficiency in them because of the lack of bike options that are provided.

For my thesis and with the help of this survey, I try to retrieve the opinions of different people on improvement ideas on bike qualities in bike sharing systems. Completing this survey takes approximately 2 minutes and is completely anonymous.

For further questions and remarks regarding this research you can contact me, Rania Ellounissi, on the following email:

R.Ellounissi@student.tudelft.nl

Thanks in advance for your time and effort."

3.3.2 Demography

Before starting the survey questions, it is needed to have a clear view of the necessary characteristics of the persons that will be answering the questions. Therefore the demographic part of the survey consists of the following 6 features that the people will be questioned about (see table below):

Table 6: Aspects in Demographic

Characteristic	Necessity
Age	With this feature one can for example identify the elderly group of the respondents, which is important for the research.
Gender	For context purposes and to potentially perceive interesting differences between men and women.
Occupation	With this aspect we can derive if their occupation has an influence on their responses.
Living area	The living area is also important since it is interesting to see is the people living in villages have the same needs, regarding shared bike mobility, as the people living in the city.
Physical limitation	This aspect will help identify the people who have a disability which make it hard for them to use normal or shared bikes. These people will then also be included into the "less agile" target group.
Cycling frequency	Here we can know if the respondent is a frequent or not frequent cyclist. This is interesting to observe if the posed solutions motivate less frequent cyclists too.

The aspects have been transformed as questions and asked as follows in the table below. The multiple-choice options that the responder can select are also associated with it.

Table 7: Questions about demographic

Question	Options
"What is your age group?"	○ < 15 years ○ 15 – 24 years ○ 25 – 64 years ○ > 64 years
"What is your gender?"	○ Female ○ Male ○ None of the above
"What is your occupation?"	○ School / Study ○ Work ○ Unemployment / Pension ○ Other
"Which residential area applies to you?"	○ City ○ Suburban ○ Rural / Village
"Do you have any physical restrictions that constrain you of using a normal bicycle?"	○ Yes ○ No
"How often do you cycle?"	○ Never ○ Monthly ○ Weekly ○ Daily

3.3.3 Questions

With the help of the questions below, the respondents can give their input on how much the introduced solutions on bike improvement can motivate or even demotivate them on the use of shared bicycles. The questions are based on 3 improvements/solutions that can be applied on the bicycle quality category of shared bicycle systems; and whether these improvements/solutions can motivate/demotivate them to use shared bicycles (more often). Then they can express their opinion on the extent to which they are demotivated or motivated with the proposed solutions. In addition, there is also a "neutral" option in case the solutions do not have any effect on them. In the following are the three questions:

- *"To what extent does the introduction of electrical bikes with wheel support (to maintain balance) in bicycle sharing systems motivate or demotivate you to use shared bicycles (more often)?"*
- *"To what extent does the introduction of lighter bicycles in bicycle sharing systems motivate or demotivate you to use shared bicycles (more often)?"*
- *"To what extent does the introduction of tricycles in bicycle sharing systems motivate or demotivate you to use shared bicycles (more often)?"*

The options for answering the questions are as follows:

Table 8: Answer options for the questions

Strongly demotivates me	Demotivates me	Neutral	Motivates me	Strongly motivates me
1	2	3	4	5

At the end the respondents are given the option to express their experience of filling up this survey by giving a 5 star rating. The 5-star rating is chosen since this is a widely used and well recognized way of measuring the users their satisfaction, this is because of its simplicity and easy understandability (Delighted, 2022).

The full length and lay-out of the survey can be consulted in Appendix: B.

3.4 Data Analysis

3.4.1 Descriptive analysis

Before starting with the statistical significance test (see next section) an overview of graphs and charts regarding basic information achieved from the demographic part will be shown. This way a nice synopsis of what kind of people and in what amount/ratio (in percentages) they have participated in the survey.

For example age, for this category it is good to have the results portrayed in a pie chart to see if the target group (the ”less agile“ group) regarding the elderly (which again are defined as people over the age of 64) could be reached with the survey. Subsequently, this also needs to be the case for the disability aspect in the demography. Here we also need to portray the people who are disabled and makeup for the other part of the “less agile” target group.

So, this part of the data analysis is to mainly check the effectiveness and bias of the survey. Did the survey reach the necessary people in a balanced amount? Were the respondents satisfied with the survey at all? And where there any outliers in the demography that have to be addressed or taken into account in further analysis? With the help of the descriptive analysis one can easily find an answer to these uncertainties. Besides, this type of analysis makes room for inspiration on other corresponding theses (Rawat, 2021)

3.4.2 Mann-Whitney U-test

For analysing the results, the Mann Whitney U test is chosen as the statistical significance test. This is necessary to see if the outcome of the introduced solutions, in the questions regarding the identified problem aspect, have any significant difference between the less agile and agile respondent groups. This is necessary because if there is a notable difference, this means the proposed solution is not as effective since it is possibly beneficial for only one party.

With this type of test, two independent groups are compared depending on their responses on a dependant variable. In this case the responses have to be ordinal, the samples have to be independent and the taken surveys have to be random. Also, the calculated differences are achieved from the different means of the compared groups (Statistics Solutions, n.d.). With the help of the IBM SPSS statistics software, the hypotheses will be tested on significance and the null-hypotheses is rejected if the significance level is under 5% (< 0.05).

