Bachelor's Thesis Creative Technology

University of Twente

Blike: Developing a cycling gamification app for teaching and motivating people to cycle

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Abstract

The University of Twente has a significant contribution to the collective carbon footprint. Each year a big chunk of the University's emissions are due to commuting, in particular using motorized vehicles such as cars, trains or busses. In order to reduce the impact of unsustainable commuting, staff and students need to make use of sustainable options instead. One such option is cycling. However, a significant percentage of staff and students cannot cycle or choose not to do so for various reasons.

In order to both teach and motivate people to cycle, a smartphone application was researched, developed and tested. This application uses various Gamification and Persuasion techniques derived from literature to achieve its goals. A lo-fi prototype was developed, then evaluated via the means of a survey. Based on the feedback obtained from said survey an improved hi-fi prototype was developed and tested via the same means. Ultimately, this hi-fi prototype can serve as a starting point to a potential full version of the application.

The results of the design and development process are a lo-fi and hi-fi prototype for the system that were both evaluated. These evaluations generated data about the preferences in learning and motivating factors of the staff and students at the University of Twente. Active learning and challenges are most liked, with no preference for group or individual learning. Engagement, interest, social elements and the values of achievement and altruism are most persuasive and motivational.

Data was also collected about how well such a system could be integrated into the University's ecosystem and what would need to be done to develop it further beyond the prototype stage. It was concluded that such a system is extremely necessary and it would be incorporated well into the existing systems, services and events at the University. Therefore, the development will continue beyond the scope of the thesis in collaboration with others.

Acknowledgments

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Finally, I would like to thank all my participants for being willing to contribute to a research project that can hopefully make a real difference in people's lives and wellbeing in the future.

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1. Introduction

On November 5 2020 the University of Twente committed to the cycling mission, proposed by the Dutch Ministry of Infrastructure and Water Management [1]. What this means in context is to attempt to increase the number of people that cycle to the UT by 10% [1]. This commitment aligns with the UT's general sustainability goals when it comes to transport, as one of them is to increase the amount of people who cycle for distances shorter than or equal to 15 kilometres [2]. This is important from a sustainability point of view, as in 2019 the UT produced 28 kilotons of carbon dioxide and of those 18% were due to unsustainable commuting [3]. This data can be seen visualized in Figure 1 and it shows that encouraging staff and students to opt for using a bicycle to commute instead of a car or bus can result in a substantial reduction in the UT's carbon footprint. This would, in turn, make the University a more sustainable institution as a whole.
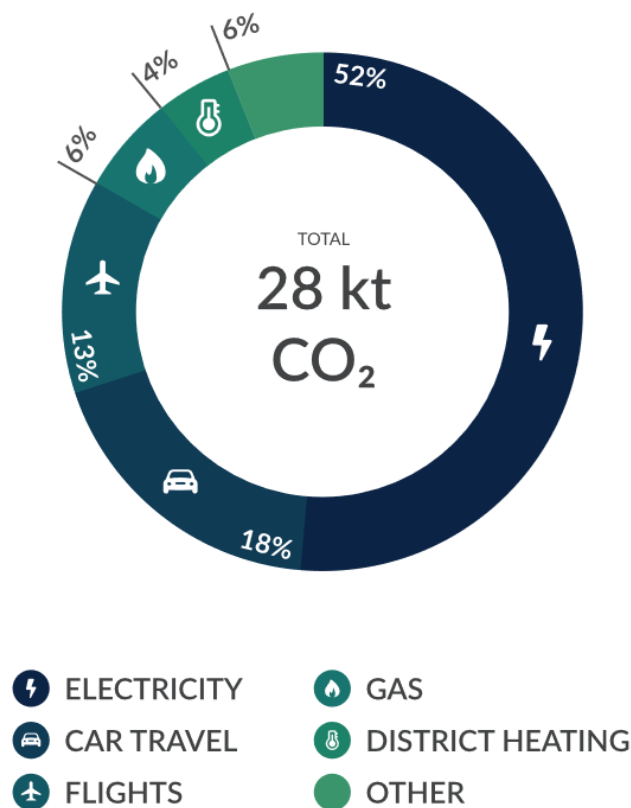
Figure 1: 2019 carbon footprint of the UT [3]

However, a sizable proportion of the students and staff at the UT do not commute by bicycle. In 2011, 44% percent of students did not and 48% of staff did not [4]. This may be especially true for international students or staff, who might not be as comfortable with cycling or may not even know how to do it. Around 31% of all students at the UT are internationals as of 2018 [5] and many of them come from countries like India, China, Romania and Bulgaria [5] where cycling may be less common as a commuting method. This means that many of them may not have the cycling knowledge or experience that the natives have, which could result in them being less willing to commute this way. Despite this, currently, the UT's efforts towards helping such people are rather limited. They offer some support, such as the Faculty ITC's cycling session in the Van Heek Park [2], however, this activity happens only once during the introduction week. Aside from it, support for international students struggling to learn and get comfortable with cycling is still in its infancy.

On the other hand, even if a person is comfortable on a bicycle they may still choose against using it. In particular, many staff and students use a car or bus to get to their place of work or study. The most popular reasons for doing so among staff, for example, are: travel time (48%) and comfort (21%) for cars, and costs (38%) and comfort (31%) for busses [4]. This data can be seen in Figure 2 and it shows that for many the choice is not only dictated by their cycling skill, but also by other factors.
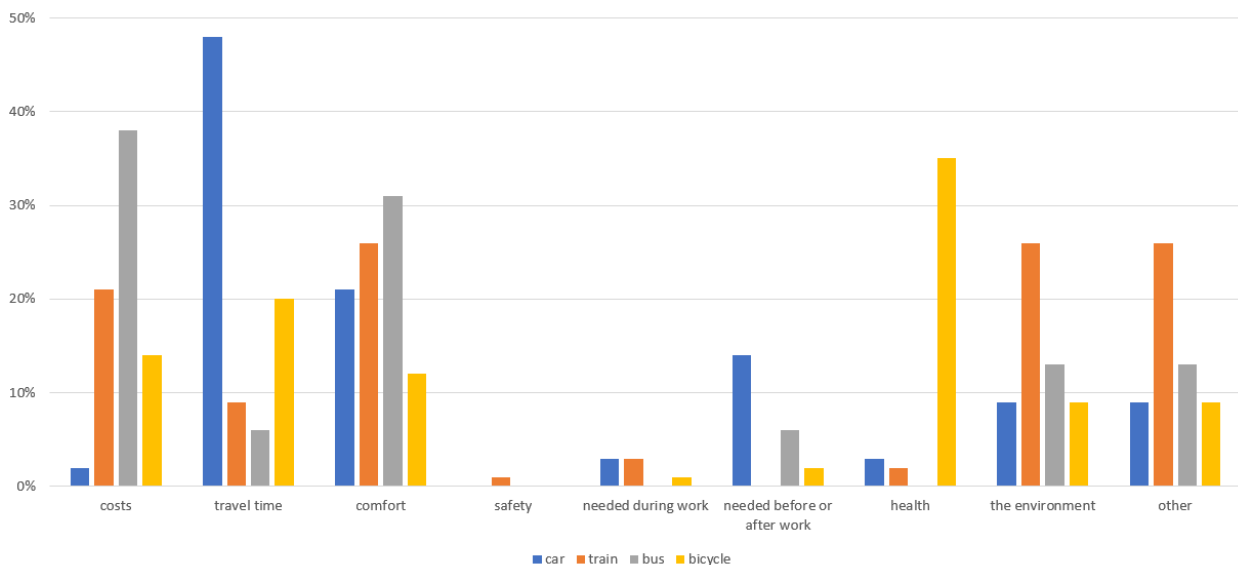
Figure 2: Overview of choosing a car, train, bus or bicycle for commuting, based on data from [4]

The aforementioned issues call for a solution that is not currently in place at the UT. This solution will be in the form of a system that will simultaneously aid people with learning and getting comfortable riding a bicycle, but also make cycling more engaging and enticing for people who already have the necessary skills. This system, its development and the research related to it are the subject of this paper.

The proposed solution is a smartphone application that aims to accommodate users of varying skill levels when it comes to cycling. For people who cannot do it, the application presents a detailed overview of the things necessary to begin learning and allows for users to connect with others who are willing to teach them (either through UT organized initiatives or voluntarily). For people who know how to cycle, but are not yet on the level of comfort they would like to be at, the application offers various challenges they can partake in to improve themselves. For example, they can set a minimum distance they would like to cycle per day and then the application automatically tracks them to see if they have completed the daily goal they set for themselves each day. If they have completed this or any other self-imposed challenges of a similar nature, users are rewarded with experience points within the application. The more experience points they gain, the higher their cycling level becomes. The higher the level, the more features of the application open up to them. For example, once a certain level is reached, the application will allow users to compete with each other on a leaderboard, rather than just against themselves. Furthermore, the competition could be made more personal with two people competing 1-on-1 against each other. Whoever wins this personal competition, will gain a reward which was previously agreed upon amongst the two competitors (for example: the loser buying the winner a meal or taking them bowling).

A system designed in this way will hopefully help aid people with difficulties cycling, making the most sustainable way of commuting available to them in a fun and rewarding way. On the other hand, the application will continually make cycling fun and engaging for more experienced cyclists too, hopefully persuading them to use this method of transportation more often.

As the application to be developed aims at both teaching and motivating staff and students to cycle, two research questions must be answered:
1. *How can staff and students at the UT be taught to cycle with a smartphone application?*
2. *How can staff and students at the UT be persuaded / motivated to cycle more with a smartphone application?*

Naturally, the end goal of this thesis is to give answers to both of these questions as thoroughly as possible, given time and other limitations. The work done to research and develop the system's prototypes as well as evaluate them is presented in this report in an order that corresponds to the Creative Technology Design Process [26]. This process contains four stages: Ideation, Specification, Realization and Evaluation in that order [26] (a detailed overview of this can be seen in Appendix A). The report begins with a State of the Art research chapter (Chapter 2), where extensive Literature Review is done, together with an overview of systems using similar concepts. Chapters 3 through 6 focus on the aforementioned stages in regards to the lo-fi prototype. Based on the evaluation results of said prototype the changes to the Specification are listed in Chapter 7. Afterwards, the Realization of the hi-fi prototype and its evaluation are discussed in Chapters 8 and 9 respectively. Chapter 10 outlines the conclusions of the research and Chapters 11 and 12 focus on discussing the results and recommending avenues for future research respectively. The report concludes with a list of all the appendices and references.