For example, according to the survey questions the independent groups are based on age, physical ability & cycling frequency. The different age group is divided into the elderly and non-elderly, so these are respectively people older than 64 and younger than 65. For the physical ability group, the people are divided in the ones having a physical limitation and those without one. The third group is divided into the ones that do cycle regularly and the ones that don’t cycle regularly (= less than weekly). The dependant variables are dependent on the different solutions for the problem aspect defined in the “Scope” section of this chapter.

In the following, two tables which represents these independent and dependent variables:

Table 9: Groups of independent variables

Group	Independent variable
Group 1	Ages
Group 2	Physical abilities
Group 3	Cycling frequencies

Table 10: Dependent variables

Variable	Dependent variable
Variable 1	Electrical supported bicycles
Variable 2	Lighter bicycles
Variable 3	Tricycles

The null-hypotheses and alternative-hypotheses are formulated as follows:

H_0 : There is no statistical difference in different **Group 1/Group 2/Group 3** regarding motivation to use shared bicycles (more often) with the addition of **Variable 1/Variable 2/Variable 3**

H_1: There is a statistical difference in different **Group 1/Group 2/Group 3** regarding motivation to use shared bicycles (more often) with the addition of **Variable 1/Variable 2/Variable 3**.

For example the first set of hypotheses would be:

H_0 : There is no statistical difference in different **Group 1 (= Ages)** regarding motivation to use shared bicycles (more often) with the addition of **Variable 1 (= Electrical supported bicycles)**

H_1: There is a statistical difference in different **Group 1 (= Ages)** regarding motivation to use shared bicycles (more often) with the addition of **Variable 1 (= Electrical supported bicycles)**

So, in total there will be 9 different combinations of null and alternative-hypotheses, which in total accumulate to 18 hypotheses.

3.4.3 Mean comparison

For the same groups and regarding the same variables, as explained in section 3.4.2., a mean comparison will be done with the help of IBM SPSS. So subsequently for all 3 categories (Age, Cycling frequency and Physical ability) the sub-groups their mean rating for each of the variables mentioned in table 10 will be calculated using SPSS. For example, we will take sub-groups from Group 1, which are the people above 64 and under 65, and calculate their mean rating on Variables 1 to 3.

By seeing if there is a significant difference between groups it is possible to conclude if the sub-groups are on the same page or not regarding a solution. This can give an indication what solutions create separation between groups. But these outcomes are not deciding whether a solution would be successful or not. Therefore, mean comparisons are needed to observe whether the subgroups are even positive about a certain solution or not. In other words, if a solution is rated by even one sub group as demotivating, the solution would have to be disapproved and/or improved. Implementing a solution at the expense of one sub-group would not be ideal. On the other hand, if a solution is given a good rating by all sub-groups it can be interpreted as a positively perceived solution by the people. And if this solution on top creates no significant difference between sub-groups, then it means that the solution is even more ideal.

4. Results

This chapter provides three different analysis methods, a descriptive, one statistical and a comparison analysis. While the descriptive analysis deals with the general figures obtained from the respondents, the rest of the analyses mainly serve to answer the sub-question. So in the first paragraph is the descriptive analysis and the second and third paragraph show the results from the Mann-Whitney U-test and mean comparison. The survey was sent out on Tuesday the 17th of may through my own social networks (like WhatsApp, Facebook and Instagram) with the message to share with friends and family as much as possible. So the survey was shared between people who live in Europe. The survey was closed a week later on Tuesday the 24th with a total of 76 respondents. The goal was to achieve at least 100 respondents since most statisticians do recommend this to have some meaningful data (Bullen, 2022). But unfortunately this was not accomplished in time.

4.1 Descriptive analysis

This part of the analysis is for review of the consistency and balance of the different results from the respondents. Starting with the ages, in the figure below can be seen that the elderly (agile) group makes up around a third of the total respondents. According to Eurostat (2022), the population percentages in 2021 of people over the age of 64 and between 15 and 64 years, are approximately 21% and 67% respectively. So, in comparison, the achieved data below does resemble the age distribution of the European population. On the other side, there is a bias existent in the data since a majority of the respondents are people under the age of 65. This means that data achieved from the agile respondents is more accurate (and therefore reliable) than the data achieved from the less agile respondents. This is unpreferred since there exists a difference in data accuracy.

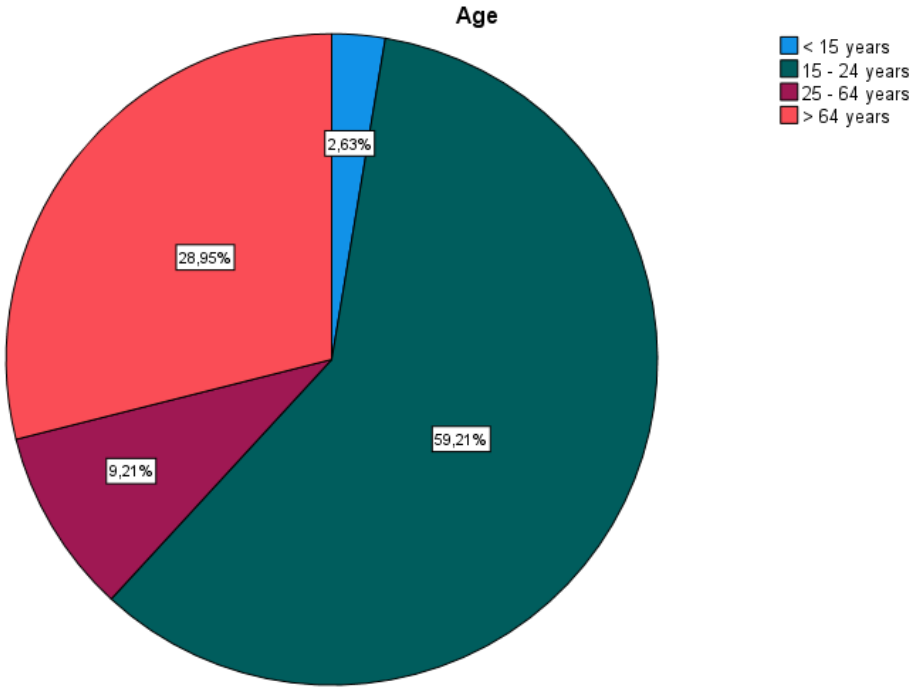

Figure 4: Ages

The next important group to be considered is the people with or without physical limitations that restrict them from using a normal bike. As can be seen in figure 5, the people with a physical limitation are a minority of 20% of the total respondents. This is also not too far from reality since the percentage of people in Europe with a physical limitation is circa 35% (Eurostat, 2015). So again the

data distribution is a realistic representation, but also here a disparity between the agile and less agile groups can be observed.

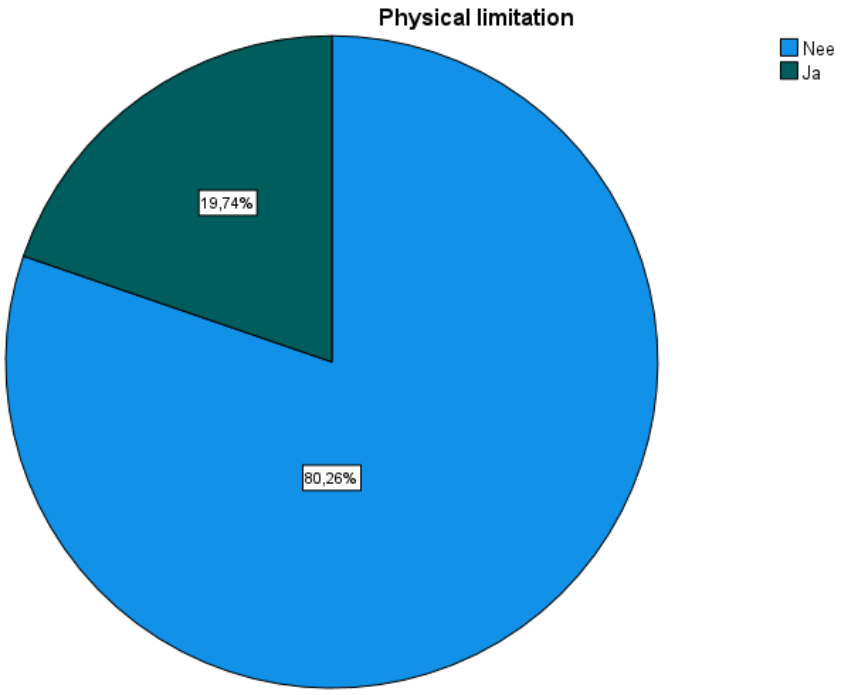

Figure 5: Physical limitations

The cycling frequency groups are on the up side pretty equally divided, which is surprising since one would expect to have many people in especially the Netherlands who cycle with high frequency. In the figure below is again a pie chart with the corresponding percentages.

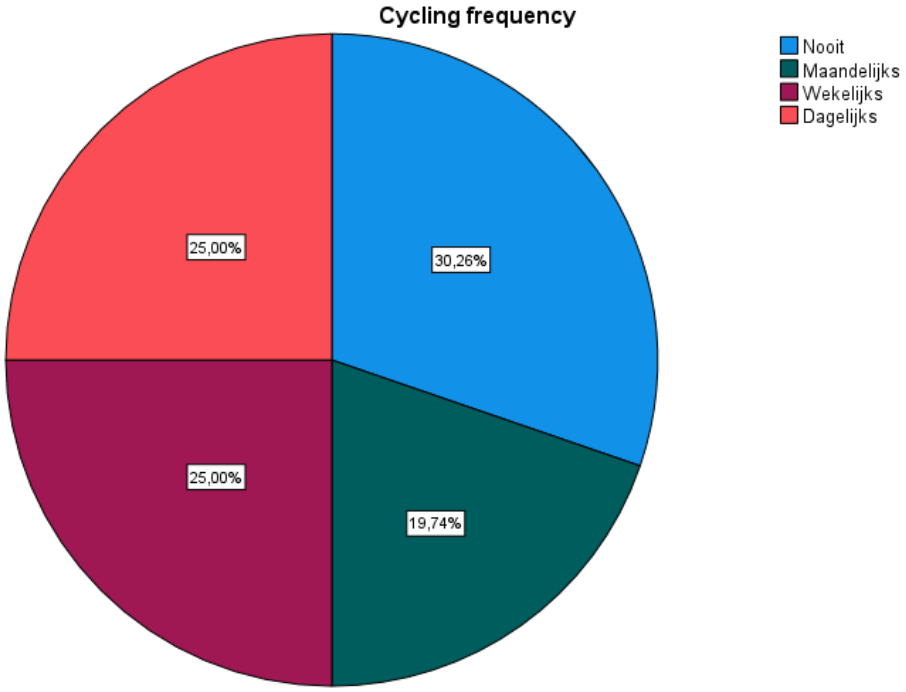

Figure 6: Cycling frequencies

Furthermore, most of the respondents were Female, live in cities and are students with percentages varying from approximately 70% to 80 %. The survey was in the end given an average rating of 4.6 out of 5 starts, as can be seen in figure 7. This is motivating feedback as the people overall had a positive experience of the survey and therefore probably no complications. This only supports that the data is more of quality. But, there is always room for improvement to construct a survey worth 5 stars. For more pie charts with the corresponding percentages, see Appendix C.