2. State of the art

In this chapter, the primary focus is to provide and summarize the main findings of the research conducted prior to the development of the system in question. This research is made up of two separate sections: a literature review and a state of the art overview. The literature review focuses on exploring the different ways users can be persuaded to change their behavior via the use of technology. The reason for this is because having more information about this subject is essential to a system, which aims at persuading people to cycle more. The state of the art overview, on the other hand, supports the theoretical findings of the literature review by providing concrete examples of persuasive technology, particularly in the field of applications aiming to change user behavior. The reason for this is mostly to gain an understanding of the current trends and also to potentially gain inspiration for the system design. Below both of these sections are presented. Note that major chunks of the literature review are taken verbatim from the writer's Academic Writing Literature review assignment. This was permitted by the teacher and said assignment was done with this report in mind to begin with.

2.1. Literature review

Changing a person's commuting behavior is a difficult task. Providing factual information about environmental impact is easy as this information is widely available through many sources. However, this is not guaranteed to actually convince someone to make a change in their behavior towards more sustainable commuting. The approach could instead be one of persuasion to use the more sustainable option. This, of course, is much more difficult than simply providing factual information. Because of this (and because persuasion techniques will be used in the system of this graduation project), the goal of this literature review is to obtain an overview of the possible answers to the question: *How can users be persuaded through technology?* The way this question is answered is by presenting four approaches to persuasive technology design, visually comparing them via a table and outlining how said approaches could be put into practice.

2.1.1. Persuasion using behavioral change techniques

Behavioral change techniques are often used as a tool for persuasion. Essentially, persuasive systems want their users to change their behavior to match a certain target behavior. For this behavioral change to occur three things must be present: motivation, ability and a trigger [6].

Motivation is a measurement of the user's desire to do an action, ability measures how capable the user is of performing an action and a trigger is an event that causes an action to occur [6]. Furthermore, the presence of a strong sense of control over behavior in a user can increase their intentions to perform said behavior as well [7].

Specific motivating factors for users can be both positive and negative. Positive motivation comes in the forms of pleasure, hope and social acceptance [6]. Essentially, if the system can convince the user that a certain action is pleasurable or will bring them hope or social acceptance, then the user is motivated to perform the action [6]. On the other hand, if a user believes that an action will prevent them from feeling pain, fear or social rejection, then they are more likely to do it as well [6]. It is worth noting that particular care should be taken to not turn motivation into manipulation when it comes to these motivating factors (in particular the ones having to do with social acceptance).

Increasing a user's ability to perform an action is essentially making the action easier to execute. The primary way to do that is by making it simpler to perform [6]. This simplicity not only ensures that more users are able to match the target behavior, but it also correlates with some of the proposed ways to boost perceived control over it. In particular, high skill, knowledge and understanding [8]. Naturally, a simple action ensures high levels in all three. In this way, it creates not only high ability through its simplicity, but also a high level of perceived control over the behavior. This is important, as these are both linked to behavioral change [6][8]. Note that simplicity can come in many forms, depending on who the target demographic is [6]. For example, if an elderly person tries to ride a bicycle, they will not have trouble with it for the same reason as an infant. Therefore, depending on the desired user group, the designer must accommodate their design for the specific problems that the group will face when using it. These may be lack of time, lack of money, lack of physical ability or others [6].

Even if motivation and ability are sufficient, without an appropriate trigger, the user will never behave as desired. Triggers come in three varieties: sparks, facilitators and signals [6]. Sparks are triggers that not only cause an action to happen, but carry with themselves certain factors that boost a user's motivation for performing an action [6]. They are designed to encourage users and push them over the threshold of motivation needed for performing an action [6]. Similarly, facilitators perform an analogous function only carrying a boost to the user's ability [6]. Finally, signals simply remind users who want to and are able to do an action that they should

proceed to do it [6]. Using the appropriate trigger for the appropriate situation is vital to causing a behavioral change to occur [6].

2.1.2. Persuasion through technology as a social Actor

If technology assumes the role of a social actor, it can persuade its users into particular actions [9]. This can be done because technology can assume the role of a human social actor, as long as it gives users appropriate social cues [9]. Essentially, persuasive technology can be designed so that it triggers certain subconscious responses humans have when receiving different social cues [9]. By using specific cues, specific responses can be expected, which the designers can take advantage of and push the user into the desired target behavior.

There are multiple types of cues technology can make use of. Physical cues are usually the ones that have to do with humans' physical senses [9]. For example, making a system more visually attractive makes it more likely that the user will comply with its demands or trust it [9]. This mirrors the results of studies showing that attractive people are also more persuasive than less attractive ones [11]. By contrast, psychological cues happen on a mental level. They most often have to do with a sense of familiarity [9]. For example, users are more likely to trust or comply with a system's demands if the system is similar to them (i.e. in the way it communicates with them or its "personality") [9].

Moreover, language cues are also valuable. A system can use a similar level or style of vocabulary to appeal to its users [9]. Praising language (even if insincere) is also extremely powerful to persuade users to continue an action [9][16]. Finally, technology can present itself taking on an explicit social role (teacher, butler, etc.) and make use of social dynamics (patterns we have when socializing) to truly sell the illusion of being a social actor [9]. For example, this can be made extremely effective for some users by having the role assumed be that of an authority figure. This falls in line with one of the principles of influence that states that people are more likely to comply with demands if they come from a place of authority [10].

2.1.3. Persuasion through gamification

The concept of Gamification is relatively recent to the academic sphere, but it can also be used in the design of persuasive technology. Essentially, gamification is the integration of "game elements and mechanics into non-game applications, systems, and services, to better engage

end-users" [12]. The primary idea may be to make the system more engaging, but an alternative definition of gamification defines a different end goal: "affecting user behaviour" [13]. This suggests a close link between gamification and persuasive design. In a way gamification can be seen as a "particular kind of persuasive design" [13]. It primarily differs from the ones presented so far (for example in [6] and [9]) in the way it goes about said persuasion. Essentially, it tries to affect the users' motivation directly, rather than trying to create an attitude or behavioral change [13].

The way motivation is affected by gamification is traditionally by following a "gamification loop" that has many elements that all center around an internal point system [12]. First, a challenge is presented to the users. Upon completing it, they get awarded points, which improve their position on a global or local ranking list. The higher their points and ranking, the higher their social status is in the system's internal social media setup. This particular element bears a striking resemblance to the "social acceptance" motivator presented in [6]. It, combined with the intrinsic value of the points, rankings and in-system rewards are at the core of persuasion using this method. All the designer has to do is pick the challenge presented at the beginning of the loop in accordance with the target behavior they are aiming for.

2.1.4. Persuasion through values

It can be argued that all human behavior is dictated by certain values people hold. For example, a person may recycle because environmental sustainability is one of their core values. In theory, this process could also work in reverse: i.e. if a designer is able to "activate" a certain value in a person, that may cause them to perform actions that are related to said value. This is a theory proposed by [14]. It suggests that people's values are of two types: extrinsic and intrinsic (also called self-enhancing and self-transcendent). Extrinsic values are "Power and Achievement" [14], whereas intrinsic values are "Universalism and Benevolence" [14]. These values are a subset of values proposed in other (non-technology based) literature on the subject [15]. In particular, Universalism refers to the desire to persevere and enhance the wellbeing of all humans and nature [14][15], whereas Benevolence is more focused on doing that for the people who are frequent personal contacts[14][15].

Knowing which type of values to activate for which types of situations is the key to persuasion via this method. In general, extrinsic values tend to dominate over intrinsic ones [14]. This is of course fine if the designer wants to achieve behavior related to either Power or Achievement.

For example, if they want to persuade a person to play a racing game every day it would be wise to activate these extrinsic values. However, other goals will require intrinsic values to be activated instead. For example, environmental behavior changes often rely on this, which makes sense as such goals often have to do with the wellbeing of others. In this case it is important for the designer to understand that they should not activate extrinsic values accidentally with their solution, because then those values will dominate and the resulting change in behavior will not be as desired [14]. This need for understanding both the goals and the user group of a system is similar to the ideas presented in [6]. In particular, the ones about simplifying systems differently for different user groups to boost their effectiveness.

2.1.5. Table comparison of persuasion Methods

Below in Table 1 a comparison is made between all four persuasion techniques.

	Behavioral Change	Social Actors	Gamification	Values
How do you persuade a user?	Through changing their core behavior	Through social cues that trigger a response	Through rewards systems and social status	Through activating their core values
Through what do you change a user's behavior?	Directly	Through their attitudes	Through their motivations	Through their motivations
Do different user groups need substantially different design approaches?	yes	no	no	yes
Does a social factor play a major role?	no	yes	yes	no
Do reward systems play a major role?	no	no	yes	no
Does praising users play a major role?	no	yes	yes	no

Table 1: A comparison of the multiple persuasion methods discussed in this section

2.1.6. Practical persuasive design

Many different papers about the theories of persuasive design exist, however, some literature chooses to focus on the practicalities and provides a guideline on how to turn abstract persuasion concepts into concrete technological solutions instead. Building off the work(s) of [6] and [9], [16] suggests that the design process should be split into three main areas of

consideration: The Intent, The Event and The Strategy. The Intent is about who the person persuading is and what type of change they would like their system to make [16]. The Event has to do with the usage, users and type of technology intervention they would like to make [16]. The Strategy describes the type of message they want to send to their users and in what way [16].

Although these three elements are important for getting an overview of a system and the users it is designed for, in this context, the method of transforming this overview into a concrete software solution is much more valuable. The designers should begin with the overview and select the persuasion principles they would like to use [16]. From there, software system requirements can be elicited through the means of several methods. These methods closely align with the theory presented in other literature. They include, but are not limited to: reducing the possibility of unwanted behavior in the system, making it very easy to perform wanted behavior (as in [6]), praising and rewarding the user (as in [6] and [12]) and creating the feeling of authority and trustworthiness of the technology (as in [9] and [10]). All of these design choices will then be reflected in the final software implementation, which, ultimately, will result in the behavior change that the designer intended for the user [16].

An alternative and more high level approach to applying persuasion theory in practice is through an 8-step method presented in [17]. Here it is suggested that designers should begin choosing the simplest target behavior they can alter (i.e. break a big behavior change down to the "smallest, simplest behavior that matters" [17]). From there, they should select a receptive target group (usually the group that is most likely to be persuaded) and design with them in mind. Afterwards, they should find out what prevents the target behavior and design their solution for solving that particular issue. In the process of designing similar technologies should be found and imitated. Finally, testing and iteration should be done until a successful prototype is developed, at which point it can be expanded into a full-fledged system following a similar iterative process.