Statistics

Enquête rating

N	Valid	76
	Missing	0
Mean		4,55

Figure 7: Mean survey rating

4.2 Mann-Whitney U-test

Now with the help of the Mann-Whitney U-test, the hypotheses posed in section 3.5.2 will be evaluated. The significant difference of the different independent sub-groups for the different dependent variables will be calculated with SPSS and shown in the table below. The definition of the groups and variables are also given in paragraph 3.5.2.

Table 11: Significance levels of different groups regarding different variables.

Groups/Variables	Variable 1	Variable 2	Variable 3
Group 1	< 0.001	0.026	< 0.001
Group 2	0.003	0.723	<0.001
Group 3	0. 356	0.123	0. 356

To achieve a solution that creates no partition between the sub-groups (the sub-groups should be on the same page after all), the significance levels between the sub-groups regarding the variables need to be observed. As can be seen from table 11 is that , especially in Group 1, more than half of the significance levels drop below 5%. These are marked in orange as they are not necessarily good results but also not bad in a sense that we need to discard the posed solutions. But these results are crucial to look at when evaluating which solution is the best. When we only look at these results, solution 2 (noted as variable 2) seems to be doing the best as it creates the least divisions between sub-groups. But we still need to criticize the solutions on the average ratings the sub-groups have given them in the survey. This will be treated in the next section. With the given results, the finally accepted hypotheses are listed in the table below:

Table 12: Accepted hypotheses

Accepted Hypotheses
There is a statistical difference in different **ages** regarding motivation to use shared bicycles (more often) with the addition of **electrical supported bicycles.**
There is a statistical difference in different **ages** regarding motivation to use shared bicycles (more often) with the addition of **lighter bicycles**.
There is a statistical difference in different **ages** regarding motivation to use shared bicycles (more often) with the addition of **tricycles**.
There is a statistical difference in different **physical abilities** regarding motivation to use shared bicycles (more often) with the addition of **electrical supported bicycles**.
There is no statistical difference in different **physical abilities** regarding motivation to use shared bicycles (more often) with the addition of **lighter bicycles**.
There is a statistical difference in different **physical abilities** regarding motivation to use shared bicycles (more often) with the addition of **tricycles**.
There is no statistical difference in different **cycling frequency** regarding motivation to use shared bicycles (more often) with the addition of **electrical supported bicycles**.
There is no statistical difference in different **cycling frequency** regarding motivation to use shared bicycles (more often) with the addition of **lighter bicycles**.
There is no statistical difference in different **cycling frequency** regarding motivation to use shared bicycles (more often) with the addition of **tricycles**.

For the complete tables with data from SPSS, see Appendix C.

4.3 Mean comparison

Through SPSS the means of all the sub-groups are obtained. The data is sorted in the table below.

Table 13: Mean ratings regarding the three solutions.

Independent Group / Dependent Variable	Electrical supported bicycle	Lighter bicycle	Tricycle
< 65 years	3.31	3.57	2.67
> 64 years	4.41	4.14	4.00
Not regular cyclists	3.76	3.55	3.18
Regular cyclists	3.50	3.92	2.92
No physical limitations	3.46	3.77	2.84
Physical limitations	4.33	3.60	3.93
Total average	**3.80**	**3.76**	**-**

As can be seen, is that the red marked averages are the ones below 3.00 and are therefore considered negative responds. So, for example, people below the age of 64 find on average the implementation of tricycles a demotivating innovation. And as all the red numbers are related to the tricycle solution, this makes it the only outlier and cannot be accepted as a potential solution anymore. What is also interesting to mention here, is that only the sub-groups that are considered as agile have given the tricycle idea a poor rating. So, it can be assumed that the agile people perceive the implementation of tricycles in bicycle sharing systems as a hindrance. To make distinction between the other two solutions (Electrical supported bicycles and lighter bicycles) which have been rated well, an average of the means has also been calculated to see which one performed the best. The electrical supported bicycle was in the end rated the best, with only a 0.04 point difference with the lighter bicycle. So both solutions are almost equally popular.

5. Discussion & Conclusion

The main ambition of this research project, is to find a solution to better the current bike sharing systems for less agile people. From literature research is implied that more bike choice in the bike sharing systems is favoured among the less agile people. To retrieve the most important data for this thesis, a survey was conducted. The target of the survey was to measure the extent of the agile and less agile people their motivation regarding the implementation of three different bikes in the shared bike systems. So a distinction between people over and under the age of 65, with or without physical limitations and whether they are frequent cyclists or not, has been made.
The survey was closed with a total of 76 respondents. This unfortunately did not meet the expectation of a minimum of 100 respondents. Therefore it signifies that the poorer sample size results in less reliable data and results. The data on the other hand, regarding age groups and people with or without physical limitations, has a distribution similar to that of the European population. However, this also means that bias between these groups exist, as a majority of the respondents were under the age of 65 and had no physical limitations. So they were agile. As both the agile and less agile party should have equal say in the subject, a bias in the data is unpreferred. A bias also creates a difference in reliability between the results of these agile and less agile respondents groups.
The cycling frequencies of the respondents was on the other side almost equally distributed, which made a nice and equal division between the frequent and less frequent cyclists.

For analysing the data, a significancy of two decimal places was used. This is considered a more critical way of looking at the results, since after all the respondents could only give their feedback in integers. But, if the number were rounded up to integers, all the results would be considered positive. However, if numbers with two decimal places are used, the outlier can be distinguished. In this case, this is the tricycle which is the only introduced solution that has been given negative feedback. To be specific, the frequent cyclists and agile respondents have rated the tricycle as a solution that would demotivate them of using shared bicycle systems. And as a solution that cannot satisfy all groups, the tricycle is not competent as a resolution for the shared bicycle system (yet).

To compare the other two solutions that were rated well, the electrical supported bike and lighter bike solutions did both almost similarly well. The idea of the electrical supported bike was only with 0.04 point better rated. But, to better distinguish which solution is better in the end, it is necessary to also look at the significant difference they create between the responds of the sub-groups. The less significant differences there are between each of the two sub-groups, the better they agree on one solution. And that is what the lighter bike solution creates. And so forth, the lighter bike solution proves to be the most promising to implement in the shared bike systems.

7. Recommendations

There is always room for improvement, in this thesis that is likewise the case. For the survey, for example, more time should be taken into consideration in general. The time that was calculated for creating and distributing the survey and then collecting the responds, was and underestimation. Setting up the survey took more time than anticipated since the questions had to be specific and understandable. One should also take into consideration what data exactly is needed to achieve from the survey and therefore will be used when discussing the results. This averts unnecessary questions in the survey, which is more pleasant for the respondent as the reporter. Moreover, prior research on the platforms were the survey would be shared should have been made. This avoids cases like finding out too late that they are insufficient and having to look for other platforms again. Besides a survey, interviews can give deeper insight on the subject from the point of view of specific people. In this case, an interview with and elderly cyclists or a representative from a bike sharing company could have given more background and inspiration on the research.

From the results is accomplished that tricycles are not a good solution for agile people. Therefore, it is interesting look into how we can make tricycles less of a hindrance for athletic cyclists. This can perhaps be an inspiration for in a follow-up research.

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Appendix A: Workplan

Work Plan

COURSE	NAME	STUDENT ID	DATE
BEP, T&P	Rania Ellounissi	5060702	20-4-2022

OVERVIEW

In the table below are the, in chronological order to be done, subjects/tasks shown for the coming weeks. Also their details and corresponding important dates (such as deadlines etc.) are presented in the table. Meetings are on Tuesday morning's 11:00 – 12:30.

SUBJECTS	DETAILS	WHEN?
WEEK 2: METHODOLOGY & DESIGN APPROACH	- Set up Research question - Set up introduction - Index - Written Methodology & Design approach (Reviewing)	Tuesday, Wednesday & Thursday (26th , 27th & 28th April) Deadline: Friday (29th) 16:00 Sunday
WEEK 3: MID-TERM REPORT 1	(Reviewing) - Process feedback - Complete Factor section - Setting up Survey - Continue writing methodology (Reviewing)	Deadline: Monday 16:00 Tuesday, Wednesday & Thursday (3rd, 4th & 5th May) Deadline: Friday (6th) 16:00 Sunday
WEEK 4: MID-TERM PRESENTATION + MID-TERM REPORT 2	(Reviewing) - Preparing presentation - Write data analysis - Finish survey (Reviewing)	Deadline: Monday 16:00 Tuesday, Wednesday(presentation) & Thursday (10th , 11th & 12th May) Deadline: Friday (13th) 16:00 Sunday
WEEK 5:	(Reviewing)	Deadline: Monday 16:00

SUBJECTS	DETAILS	WHEN?
PRELIMINARY RESULTS FOR REPORTS	- Send out survey - Methodology - Write preliminary results - Write preface	Tuesday, Wednesday & Thursday (17th, 18th & 19th May) Deadline: Friday (20th) 16:00
WEEK 6: PRELIMINARY SUMMARY, CONCLUSION & RECOMMENDATIONS	- Close survey - Write results - Start conclusion & discussion - Start presentation/pitch (Reviewing)	Tuesday, Wednesday & Thursday (24th, 25th & 26th May) Deadline: Friday (27th) 16:00 Sunday
WEEK 7: ELEVATOR PITCH: CONCL + RECOMMEND	(Reviewing) - Finish presentation/pitch - Finish conclusion & discussion	Deadline: Monday 16:00 Monday(30th) & Tuesday (31st) Till 7th June
WEEK 8: FINAL REPORT	- Finish summary - Finalize report (with criticism) - Start preparation Final Presentation	Till 7th June Deadline: Tuesday 7th June
WEEK 9: FINAL PRESENTATION + SELF EVALUATION	- Prepare Final Presentation - Write self evaluation	Deadline: Tuesday 14th June After presentations

Appendix B: Survey

Onderzoek deelfietsmobiliteit voor minder wendbare fietsers

Deelfietsen zijn tegenwoordig populaire vervoermiddelen. U kunt een fiets huren in de buurt en deze parkeren op een locatie in de buurt van uw bestemming. Maar helaas wordt een groep mensen in deze activiteit over het hoofd gezien: de minder behendige. Ouderen en gehandicapten hebben vaak behoefte aan eenvoudig vervoer, zoals eerder genoemd, maar zien daar onvoldoende in vanwege het gebrek aan fietsopties die aangeboden worden.