2.2. State of the art overview

2.2.1. Duolingo

Duolingo is a smartphone application that aims at helping users learn a new language. It features an internal points system, in-app rewards, tiers, leaderboards and most other core concepts of the Gamification loop [18]. In addition, it also makes use of praising language and other social cues to encourage users to continue learning. Applying these concepts seems to have proven beneficial to the learning effectiveness, as a study conducted showed statistically significant improvement in language skills when using the application to learn Spanish [19]. Furthermore, the main factor for this improvement was found to be motivation [19], which suggests that Gamification is useful for keeping users motivated to continue a certain behavior (in this case learning a language). In the context of the Graduation Project, these techniques could be applied in much the same way, only in the context of learning to cycle / gaining motivation to do so, instead of learning a new language.

2.2.2. Spinify

Spinify is an application that is aimed at improving individual and team productivity in the workplace. It features several interesting concepts, but it primarily focuses on Gamification of work tasks [20]. For example, it allows for earning in-app points which then earn badges and achievements. These badges and achievements in turn boost an employee's status on the application's social media. All of this is, of course, in line with the Gamification loop [18]. However, a more interesting feature Spinify has is competitions. Essentially, teams compete to boost their KPI's on a leaderboard. The effectiveness of this competition aspect seems to be well received by higher ups using Spinify as can be seen by the citations on their website [21]. These state things like "healthy competition" [21] and "competition in the team" [21] in relation to boosting engagement [21] and accountability [21] in the work environment. Perhaps due to its seeming effectiveness this competition aspect could be integrated in some form within the GP system. For example, users could compete to see who can cycle more in a certain timeframe to boost engagement with cycling.

2.2.3. Samsung health

Samsung Health is a Samsung developed smartphone application that focuses on visualizing a user's health data [22]. Its primary aim is not to actively persuade users into making any change

in their behavior. Instead, it simply tracks their health data in an unobtrusive way and presents it in a clear, concise and understandable manner. From there, users can make more informed decisions about their own health based on this data. For example, the application passively tracks how many steps a user takes per day and visualizes it as a bar chart set against a certain target of steps to be made per day. This target is initially set automatically by the application, but users are able to adjust it to their liking as well. The idea is that users are able to get an objective overview of their steps compared to a goal of steps per day and then decide to increase how much they walk, if necessary. This is a form of a self-imposed challenge, as the system doesn't explicitly reward users with anything if they manage to reach or surpass their step goal for the day (aside from filling up the bar on the bar chart). It simply tracks and presents information with the hopes of triggering a user's values [14]. In particular, the application relies on the fact that almost everyone values their own health and well being, so triggering this value by presenting objective information in a clear way can help change their behaviors towards ones that are more healthy (in this case: walking more).

This form of self-imposed challenge, unobtrusive tracking of data and objective information visualization can prove useful for the GP system as well. For example, if walking is to be replaced with cycling, the system could function analogously, with how much a user cycles per day being tracked in the background and compared to a certain set goal in a visualization. This can hopefully trigger user values in much the same way as Samsung Health does and result in an increase in cycling amount for users.

2.2.4. Habitica

Habitica is another Gamification system focusing on habits, daily goals, and to-do lists. [23]. Essentially, the system provides users with an in-app avatar, which can gain different features the higher their level is. These features are modelled after established gaming concepts such as "battle armor, mysterious pets, magic skills, and even quests" [23]. The way the in-app avatar levels up is through experience points. This is once again in line with Gamification concepts [12]. Additionally, another persuasion technique employed here is the social element. This is also what makes Habitica unique. Essentially a user's avatar can compete in in-app battles with monsters together with their friends. Through these battles they earn currency which can be spent on rewards both in the app and outside of it (like "watching an episode of your favorite favorite TV show" [23]). This incentivises users to level up their avatars and in turn, accomplish their daily goals and to-dos. For the context of the GP system, a similar checklist approach

could be used when users have to purchase the things needed to start cycling. Checking off an item in the list can reward them with experience points, for example, just like checking off goals and to-dos does the same in Habitica. Furthermore, the collaborative social element could also be employed in the GP system with, for example, collaborative goals of cycling together being able to be set and participated in.

2.2.5. University of Groningen Travel Policy & University of Utrecht Travel Check

The University of Groningen has a Travel Policy document currently in place indicating the ways their staff and students should commute to appointments [24]. This travel policy provides a decision tree with multiple branching points where users are asked to answer a series of questions [24]. Based on their answers they ultimately arrive at a certain leaf of the decision tree that indicates the best method of travel they can use for their current situation. The Travel Policy is a relatively low-tech solution, as it is essentially just a static image [24].

The University of Utrecht also provides a similar system in the form of its travel check [25]. However, there are also several differences in its design. While it also takes a decision tree approach, the UU's system presents several smaller decision trees on each branch that are connected with each other [25]. The users are initially asked about the destination of their commute, after which they are funneled through a series of smaller decision trees that end up at the most sustainable way of travelling based on the context [25]. This solution is also relatively more high-tech as it is in the form of an interactive PDF document that allows for user interaction (primarily via clicking the mouse) [25].

Both the UG and UU's systems are similar to the one in the GP in terms of their end goal: get staff and students to choose sustainable travel options. However, there are some key limitations and differences. For one, due to the systems' low-tech nature, user engagement is perhaps rather limited as no interaction is really possible. Both solutions read like an attempt to inform, rather than engage or persuade. This is further reinforced by the fact that neither system noticeably employs any persuasion techniques. There are bits of information provided throughout the decision trees, however, the majority of it is informative and not persuasive. Furthermore, due to the low amount of user interaction, most of the techniques discussed in the literature review are not applicable. This, of course, may be the goal - to inform, rather than

convince, but it is worth exploring how the effectiveness of such systems could be improved if they were to become more persuasive in nature.

2.3. Conclusions

The literature review outlined several techniques widely used to change users' behaviors and persuade them. The primary ones examined were through behavioral change techniques, technology as a social actor, gamification and user values. While the review does not provide information on persuading users in the context of sustainability, it does outline many possible techniques that can be applied in the design of the project. However, because of their broad and theoretical nature, it does not restrict the designer into applying them in a certain way. Because of this, while the primary way of persuasion in the context of the system will be gamification, several elements will be mixed and matched throughout to achieve the best persuasive and behavioral change effect. Regardless, gaining an understanding of how these techniques work and how to apply them is a solid starting point for developing a persuasive system.

The state of the art provides an additional stepping stone. As can be seen many gamification systems exist, all implementing different versions of the technique. Furthermore, using gamification in conjunction with other persuasion techniques could boost effectiveness. For example, praising language, social elements, user values and others. Ultimately, it seems that smartphone and web applications are already in use by designers aiming to cause a behavioral change in users. This informs the choice to combine the techniques found in the literature review, together with inspiration from the examples of this section to create a persuasive system that will hopefully engage users and make them commute more sustainably via cycling.

3. Ideation

To arrive at a system concept a fair amount of ideation was needed. Inspired by the research done in the State of the Art chapter, five ideas for a persuasive piece of technology that aims at getting more people to cycle were developed. All of them were deepened into a basic concept pitch and afterwards one was selected as the starting point of the system. The final idea was developed even further and the result of that is presented in the Requirements Capture. Below all five initial ideas are listed, together with the final idea chosen, supported by the reasons for choosing it specifically.

3.1. Decision tree application

This idea consists of a smartphone application that centers around detecting the user's commute automatically and presenting them with a decision tree of their travel options for said commute. Its primary target group would be students and staff that commute from within Enschede or Hengelo to the University. Thus, it aims at reducing car and bus travel and increasing cycling and walking as a commuting method. Essentially, the system would detect when a user leaves their house (via the usage of GPS, for example) and would then display a notification, prompting the user to open a decision tree within the app. Said decision tree would then ask several questions about the destination of the commute, the desired time of arrival and so on. Upon answering, the app would present the user with the optimal and most sustainable way to travel, together with some information about why they should travel using this method instead of, for example, a less sustainable one. This would hopefully convince the user to ultimately take the most desirable option of transportation.

3.2. Website for staff commuting

This idea proposes a solution, aimed at a different target group: that of professors and staff that commute to places outside of the Netherlands for press conferences or other education-related events. The aim is to make them choose for more sustainable travel, but instead of targeting local travel, international travel is instead the focus. Thus, the idea is to convince professors and other staff to either look for a way to attend these events remotely and if that is not possible and travel is inevitable: to take trains instead of planes as a way to commute. The way this would be achieved is through the involvement of a third party: i.e. the secretaries responsible for booking such travel. Essentially, a website would be developed which would be promoted by the UT as

the way to book educational trips from now on. On this website a decision tree would be presented, similar to that of the idea in section 3.1. The secretaries using this website would choose answers to the tree's questions and ultimately be presented with the most sustainable and convenient option for their employer's current travel, together with arguments as to why this option is the best one. From there, the secretaries would present their employers with this option to get approval for it, which would hopefully be easy, as long as the arguments are convincing enough. Ultimately, this system would lead to a reduction in unnecessary and / or unsustainable travel abroad.

3.3. Bicycle hardware solution

This idea centers around a hardware solution that couples together with a user's bicycle. Essentially, it would consist of a device that attaches itself easily to the bicycle's pedals and measures some sort of metric indicative of how often the bicycle is used. This could, for example, be the amount of rounds the pedals have made, or something similar to how car mileage is measured. This metric would then be converted to points, stored within the device's local storage. The more the bicycle is used - the higher the metric, and the higher the metric - the more points are accumulated. Said points could then be spent in exchange for some sort of material reward. This could be a universal reward like points at the UT's Union Shop, or be programme specific, such as points at the Proto Shop for students of Creative Technology, for example. Ultimately, the goal would be to encourage students to cycle more often by incentivising them both with the intrinsic value of the points as well as the extrinsic material value they can be converted to.

3.4. UT travel check

This idea would closely mirror the systems developed at the University of Utrecht [25], as well as the University of Groningen [24]. Both of these Universities have a system currently in place that aims to achieve what is essentially the goal of this project: to convince staff and students to travel more sustainably. The way they want to achieve this is through a decision tree, similar to the ones described in the ideas of sections 3.1 and 3.2. However, the current implementations of these systems are relatively low tech. The UG uses an image that displays a decision tree in a rather straightforward and classic approach [24]. There is no true interaction between user and system here. The UU's solution uses a PDF document that emulates interaction by asking the user to click on options within it, upon which they are redirected to the page of the document

that corresponds to their option [25]. The idea for this project is to take inspiration from both of these systems but create a more high tech and refined solution. The system would be more interactive: for example, a decision tree website. What's more, this higher interactivity would also allow to make the decision tree traversal more granular, presenting more options, but less information per choice. This would, of course, result in less information overload and a more informed decision. Ultimately, this decision would hopefully be the most sustainable for the current travel context.