Voor mijn scriptie en met behulp van dit onderzoek probeer ik de opinies van verschillende mensen te achterhalen over verbeterideeën wat betreft fietskwaliteiten in deelfietssystemen. Het invullen van deze enquête duurt ongeveer 2 minuten en is volledig anoniem.

Voor verdere vragen en opmerkingen over dit onderzoek kunt u contact opnemen met mij, Rania Ellounissi, op het volgende e-mailadres:
R.Ellounissi@student.tudelft.nl

Bij voorbaat dank voor uw tijd en moeite

Research on shared bicycle mobility for less agile cyclists

Research on shared bicycles are nowadays a popular mode of transportation. You can rent a bike nearby and park it at a location near destiny. But unfortunately a group of people is neglected into this activity: the less agile. Elderly and the disabled find themselves often in need of simple transportation as mentioned before, but do not see sufficiency in them because of the lack of bike options that are provided.

For my thesis and with the help of this survey, I try to retrieve the opinions of different people on improvement ideas on bike qualities in bike sharing systems. Completing this survey takes approximately 2 minutes and is completely anonymous.

For further questions and remarks regarding this research you can contact me, Rania Ellounissi, on the following email:
R.Ellounissi@student.tudelft.nl

Thanks in advance for your time and effort

Sectie 1

1. Wat is uw voorkeur taal? / What is your preferred language? *

- Nederlands
- English

Demographie

2. Wat is uw leeftijdsgroep? *

- < 15 jaar
- 15 - 24 jaar
- 25 - 64 jaar
- > 64 jaar

3. Wat is uw geslacht *

- Vrouw
- Man
- Geen van de bovenstaande

4. Wat is uw beroep? *

- ◯ School / Studie
- ◯ Werk
- ◯ Werkloosheid / Pensioen
- ◯ Anders

5. Welk woongebied is van toepassing bij u? *

- ◯ Stedelijk
- ◯ Voorstad
- ◯ Plattelands / Dorp

6. Heeft u enige fysieke beperkingen waardoor u een normale fiets niet kunt gebruiken? *

- ◯ Ja
- ◯ Nee

7. Hoe vaak fietst u? *

- ◯ Nooit
- ◯ Maandelijks
- ◯ Wekelijks
- ◯ Dagelijks

Introductie van nieuwe fietsen in deelfietssystemen

8. In hoeverre motiveert of demotiveert de introductie van elektrische fietsen met wielondersteuning (om het evenwicht te bewaren) in deelfietssystemen u om (vaker) gebruik te maken van deelfietsen? *

	1	2	3	4	5	
Demotiveert mij erg	○	○	○	○	○	Motiveert mij erg

9. In hoeverre motiveert of demotiveert de introductie van lichtere fietsen in deelfietssystemen u om (vaker) gebruik te maken van deelfietsen? *

	1	2	3	4	5	
Demotiveert mij erg	○	○	○	○	○	Motiveert mij erg

10. In hoeverre motiveert of demotiveert de introductie van driewielers in deelfietssystemen u om (vaker) gebruik te maken van deelfietsen? *

	1	2	3	4	5	
Demotiveert mij erg	○	○	○	○	○	Motiveert mij erg

11. Hoe beoordeelt u uw ervaring met deze enquête op basis van een 5-sterrenbeoordeling? *

☆ ☆ ☆ ☆ ☆

Appendix C: Results

Descriptive analysis

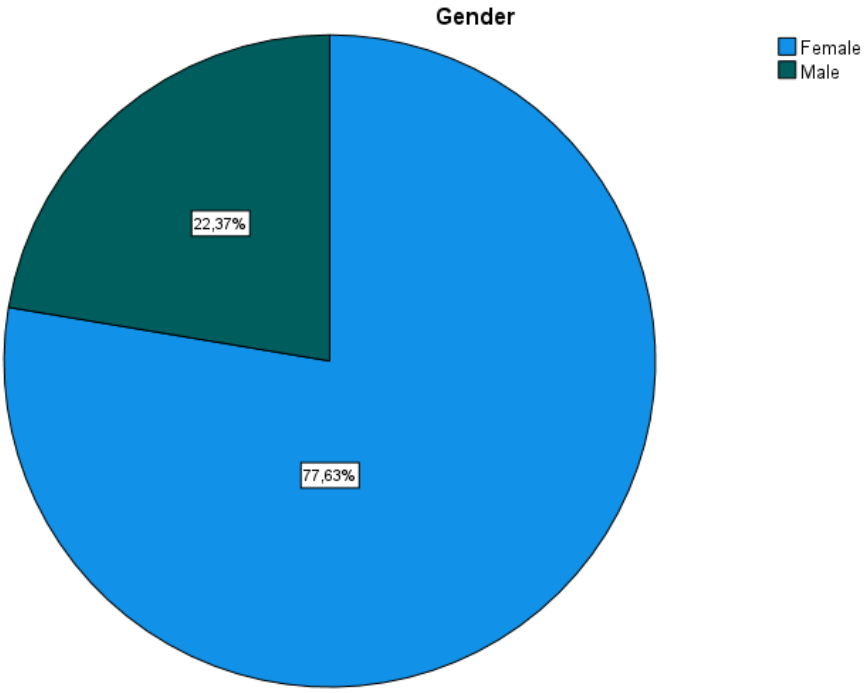

Figure 1: Gender distribution

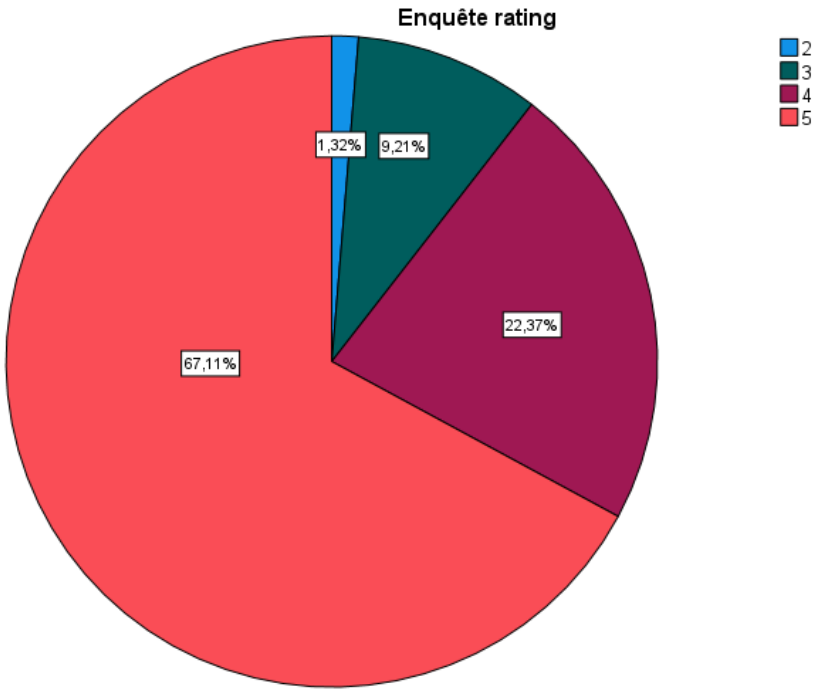

Figure2: 5 Star Rating

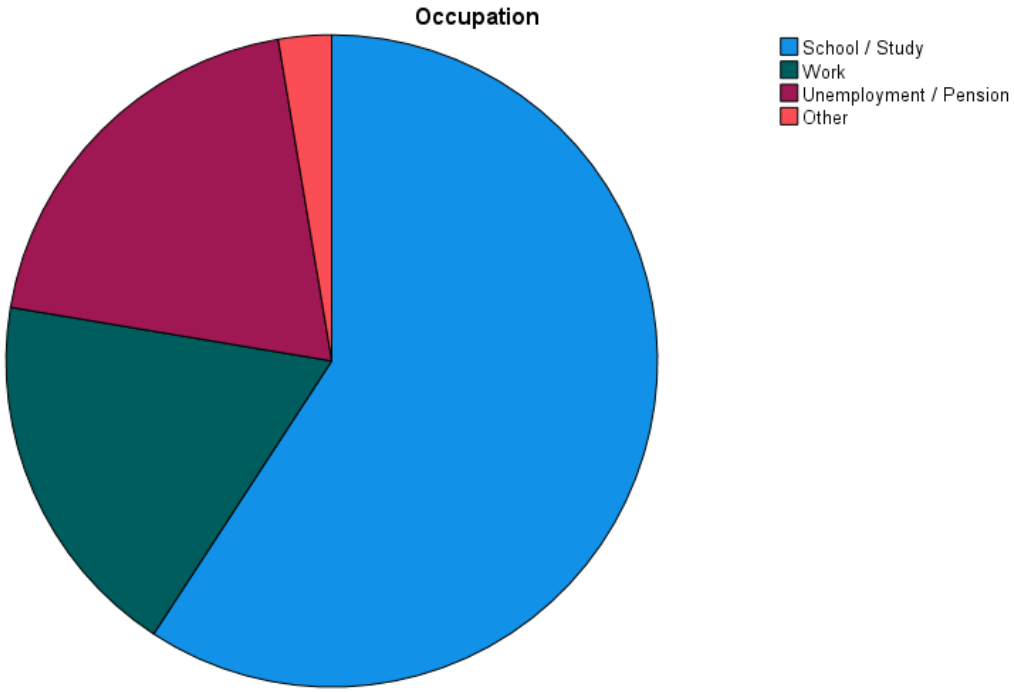

Figure 3: Occupation distribution

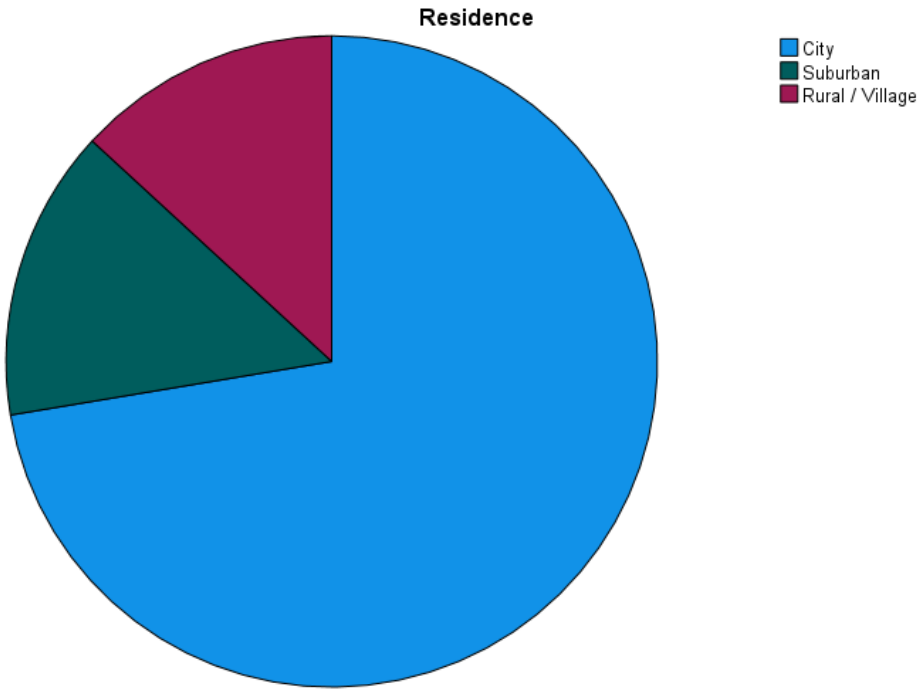

Figure 4: Residence distribution

Mann-Whitney U-test

Ranks

	Age	N	Mean Rank	Sum of Ranks
Motivation for electrical bikes	<65 years	54	31,53	1702,50
	> 64 years	22	55,61	1223,50
	Total	76		
Motivation for lighter bikes	<65 years	54	35,06	1893,50
	> 64 years	22	46,93	1032,50
	Total	76		
Motivation for Tricycles	<65 years	54	30,97	1672,50
	> 64 years	22	56,98	1253,50
	Total	76		

Test Statistics[a]

	Motivation for electrical bikes	Motivation for lighter bikes	Motivation for Tricycles
Mann-Whitney U	217,500	408,500	187,500
Wilcoxon W	1702,500	1893,500	1672,500
Z	-4,534	-2,220	-4,891
Asymp. Sig. (2-tailed)	<,001	,026	<,001

a. Grouping Variable: Age

Figure 5: Mann-Whitney U-test for different ages

Ranks

	Physical limitation	N	Mean Rank	Sum of Ranks
Motivation for electrical bikes	No physical limitation	61	34,98	2133,50
	Physical limitation	15	52,83	792,50
	Total	76		
Motivation for lighter bikes	No physical limitation	61	38,93	2374,50
	Physical limitation	15	36,77	551,50
	Total	76		
Motivation for Tricycles	No physical limitation	61	34,34	2095,00
	Physical limitation	15	55,40	831,00
	Total	76		

Test Statistics[a]

	Motivation for electrical bikes	Motivation for lighter bikes	Motivation for Tricycles
Mann-Whitney U	242,500	431,500	204,000
Wilcoxon W	2133,500	551,500	2095,000
Z	-2,950	-,355	-3,475
Asymp. Sig. (2-tailed)	,003	,723	<,001

a. Grouping Variable: Physical limitation

Figure 6: Mann-Whitney U-test for physical limitation

Ranks

	Cycling frequency	N	Mean Rank	Sum of Ranks
Motivation for electrical bikes	Not regularly	38	40,72	1547,50
	Regularly	38	36,28	1378,50
	Total	76		