3.5. Cycling Gamification Application

The final idea once again targets staff and students and aims at making them cycle more instead of using motorized means of transportation. It has two primary target groups: Staff and students that cannot cycle / are not comfortable with cycling yet and staff and students who are comfortable cycling, but chose not to. For target group one, the app would provide a variety of options to learn cycling (for example: lessons meant to be done on your own, asking for volunteer help or pointing users to University organized events). Through these lessons they could hopefully learn to cycle and feel supported. From there, they can continue using the app to get more comfortable with cycling once they have learned it. The way this would be done is through Gamification. The more a user cycles - the more experience points they gain. These experience points would then be used to unlock features of the app. For example, at the beginning users would only be able to compete against themselves using daily goals, but once they gain more experience (become more comfortable with cycling), they can start competing on a local leaderboard. For the second target group, cycling would be made more engaging by said leaderboard, as well as through personal 1-on-1 challenges that they can enter with their friends (or strangers). Essentially, both parties would agree to compete based on some criteria (for example: who cycles more this week) and the app would keep track of this competition. At the end the winner would receive some reward both in-app and physical, which was agreed upon by the two parties. Ultimately, the idea is to not only make cycling more engaging, but also transform target group one into target group two via the use of Gamification.

3.6. Final Idea and Justification

The final chosen idea is the one of section 3.5: The Cycling Gamification Application. There are several reasons for this. First and foremost, the idea is the most unique, as currently most cycling apps are focused on targeting people already into cycling as a sport. An app aimed at

beginners seems to be a relative gap in research as well as products. Moreover, the systems in place at other Universities are also rather different (i.e. the ones at the UU and UG). This would place the system in a unique spot, allowing it to also serve as a test of sorts for the effectiveness of a different approach, tied to Gamification. Furthermore, this application would be less intrusive than the other proposed ideas. Many of them involve explicit decision trees or notifications, which are most likely to make the experience less enjoyable, thus, maybe even lead to the opposite effect of the desired one, if the user becomes annoyed. What's more, this application is universal (i.e. it doesn't target just students or just staff), therefore, it has the widest reach of the ideas proposed. This would allow it to hopefully make the biggest impact as well.

4. Specification

In order to obtain a specification for the system, several use case scenarios were developed that showcase the primary users and usage of the system. After receiving feedback on them from the client, a high level design for the system was developed and a set of requirements were elicited from it and the use case scenarios, following the MoSCoW method [26]. In this section first the use case scenarios are presented, followed by an overview of the high level design and finally a list of the requirements elicited for the system is given. Of course, these requirements would be for a final version, so the requirements for the lo-fi prototype are also listed at the end of this section.

4.1. Use case scenarios

4.1.1. International gets cycle assistance through the app

> ***Primary actor:*** Carlos Rodrigez - an international who has just arrived in the
> Netherlands, but cannot cycle

1. Carlos is made aware of the app via the International Student Handoutbook
2. He installs the app from the app store and starts it
3. A screen appears that asks him about his level of cycling experience
4. He chooses: "None (I cannot cycle yet)"
5. The app redirects him to a landing page that presents a checklist of cycling related items (a cycle, a helmet, knee pads, etc.). It asks him to check off the ones he has and informs him that for the ones he doesn't, he can click on each item to get to know where to get them.
6. He has brought the majority of them to the country already and is only missing a bicycle. Therefore, he checks off all the items other than that one. For the cycle, he clicks on it to get an idea of where to find one.
7. The app informs him that he can rent one through SwapFiets (at a discounted price), so he does so.
8. After obtaining the bicycle and checking that off the list, the app redirects him to the Beginner cyclers landing page. Here he can start to learn cycling in one of three ways:

on his own, through University provided help or through volunteers. If he chooses on his own, he will get a detailed step-by-step plan on how to learn cycling + various online resources on the subject. If he goes for University provided help, the app will check to see if an event is organised anytime soon and let him sign up / put it on his agenda. If he chooses for volunteer help, he can put out an ad on the app's social media network (Dashboard) that volunteers can respond to and arrange meetings to teach him cycling.

9. Carlos chooses for the University help option, however, no events seem to be anytime soon.
10. He goes back and puts a request out asking for volunteer help. The app asks him if he'd like help at any particular point in time (As soon as possible, in a week, etc.) He goes for "As soon as possible".
11. The app then asks him if he'd like to add some details to his request, so he adds: "I'm an absolute beginner. Speaking Spanish would be a nice bonus".
12. After some time, Carlos gets a notification that informs him someone would like to pick up his request. His name is Jeroen.
13. He accepts Jeroen's offer and they begin talking via the app's messaging system.
14. They exchange phone numbers and move their communication to WhatsApp.
15. From there Carlos starts learning to cycle with the help of Jeroen.
16. In relatively little time, he can now cycle and is ready to continue to the next level of cycling.

4.1.2. International gets more comfortable cycling using the app

Primary actor: Carlos Rodrigez - an international who has just learned to cycle but is not yet 100% accustomed to it

1. Carlos is not yet very comfortable with cycling, despite having learned how to do it recently. He is unsure if he should cycle or take the bus to University.
2. He opens his phone and the app greets him with a small encouraging notification that praises him for his good work with learning to cycle. It also tells him to make sure he keeps at it to reach his daily goal.
3. Carlos is intrigued by the mention of this daily goal and opens the app to learn more. He learns that the application thinks he should cycle about 2 kilometers every day. This goal is represented in a simple circle bar chart. So far, the bar is empty, since the day is just

beginning. This encourages Carlos to cycle to University today to try to meet his daily goal.

4. Carlos commutes to University using his cycle and although he is still not completely confident he manages. Once he is back from University, he opens his phone again to see a notification praising him for accomplishing his daily goal and prompting him to collect his experience points for doing so.

5. Intrigued, Carlos opens the app and sees that, indeed, he has filled up the bar, indicating that he has accomplished his daily goal. He clicks the big button that says "Collect experience points" and a satisfying animation plays indicating that some points have been added to his experience level.

6. Carlos clicks on his experience points counter at the top right and that redirects him to another page of the application where he learns that the higher his experience level - the more features of the app he can unlock. His next milestone is unlocking the local leaderboard at level five. This encourages Carlos to try to meet his daily goal tomorrow as well.

7. The next day he not only meets his current daily goal, but surpasses it. This is because he chooses to cycle to the grocery store, as well as to University. This, naturally, rewards him additional experience points. He feels even more motivated to keep cycling.

8. After a while he gains enough experience points to level up to level 5, where he unlocks the local leaderboard, allowing him to compete with other people with the same experience level. At this point, without knowing it, he has grown quite accustomed to cycling and is motivated to continue in order to see what other features he can unlock and how high he can be placed on the leaderboard each day.

4.1.3. A person comfortable with cycling gets motivated to cycle more via the app's features

Primary actor: Joep Bosmans - A national of the Netherlands who is very comfortable with cycling but feels discouraged from doing so because it is less convenient

1. Joep doesn't cycle a lot, because he finds it less convenient than public transportation. One day he hears from a friend of his that a cycling app exists that people can have fun competitions on.

2. He decides to install the app from the app store and starts it.
3. A screen appears that asks him about his level of cycling experience
4. He chooses: "Very experienced", as he has been comfortable with cycling since he was a child.
5. The app redirects him to a main screen where he sees a daily goal for the amount of cycling, as well as easy ways to navigate to a "Local Leaderboard" and "Personal Challenges" tab.
6. He quickly makes his way around the app, figuring out most of the systems in place (experience points, daily goals and the leaderboard).
7. He starts cycling a bit more, as a personal challenge to himself and to see if he can beat his friends on the Local Leaderboard.
8. He finds this quite satisfying to do. Most of the time he ends up quite high on the leaderboard, beating most people, but sometimes his friend Sjoerd manages to barely come out on top with just a few more points than him. This creates some "heated" competition between the two.
9. When Joep meets Sjoerd for their weekly board-game meet up, Sjoerd jokes around, saying that he will probably beat Joep again this week. Joep disagrees and they get into a light-hearted argument. Ultimately, Sjoerd suggests they enter a personal competition to see who is truly better.
10. Joep is intrigued by Sjoerd's proposition and agrees. He opens the app to send out a personal challenge via the app's social media system.
11. The app asks him what the challenge is and he picks "cycle more than me in the next week".
12. The app then asks him about the reward to the winner and after some discussion Sjoerd and Joep agree that the loser should buy the victor dinner as a reward. Joep types this into the reward field of his challenge.
13. Finally, the app asks if Joep would like to send this out to anyone to respond to or just a particular person. He doesn't want to compete with strangers so he chooses the latter and sends the challenge to Sjoerd. Sjoerd accepts.
14. In the following week both of them work very hard, but Joep manages to come out on top. At their next weekly board-game meet up, Sjoerd does as promised and buys Joep dinner.
15. Joep feels satisfied and motivated to keep cycling more in the future and Sjoerd even offers a rematch for the following week.

4.2. High level design overview

Before providing a final list of requirements, it is important to outline how exactly the application itself would be set up from a high level point of view. Essentially, it would have three different versions based on a user's level of cycling experience. The learning version would be for users who are still learning to cycle. It would feature a home screen with visualizations of daily cycling statistics, a step-by-step guide to learn cycling on your own, a page with group events meant to teach cycling and the ability to post help requests on the application's social media.

The beginner version would be intended for users who can cycle but are still getting comfortable with it or are simply not quite good enough at it to be considered "experts". This version would feature the same home screen as the previously described learning version, alongside a local leaderboard, cycling quests and the ability to volunteer to help other users looking for assistance with learning to cycle.

The final version would be the experienced version. This one would be intended for people completely comfortable with biking, but who are looking to make it more engaging and fun for themselves or looking to help others. It would contain all the same features as the beginner version with only the ability to challenge other users to 1-on-1 cycling competitions being added.

The way these versions would be managed and accessed is relatively simple. Upon starting the application for the first time, a user would be prompted to answer a question about their cycling experience. Three options would be presented: "None (I cannot cycle yet)", "Beginner (I have not cycled a lot)" and "Experienced (I have cycled a lot)". Depending on their answer they get redirected to the associated version of the app.

While using the app, users will accumulate experience points via doing all the activities possible. This will increase their cycling experience level. Once their level is high enough, they will be able to progress from one version of the app to the next. For example, if they are in the learning version, once their level is high enough they can progress to the beginner version and unlock new features. This navigation, as well as the different versions and features associated with them can be seen visually outlined in Figure 3.
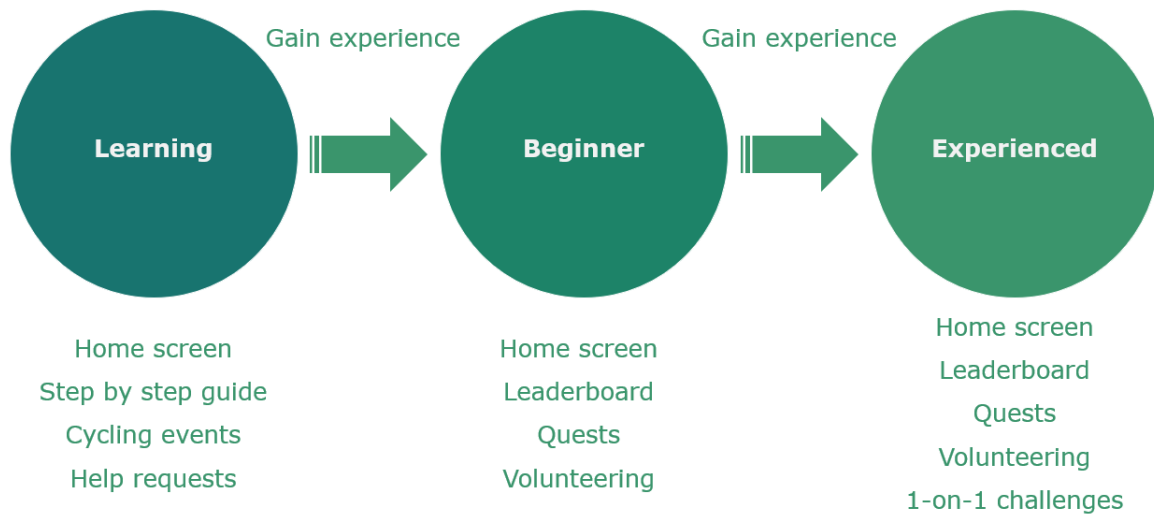
Figure 3: A high level design overview of the application

4.3. System requirements

Based on the use cases and the high level design presented, some system requirements were derived. These requirements were grouped together using the MoSCoW method [27]. Essentially, each requirement was placed in a distinct category: Must have, Should have, Could have and Will not have (this time) [27]. Each of these categories is self-explanatory. There are two sets of requirements elicited at this stage: those for the finished system and those for the lo-fi prototype. Both are presented below.

4.3.1. Final requirements

Must have:

- Tracking of the users' cycling amount
- Rewards for achieving certain cycled distances
- A leveling system based on experience
- A list of events aimed at teaching cycling
- A step-by-step guide on how to learn cycling on your own
- Leaderboards

Should have:

- The ability for users to post requests looking for help with cycling

- The ability for users to respond to requests looking for help with cycling
- The ability for users to challenge each other either by posting a challenge for anyone to respond to or personally challenging one of their friends

Could have:
- A more in-depth social media element
- Personal messaging within the app

Will not have (this time):
- Moderator functionality for the social media elements
- Statistics page for tracking cycling over a long period of time
- The ability to run on a smartwatch
- Aesthetic personalization

4.3.2. Lo-fi prototype requirements

As the lo-fi prototype is only meant to illustrate the concepts of the app, all its requirements are mockup illustrative versions of the functionality of the final application. Furthermore, some of the functionality is omitted so as to not overly complicate the design.

Must have:
- A home page displaying a mockup visualization of amount a user has cycled today
- A page giving a step-by-step guide of how to learn cycling on your own
- A page listing example events organized to teach cycling
- A page containing a mockup leaderboard visualization
- A mockup page with a checklist of items showing what is necessary to start cycling

Should have:
- A mockup request submission page illustrating the process of submitting a request looking for help with learning to cycle
- A mockup page illustrating the ability to pick up requests of others looking for help with learning to cycle
- A mockup page containing a dashboard of all active challenges currently looking for someone to take them on

- A mockup page illustrating the process of posting a challenge to the challenge dashboard

Could have:
- A mockup page showing all your current requests looking for help
- A mockup page showing all your current active challenges
- A mockup page showing more details for each event organized
- A mockup page showing details of each challenge

Will not have:
- Any mockup chat or social media functionality
- Any actual functionality that is not illustrative in nature

5. Realization of Lo-fi Prototype

After having developed a high level design for the system and having elicited the requirements for the lo-fi prototype in the previous chapter, the next step is to develop said prototype into an existing product. For this purpose a mockup app was developed using stock HTML, CSS and Javascript. This prototype was essentially a website built to look like a smartphone application. This website would then be hosted online for users to interact with and evaluate as per the description in Chapter 6. To better understand the mockup's structure and design this chapter will focus on the architecture, system components and interface of the prototype. Afterwards, a comparison between the delivered product and the elicited requirements will be made to see to what extent they align and if something is missing.

5.1. Architecture and system components

Essentially, the lo-fi prototype is a website, as mentioned before. It aims at delivering a mockup illustrative application that incorporates the high level design presented in Section 4.2. Each of its screens is just an HTML page designed to look like a phone application screen. The navigation between different tabs, menus, etc. in the application is basically like clicking on links that redirect you to a different html page. For example, if one were to click the home button in the bottom navigation bar, that simply redirects them to the "home.html" page using the href attribute, the same way a link would redirect a user on a website. This can be seen illustrated in the code snippet in Figure 4. Altogether, this simple architecture does a sufficient job of creating the illusion of seamless navigation and an app that is one whole.

```html
<a href = "home.html">
    <i class="fa fa-home"></i>
    <p style = "font-size: 2.5vw; margin-top: 5%; color: ■#929ec0;">Home</p>
</a>
```

Figure 4: Code snippet for linking to the home page from the bottom navigation bar

When it comes to system components, on the highest level, these are the different screens of the application, also referred to as "tabs". For example, the Home tab, the Self-learning tab, the Leaderboard tab, etc. These tabs, in turn, all contain individual smaller components that make up their content. Most of the time, these are simply HTML containers like div's, span's, etc.

styled heavily with CSS to serve the visual purpose they need to serve. Such is the case with the Event cards in the Events page for example, which can be seen in Figure 5.
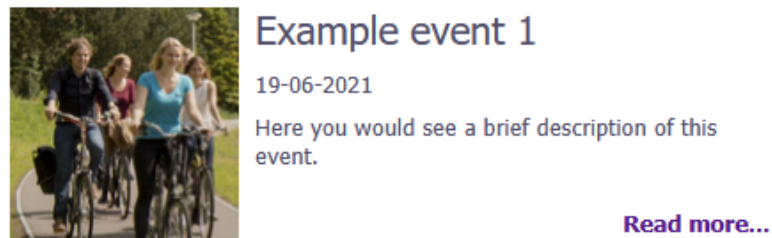
Figure 5: An event card in the lo-fi prototype

Additionally, some special components were used in the system as well. For example, HTML forms were used for the sections where user information is necessary, such as for the posting of a request for help or posting a challenge. These forms have no backend functionality, thus, they do not actually submit anything, but they do serve to illustrate the functionality visually. How one of them looks can be seen in Figure 6.

Figure 6: Form for making a new challenge

Another more involved component are the visualizations on the Home pages seen in Figure 7. The experience level bar is simply a styled span element, however, the Doughnut chart showcasing a user's daily goal is achieved via an external Javascript library called chart.js [28]. This library essentially allows developers to generate different types of charts to display a set of data on a canvas [28]. The data here is hard-coded, of course, as it is only illustrative.
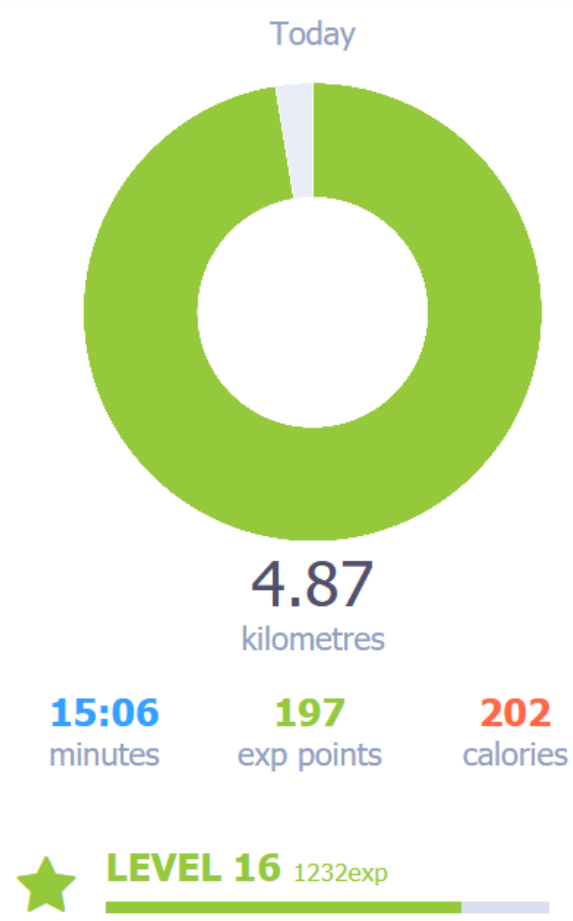
Figure 7: Home screen visualizations

Overall, all system components and interactions are kept simple and clean in their software design, because their only real purpose is to display the idea of their functionality well, rather than actually have said functionality. A full overview of all the tabs in the system can be found in Appendix B.

5.2. Interface

As mentioned before, the primary purpose of the lo-fi prototype is to illustrate functionality. This is most easily achieved via a good interface, so a significant amount of time was spent designing and implementing it. The first important dilemma was how to handle navigation. Ultimately, the app would have a different set of pages depending on a user's experience level. This means that at any given time, there would be no more than four to five screens a user needs to navigate between. Due to this relatively small amount, a bottom navigation bar was chosen as a way to maneuver between tabs, as opposed to a hamburger menu or some other more complex navigation system. To make navigation even more intuitive and visual, aside from the names of the tabs, an accompanying icon is present taken from the Font Awesome library of icons [29]. This hopefully helps users to more quickly identify which tab they want to click on just by its icon. The way this looks altogether can be seen in Figure 8, showcasing the navigation bar for the experienced version of the app.
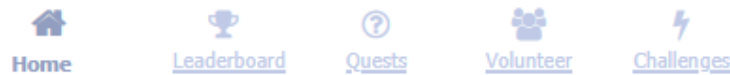
Figure 8: Bottom navigation bar in the experienced version of the app

Aside from the bottom navigation bar, most screens on the app are rather simple, not needing much additional navigation aside from scrolling up or down or clicking on buttons and links. This is functionality that most people are familiar with due to interactions with other apps and websites. Only some screens require further navigation, due to the fact they need to present multiple vastly different sets of information to the user. For example the Challenges tab needs to hold a Dashboard of the current challenges near you, an overview of the challenges the user is currently taking part in as well as a section where the user can make a new challenge. This is a lot of information and functionality for just one tab, so as to not overwhelm the user with it, it is better to split it into three distinct sections. However, having three tabs in the bottom navigation bar is not a good solution, because then the bar becomes too cluttered and hard to read. The solution was to implement another pseudo-navigation bar at the top of the Challenges tab as seen in Figure 9. This bar redirects the user to the appropriate section and keeps things segmented as to avoid information and functionality overload.