Motivation for lighter bikes	Not regularly	38	34,76	1321,00
	Regularly	38	42,24	1605,00
	Total	76		
Motivation for Tricycles	Not regularly	38	40,72	1547,50
	Regularly	38	36,28	1378,50
	Total	76		

Test Statistics[a]

	Motivation for electrical bikes	Motivation for lighter bikes	Motivation for Tricycles
Mann-Whitney U	637,500	580,000	637,500
Wilcoxon W	1378,500	1321,000	1378,500
Z	-,923	-1,541	-,922
Asymp. Sig. (2-tailed)	,356	,123	,356

a. Grouping Variable: Cycling frequency

Figure 7: Mann-Whitney U-test for cycling frequencies

Mean comparison

Motivation for electrical bikes Motivation for lighter bikes Motivation for Tricycles * Age

Age		Motivation for electrical bikes	Motivation for lighter bikes	Motivation for Tricycles
< 65 years (non-elderly)	Mean	3,31	3,57	2,67
	N	54	54	54
	Std. Deviation	,987	1,021	,991
> 64 years (elderly)	Mean	4,41	4,14	4,00
	N	22	22	22
	Std. Deviation	,908	1,037	,976
Total	Mean	3,63	3,74	3,05
	N	76	76	76
	Std. Deviation	1,081	1,050	1,153

Figure 8: Means of rating from different ages

Motivation for electrical bikes Motivation for lighter bikes Motivation for Tricycles * Cycling frequency

Cycling frequency		Motivation for electrical bikes	Motivation for lighter bikes	Motivation for Tricycles
Not regular cyclists	Mean	3,76	3,55	3,18
	N	38	38	38
	Std. Deviation	,998	1,132	1,205
Regular cyclists	Mean	3,50	3,92	2,92
	N	38	38	38
	Std. Deviation	1,157	,941	1,100
Total	Mean	3,63	3,74	3,05
	N	76	76	76
	Std. Deviation	1,081	1,050	1,153

Figure 9: Means of rating from different cycling frequencies

Motivation for electrical bikes Motivation for lighter bikes Motivation for Tricycles * Physical limitation

Physical limitation		Motivation for electrical bikes	Motivation for lighter bikes	Motivation for Tricycles
No physical limitations	Mean	3,46	3,77	2,84
	N	61	61	61
	Std. Deviation	1,089	,990	1,128
Physical limitations	Mean	4,33	3,60	3,93
	N	15	15	15
	Std. Deviation	,724	1,298	,799
Total	Mean	3,63	3,74	3,05
	N	76	76	76
	Std. Deviation	1,081	1,050	1,153

Figure 10: Means of rating from different physical limitations