Figure 9: Top navigation bar in the Challenges tab

The rest of the interface elements (buttons, links, dropdown menus, textboxes, etc.) are all commonplace within these types of systems, based on the researcher's personal experience, but also as can be seen in a lot of the applications covered in the Chapter 2. Therefore, they are not worthy of a deep-dive like the aforementioned ones. Instead, it is better to focus on the app's aesthetic choices. The lo-fi prototype incorporates a light mode simplistic palette. Whites and various shades of gray are used as primary colors, with black or dark grey text set against them. Color is used sparingly, with blue, red, green and yellow being present. Blue is most often used as an accent color, such as for the title bar at the top, or as the background of the buttons, as seen in Figure 10.
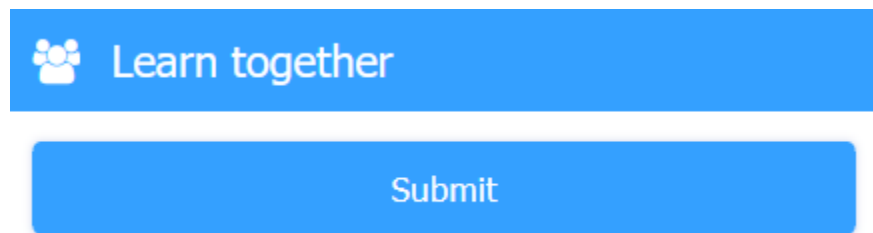
Figure 10: Blue used in the title bar and submit button

Red is used to signify elements of excitement, conflict or negativity, as per its symbolic meaning in culture. For example, it is used as a text color for the challenges as seen in Figure 11.

Figure 11: Red used for the challenge text

Green is used for elements that have exactly the opposite meaning: confirmation, positivity, etc. For example, you can see it be used as the experience bar color in Figure 12.

Figure 12: Green used in the experience bar

Finally, yellow is used as a subtle accent color signifying achievement or winning. This is mostly present in the leaderboard, as seen in Figure 13.

Figure 13: Yellow being used in the leaderboard

Ultimately, all color is used sparingly and as an accent, in order to keep the clean light mode look. The colors themselves were chosen based on the designer's intuitive understanding of color meanings and theory based on their experience in art and UI design. A light mode was chosen as a basis for much the same reasons, as light-colored applications tend to be more inviting and positive (based on the subjective opinion of the designer). A full overview of the lo-fi prototype's color palette can be found in Appendix C.

The last aesthetic elements are the images, which are mostly pictures used from the internet that illustrate the point. For example, the step-by-step cycling guide uses images to support the text.

5.3. Comparison of lo-fi prototype and requirements

For the sake of simplicity, the lo-fi prototype's requirements from Section 4.3.2 are once more presented below, but this time in a table. A green square next to each requirement signifies that said requirement has been fulfilled in the final lo-fi prototype. A red square signifies the opposite. This can be seen in Table 2.

Must have	
A home page displaying a mockup visualization of amount a user has biked today	🟩
A page giving a step-by-step guide of how to learn biking on your own	🟩
A page listing example events organized to teach biking	🟩
A page containing a mockup leaderboard visualization	🟩
A mockup page with a checklist of items showing what is necessary to start biking	🟩
Should have	
A mockup request submission page illustrating the process of submitting a request looking for help with learning to bike	🟩
A mockup page illustrating the ability to pick up requests of others looking for help with learning to bike	🟩
A mockup page containing a dashboard of all active challenges currently looking for someone to take them on	🟩
A mockup page illustrating the process of posting a challenge to the challenge dashboard	🟩
Could have	
A mockup page showing all your current requests looking for help	🟩
A mockup page showing all your current active challenges	🟩
A mockup page showing more details for each event organized	🟩
A mockup page showing details of each challenge	🟥
Will not have	
Any mockup chat or social media functionality	🟥
Any actual functionality that is not illustrative in nature	🟥

Table 2: Fulfillment of the lo-fi prototype's requirements

As can be gathered, all requirements for the sections Must have and Should have are fulfilled. Majority of the Could have's are also present, with the exception of the mockup page that shows details for each challenge. The Will not have's are also naturally not present in the lo-fi prototype.

Based on this brief analysis, it can be concluded that the lo-fi prototype matches its requirements more than sufficiently enough and is ready to be evaluated as described in the next chapter.

6. Evaluation of Lo-fi Prototype

With the lo-fi prototype completed, the next step is to evaluate it with its potential users. This chapter aims to outline this process and the results of it. The first part will focus on the goals of the evaluation, the second part on the methods, the third on the requirement of participants, the fourth part will outline the results and the final and the fifth part will focus on the limitations of the evaluation that are worthy of keeping in mind.

6.1. Goals of evaluation

Before considering the methods, it is important to keep in mind the two research questions, as the goal of this thesis (and thus, of this evaluation) is to get closer to obtaining answers to them. In brief, the RQ's aim at finding out how best to teach staff and students to cycle and how best to persuade / motivate them to cycle more. Therefore, the evaluation, regardless of its method, should be centered around obtaining an idea of the effectiveness of the prototype to both teach and motivate. Thus, the primary sets of questions asked to participants should be about these two things.

Additionally, it is important to understand participants in these contexts as well. Knowing what motivates a certain participant, what their preferences in learning are and how, when, etc. they learned to cycle (if they did), are useful for that. Based on this knowledge biases can be identified and the evaluation can be made more accurate. For example, if a participant shows an affinity towards learning in a group, then of course the effectiveness of the learning to cycle via University held events will be rated way more positively than the Step-by-step guide to do so on your own. This does not mean the latter type of learning is not effective in general, just not for this particular individual and group of individuals like them.

Finally, it is also important to examine how well the system functions as an application. Although this is not part of the research questions, a well-functioning and designed app that is aesthetically appealing, is one of the client's desires by the end of the thesis, as well as in the future. Therefore, the system's functionality be tested as well.

Ultimately the evaluation focuses on obtaining answers to the following questions:
1) What are participants' preferences in learning?

2) What motivates participants generally?

3) How effective is the prototype at teaching users to cycle?

4) How effective is the prototype at persuading users to cycle?

5) How usable is the system presented in the prototype?

6.2. Methods of evaluation

The method of evaluation is in brief the following: users will be sent a survey, containing a link to the lo-fi prototype, which is hosted online, together with a set of questions about it. Upon filling out the survey, they will have given opinions and information that upon being grouped and analyzed will result in achieving the goals of the evaluation. Said goals amount to answering the aforementioned questions and are as follows:

1) Finding out the users' preferences in learning (answering Q1)

2) Finding out what motivates users (answering Q2)

3) Finding out how effective the prototype is at teaching (answering Q3)

4) Finding out how effective the prototype is at persuading (answering Q4)

5) Finding out how functional the system is (answering Q5)

In brief, for each of these goals, a set of questions is present in the survey. For 1) and 2), the users are asked to interact with the tabs and functionalities of the app that have to do with teaching to cycle and persuading to cycle respectively, after which they are asked for opinions on them, suggestions for inclusions and about their general effectiveness. For 3) and 4), a set of questions at the beginning are present to find out about these things. They are rather direct, but kept as impersonal as possible. For 5) the System usability scale a.k.a S.U.S test is used [30]. This test asks ten simple questions for ranking statements on a scale from one to 5 and then calculates a S.U.S score that indicates how usable and intuitive the system is [30]. This score is on a scale from 0 to 100, with 68 being a system with average usability and anything equal to or above 75 being considered a system with good usability [31]. The full scale can be seen below in Figure 14 and for more information on how the score is actually calculated, see Appendix D.

Figure 14: S.U.S test scale [32]

Finally, for a full list of the survey questions, visit Appendix E.

6.3. Recruitment of participants

Recruiting participants was done via an advertisement post made in various Facebook, Whatsapp and other online communities. Furthermore, some personal contacts of the researcher were invited as well. Ideally, the target group would be people who do not know how to cycle / have learned recently, or people who know how to cycle, but often do not do so. This is because these participants would result in the most accurate feedback for the application, as they are the exact target group. Due to them being a relative niché audience, however, anyone who was working or studying at the UT currently (or at some point recently) was invited to participate as well, given they are over the age of 18 and are competent. As a result of these recruitment efforts 8 participants took part in the survey.

6.4. Evaluation results

For organisational purposes the results of the survey will be examined per question / goal of the evaluation. For Q1 and Q2 some additional observations will be made relating to the prototype. Primarily, how well it currently matches the participants' desire to learn and be motivated. Finally, a general overview of the results will be given at the end of this section.

6.4.1. User preferences in learning

When it comes to learning, participants showed a preference for active learning. In total, 62.5% of participants showed a preference or strong preference for active learning, with only 12.5% being neutral and 25% showing a light preference for passive learning. This desire for active participation also reflects in what type of activities the participants find appealing. Activities such as competitive quizzes or small rewards for learning consecutively were most liked, whereas more passive forms of learning such as pre-recorded lectures or lecture slides were liked much less. What's more, passively listening and taking notes was not liked with only 12.5% showing a preference for it.

When it comes to challenges in learning, they are considered a positive addition. 87.5% of participants find them helpful and only 12.5% indicate a neutral opinion on the matter. Furthermore, no strong preferences were given when it comes to the type of challenges. Roughly an equal number of participants liked self-imposed challenges, as they did competitive challenges against others, with only a small skew (12.5% showing a strong preference) towards self-challenge.

Moreover, no strong opinion was given on group versus individual learning. 50% of participants were neutral on the matter, with 25% showing a preference for group learning and 25% showing a preference or strong preference for individual learning.

Finally, a majority of participants had learned something through a smartphone application before, ranging from language to interpersonal skills and combating bad habits.

6.4.2. User motivation

Users stated multiple reasons for feeling motivated. Firstly, interest was cited as a big factor for multiple participants, with a liking for the activity being closely related to this. Essentially, participants would like to do something if they enjoy it and find it interesting.

Secondly, participants are often motivated by a sense of enthusiasm, a desire for self-improvement, satisfaction or a feeling of having a purpose. These factors come internally, but could be created via different other factors or system elements in this case.

Thirdly, other people play an important role in participants' motivation. This is both generally through interacting with them or getting support from them, or in particular via competing with them (in a friendly manner).

Finally, external factors also influence participants' motivation, be that negative or positive factors. On the negative side, deadlines were cited as a motivator and on the positive side feedback, rewards and a desire to make money were cited.

When it comes to who exactly motivates participants actions, there was no strong preference shown towards doing things for yourself or doing things for others. An approximately equal number of participants keep themselves in mind as they keep others in mind and 50% showed no indication of either.

Values also play a role in motivation. The overwhelming majority of participants (85.7%) are motivated by Achievement [14] and a total of 80% are motivated by Benevolence (trying to do the best for the people close to them) [14] and Universalism (trying to do the best for everyone) [14]. Both of the latter relate to Altruism. Overall, this data shows that both intrinsic and extrinsic values [14] work equally well when it comes to motivating participants.

Finally, motivation for cycling specifically is mostly because of speed, convenience and cost, in order from most motivating to least motivating. Although it should be noted that all three were indicated as motivational in general.

6.4.3. Effectiveness in teaching

Users had varying opinions about the different ways of learning on the app. Firstly, when it comes to the introductory section where users are presented with a checklist of items to get to start cycling that they must get and check off before getting to the core functionality, most users (75%) thought that this was a good flow for someone just starting to learn and use the app. The items listed were deemed a sufficient amount by the same percentage of participants, however, some thought requiring users to get every item and check them all off was too restrictive. An element of choice was requested by allowing users to not get certain items. Instead, it was suggested that they are warned about the dangers, but could proceed without getting knee pads or a helmet, for example. Some participants thought the amount of extra information per item

was not enough (25%) and the same percentage of participants could not easily find where this information was located. Overall though, this beginning section of the app was well-received.

The self-learning section of the app which contains a step-by-step guide for an individual to learn cycling on their own was quite divisive. Participants are mostly neutral when it comes to how effective this way of learning is and how motivational it is. Opinions are also evenly split on if the guide is detailed enough. The primary missing elements listed as not present but necessary are information about adjusting the steering of the cycle, how to balance properly, how to adjust different cycle seats and information about cycling traffic rules.

The tab containing different events to help teach users cycling was more positively received. 71.4% of participants find this idea appealing, with their vision for such an event generally being a trained instructor or instructors teaching attendees via exercises or using the same steps as presented in the self-learning page. Many also imagine the event as a fun activity with a high level of humour. First aid, a good location, different groups for different levels of skill and tools for fixing bicycles were also listed as essential. Regardless, all participants view the idea of such events positively or are neutral about them, with a 57.2% majority finding them effective for helping someone learn. A small majority would look at this section of the app first when trying to learn to cycle and most are neutral about whether they would regularly check to see if new events become available. Ultimately, 71.5% of participants were less likely to attend such an event alone and events would be most liked if organised by the University, then if organised by another institution such as the ITC Hotel and finally if organised by the Enschede Municipality (in that order).

When it comes to submitting requests for help on the app's social media, participants had an overwhelmingly positive reception to them. 71.5% of them find the idea appealing and 85.7% find it useful for learning to cycle. The same percentage of people would be more likely to seek help from their friends than from strangers, with a small majority of them being unwilling to trust strangers on the app at all. Regardless, 28.6% of participants feel neutral when it comes to how safe posting such requests is and 42.9% of participants feel completely safe doing so. Overall, this is the best received way of learning to cycle with the only missing element being an indication of the location a user would like to be helped at. This could be useful to avoid commuting problems for either the helper or the one being helped.

6.4.4. Effectiveness in persuading

The first persuasive / motivational element of the app is its Home screen, displaying visualizations of various statistics about the user's daily cycling, including the amount, time, calories burned, daily goal for cycling, steak and cycling level. When it comes to understanding these statistics, a vast majority of participants (87.5%) found them understandable or completely understandable. Furthermore, all participants found the visualizations chosen for each bit of data logical and clear. For the daily goal in particular, some users are neutral on whether they would want to meet their goal every day and the remainder is evenly split between lacking the desire to do so and having it. The cycling experience level is more effective with 75% of participants wanting to see it go up. The same percentage would also be interested in keeping a cycling streak going for some amount of time, although the desire here is less strong than wanting to get a higher level of cycling. Users were generally enthusiastic about the Home screen with the only additions suggested are displaying the daily goal as text on the screen and also allowing it to be customizable.

The Leaderboards are another way to persuade and motivate users to hopefully cycle more. Participants generally agree that competing with others is motivational and so is comparing your achievements and progress with others. Therefore a small majority (52.5%) find the Leaderboards motivational for cycling more and the same percentage would be even likely to form a 'personal rivalry' of sorts with another user on the Leaderboard who ranks close to them consistently. The primary issue pointed out with the Leaderboard is lack of personalization. Suggested additions are adding profile pages for the different users to see more about them and the ability to customize the Leaderboard based on what is most important to a user: speed, distance or longest single cycling session. All of these personalization features would make this section of the app more engaging and persuasive for users.

Another way to persuade and motivate is the Quests tab. Although a simple concept, 75% of users found the desire to achieve a quest motivational for cycling more. Additionally, an even higher percentage (87.5%) would go for full completion, with trying to achieve all the quests they currently have available. Most participants think quests should be added weekly and it was suggested that they are added only after completing all the ones currently available, so as to not overwhelm users. It is indicated that five quests a week is also a good number of quests to have, with a maximum number of quests at any given time being in place. Most suggested quest types have to do with achieving maximum distances or speeds, but some more interesting

ideas include allowing players to go on quests to gather certain items (akin to treasure hunting) or finding their way to certain locations in the city or around it.

Challenges were also really well received. 87.5% of participants found them understandable as a concept and 75% thought they are motivational for cycling more. All participants would use the system to challenge their friends, while when it comes to strangers, there was a completely even split with an equal number of participants being willing to challenge them as they are unwilling to challenge them. Even so, half of participants would still pick up a stranger's challenge from the dashboard. In this case, the reward would play a role as well, with 75% of participants indicating that to be the case for strangers' challenges. With friends' challenges the data seems to be almost exactly the opposite with a majority of participants indicating that the reward would not play much of a role in their decision to accept a friend's challenge. When it comes to types of challenges suggested, most focus around fastest speeds or longest distances with a few more creative suggestions such as getting a higher weekly elevation gain or cycling the longest consecutive distance without stopping at a traffic light. Suggested rewards seem to be mostly food or drink related with beer being cited quite often together with small snacks like cookies or sunflower seeds. On a final note about challenges and rewards, it was indicated that participants would prefer to get suggestions from the app for different challenges in case they do not have many ideas themselves.

6.4.5. System usability

As mentioned before the S.U.S test was used to measure the System usability of the lo-fi prototype on a scale from 0 to 100 [30]. The average score for a system is around 68 [32]. Running the calculations on the data gathered from the 10 questions in the survey returns a score of 75 for the lo-fi prototype's usability. This places it on the 'good' side of the spectrum, but still with room for improvement. The main issues seem to stem from the system being slightly cumbersome to use and the users not feeling confident enough with using it. Furthermore, some smaller problems with the system's integration and consistency also seem to be present. These are potential places to improve in order to make the system score even higher and into the 'excellent' side of the usability spectrum.

6.5. Evaluation conclusions and reflection on the prototype

Overall, participants value active learning, especially through challenges. As the prototype (and the app itself) uses Gamification, this makes it more proactive than traditional forms of learning. Furthermore, this approach focuses on challenging users constantly, as discussed in the Gamification loop [12], therefore, users' desire for challenge in learning is also fulfilled. The lack of strong preference in individual vs. group learning and self vs. competitive challenges are also reflected in the prototype, as it features options for both individual learning (the step-by-step guide) and group learning (cycling events and 1-on-1 help), as well as both self-challenges (daily goals, streaks and quests) and competitive challenges (leaderboards and personal 1-on-1 challenges). In this way, the prototype satisfies the participants' wants and preferences in learning completely, with only implementation tweaks needed to make it more effective.

When it comes to teaching cycling in particular, there are doubts about the effectiveness of learning on your own via a step-by-step guide. This could possibly be improved via adding more detail and expanding the guide to feature more information. The concept of Events is well received, but if put forward in practice, they should be kept fun, engaging and conducted by professionals, preferably stemming from the University of Twente. Finally, the ability to make 1-on-1 help requests was deemed very effective for learning, but lacked some minor customization options that would make it even better in a future iteration.

Persuading and motivating users involves many factors, but at the core of all of them is either the desire to achieve something or to help others. The prototype features the possibility for both. Achievements come in many forms - from meeting daily goals to placing higher on the Leaderboard, whereas the altruistic desire to help others is fulfilled by the ability to volunteer and directly assist other users with learning to cycle. It seems like the prototype satisfies both core values that motivate and persuade people to do things (in this case cycle more). The room for improvement here is once again in implementation. A more personal and engaging system is needed for all these concepts presented.

Finally, the system was deemed usable at a good level, but could be taken even further with actual implementations of the features rather than just an illustrative interface, as well as some general design tweaks as described in the previous sections.

6.6. Evaluation limitations

The first and most obvious limitation is that of time. As the evaluation was done over just one week, not a large number of participants took part (only 8), which may have skewed the results or made them less statistically significant. A larger group of participants should be sampled, in order to obtain more convincing data. Furthermore, the participants themselves did not match one of the target groups of the app, as they indicated having learnt to cycle long ago and also having an overall positive experience with it. This has also undoubtedly biased the evaluation results. Finally, due to the quantification of the data (i.e. representing complex human opinions as essentially a number from 1 to 5, for example, with the questions about agreeing to a statement) some nuance may have been lost in this process that could be essential to understanding or contextualizing user opinions.

7. Changes to Specification

As a result of the Evaluation several changes were made to the Specification for the next prototype to be developed. In this section they are outlined and ultimately a new list of requirements is presented, but this time: requirements for the high fidelity (hi-fi) prototype of the system.

First and foremost, the first change is a change in technology. Rather than the relatively limiting and primitive HTML, CSS and Javascript used in the lo-fi prototype, there must be a more complex toolset at the basis of the next iteration. This toolset would need to allow for a more interactive and functional system prototype. This is for several reasons. On one hand, such a change allows for a prototype that much better illustrates what the actual application would look and behave like. On the other hand, it improves the system's usability score, because by having more functionality implemented, rather than just illustrated, the system itself becomes more usable by definition. Finally, one of the major goals of this research is to build a fully functional application after the completion of the Bachelor's Thesis, meaning that a better choice in technology for the hi-fi prototype could aid in that process in the future.

The second change in specification is an aesthetic one. This prototype should be made to be more visually appealing and fitting both modern design trends and most importantly, the University of Twente's general visual aesthetic when it comes to websites and web applications. This includes altering fonts, colors, icons and whatever else is needed in order to achieve this look and feel. The reason for this is not necessarily dictated by the lo-fi evaluation, as it featured no measurement of aesthetics. Instead, it is driven by the idea of a fully functional system beyond the scope of this thesis. This system would need to fit within the context of other modern applications, but also within the UT's range of web services and products. This is why such an aesthetic is a good step towards making the system more easily adoptable in the near future.

The final set of changes are based on direct feedback from the open question of the lo-fi evaluation survey or on the summed data from the closed ones. These changes do not necessarily relate to each other, nor do they fit in categories, so in the interest of keeping things organised, they will simply be listed below with reasons for each described briefly:
1) The Self-learning tab's step-by-step guide should be expanded to contain more information about steering, balancing, adjusting the bicycle seat and traffic rules.

2) The Events tab should contain actual cycling events, instead of placeholders as was the case with the lo-fi prototype. This would make the system more functional and illustrative.

3) The form for posting requests should now ask for the user's location that they would like to be helped at as to avoid commuting issues both for the user helping and the user being helped.

4) The app's general personalization should be improved by adding profile pages that contain some information about a user. These profile pages should be integrated into all the appropriate places (Home screen, Leaderboards, Challenges, Help requests, etc.). This would make them more personal, engaging and motivational.

5) The quests should be made more engaging and interactive to better illustrate their functionality.

6) The home page should display the current daily goal for cycling in text form and allow users to change it. This would make this screen more interactive and engaging.

7) The Leaderboard should allow users to select what to order the leaderboard by: speed, longest distance cycled in one go or total distance cycled this week. This would make this tab more interactive and engaging as well.

Other minor design tweaks may also be present within the hi-fi prototype, however, they are mostly very minor and not relevant enough to mention explicitly within this section of the report.

7.1. Hi-fi Prototype Requirements

Following the previously outlined changes in specification based on the evaluation of the lo-fi prototype, combined with the general desire for bringing the system one step further to a complete and functional product some requirements for the hi-fi prototype were elicited. These were once again grouped using the MoSCoW method mentioned in Chapter 4 [27]. Below these requirements are listed.

Must have:
- A home page displaying a dynamically generated visualization of the distance a user has cycled today
- A page giving a step-by-step guide of how to learn cycling on your own
- A dynamically generated page listing example events organized to teach cycling
- A page containing a dynamically generated leaderboard
- A help request submission page

- A dynamically generated Volunteer page where users can see mockup requests they can pick up
- A dynamically generated challenge dashboard showcasing mockup challenges that users can pick up
- A challenge submission page

Should have:
- Text displaying the current daily goal and the ability to change said daily goal
- Mentions of steering, balancing, adjusting the bicycle seat and traffic rules in the cycling step-by-step learning guide
- An events page that features mockup event titles and details instead of placeholder text
- A field that asks users for their location when submitting a help request
- The ability to sort the Leaderboard page by speed, longest distance cycled in one go or total distance cycled this week

Could have:
- The ability to dynamically add, remove and edit help requests
- The ability to dynamically add, remove and edit challenges
- The ability to complete quests and indicators of how far a quest is to completion
- .json file input for all dynamic data
- .json file output for dynamic data storage

Will not have:
- Any chat or social media functionality
- Any backend functionality involving a server

8. Realization of Hi-fi Prototype

This section will follow a similar pattern to Chapter 5, only focusing on the Architecture, System components and Interface of the hi-fi prototype. Generally, the hi-fi prototype follows a similar concept to the lo-fi one, but is built on top a reactive Javascript framework instead of stock HTML, CSS and Javascript. This reactive framework is called Vue.js [33] and it essentially allows for real time manipulation of the HTML of a website based on some kind of user input (or to word it differently: the HTML layout, elements and styling "react" to user manipulation via input) [34]. Vue was chosen because it is by far the simplest and quickest to set up compared to its competitors like Angular.js or React.js [35]. Furthermore, the developer had the most experience with it, making the creation of the hi-fi prototype even faster as a result.

In addition to Vue.js, several other frameworks and tools were used. Primarily the Ionic Framework [36]. This is essentially a CSS framework that includes many built-in styles for all the common elements in modern web applications. These include, but are not limited to: top and bottom navigation bars, hamburger menus, progress bars, buttons, cards, etc. [37] These elements are ready to use in conjunction with Vue and are ensured to look and behave identically on both Android and iOS devices [36]. Using this framework saves a lot of time on writing custom CSS styling on the part of the developer, it ensures a consistent look and also that the hi-fi prototype is in line with the newest web application design and visual conventions.

Finally, to build the application into an actually usable phone app, instead of just a browser website, Capacitor was used [38]. This is another Javascript tool that essentially takes the web application that runs in a browser on the developer's computer and compiles it into native application code for either Android or iOS devices [38]. Essentially, the hi-fi prototype is written in Vue as if it were any other web application or website, but Capacitor creates the files necessary for running this web application as if it were made for phones from the ground up. This approach saves time on writing native apps using Java or other lower level programming languages, different from Javascript, HTML and CSS.

8.1. Architecture

The architecture of the prototype follows the standard practices of Vue. Essentially there are three things at the core of the application: the components [39], the router [40] and the store

[41]. Components can be thought of similarly to objects in Java or C#. A component can be a full page of an application and contain other components, as well. These types of components will be referred to as "views" throughout this section. Views are important as, generally, Vue.js apps are so-called "single page applications" [42], meaning that all content is displayed on a single page. The way this works is by setting up this single page to contain nothing by default and simply act as a container to display different views. Which view is displayed is determined dynamically, so by swapping out which one is currently displayed in the container page, the illusion of multiple pages is created for the user.

Which view is displayed at which time is determined by the second component: the router [40]. Essentially, it holds a list of paths that have different views associated with them. For example the path '/home' would be associated with the view corresponding to the home page, whereas the path '/leaderboard' would be associated with the view corresponding to the leaderboard page. Depending on which path the user is currently on, the view associated with it is displayed. By clicking on different elements of the application (for example the icons in the bottom navigation bar) the user can navigate to a different path. So if they are on the Home screen and click the 'people' icon, this will change the path to the one that corresponds to the Help requests page and this will in turn change the view currently displayed to the one corresponding to the Help requests page. This is essentially how navigating in Vue works in principle and also in the hi-fi prototype.

The final element of the system architecture is the Vue store [41]. This element is responsible for temporarily holding data for the current state of the system. This is handled by Vuex, which is an additional library [41]. Put simply, Vuex holds some data about the application, similar to a database. For example, it can hold a variable indicating how much a person has cycled today. This variable is then accessible throughout the entire application and can be retrieved or changed at any point [41]. This allows different views to communicate with each other via changing variables they all have access to. For example, the view that allows users to change their daily cycling goal alters the daily goal variable in the Vuex store. This variable is then accessed by the Home screen view and now it displays the new changed variable both in text and on the graph.

Another way the Vuex store is used in the hi-fi prototype is to mock a database. For example, in a final version of the app, the events would be dynamically retrieved from a server, however, this

server does not exist in the hi-fi prototype. Instead, the list of events is held as a Javascript array of objects that is stored in the Vuex store. This array is retrieved by the Events page, allowing it to display events dynamically, based on what is held in the Vuex store list of events. In the final application, the Vuex store would not have this list be pre-determined and hard-coded, but rather it would make an HTTP request to the database on the server and populate the events array with data from said server.

8.2. System components

System components in the hi-fi prototype are also handled using standard Vue practices. Essentially this is similar to Object Oriented Programming. Template code for different components of the prototype can be written, which can then be used to display specific components within the application by populating the templates with data. The easiest way to understand how this works is with an example. For the Events page a list of events is displayed to the user. Each event is displayed as an event card that has an image of the event, a title for the event and a description of the event. This image card is a component. A template is written for it that contains no data. This template simply declares that the event card will display whatever image is associated with it on the left side, then on the right of the image a title and then right below it a description. Then, from the Events view, a list of the events is retrieved from the Vuex store, then for each event in that list an Event card is displayed, populated with the data corresponding to that event. So for each card displayed, the template is told which image to display, which title to display and which description to display. This approach is used for all components of the hi-fi prototype, as it allows for greater flexibility, granularity and reusability. It saves on manual labor and allows more dynamic displaying of data as well. When it comes to the components themselves, they are handled essentially the same way as the lo-fi prototype: CSS styling is used to change how they look and specific libraries or components are used for charts, forms, etc.

8.3. Interface

The interface of the hi-fi prototype remains largely the same as it was in the lo-fi prototype. Navigation is still done via a bottom navigation bar and links or clickable elements within the pages themselves (for example, clicking the daily goal text on the home page allows users to navigate to the page where they can change it). This type of navigation was well-received in the lo-fi prototype as indicated by the general feedback and the S.U.S score, thus, it was not

changed drastically. Only minor tweaks were made to the interface to make the system more in line with modern design conventions and also lower the amount of tabs and information on the screen. For example, in the lo-fi prototype, adding a new help request was done via its own separate tab, however, now this is done by simply navigating to the Help requests page and then clicking the plus icon on the top right of the header, as can be seen in Figure 15. This streamlines adding new requests by making it faster and more convenient, but also eliminates the need for an extra tab. This type of streamlining is applied to the Challenges tab as well.

Figure 15: Plus icon in the header for adding a new help request

Another change was to make elements more visual. For example, there is no longer text for the cycling streaks, but rather an icon and number, as seen in Figure 16. Furthermore, the bottom navigation bar now features only icons, as seen in Figure 17, rather than icons and text. Moreover, icons are generally used to support text content. For example, the page for changing your daily goal has a bicycle icon on the top to reinforce what this page relates to as seen in Figure 18. These changes were made with the users in mind. Text could be potentially overwhelming so using universal imagery instead hopefully leads to a cleaner interface that is less cumbersome to use. What's more, using supportive imagery may also boost understanding of the different elements of the prototype.

Figure 16: Streak icon

Figure 16: Icons used in the bottom navigation bar of the experienced version of the app
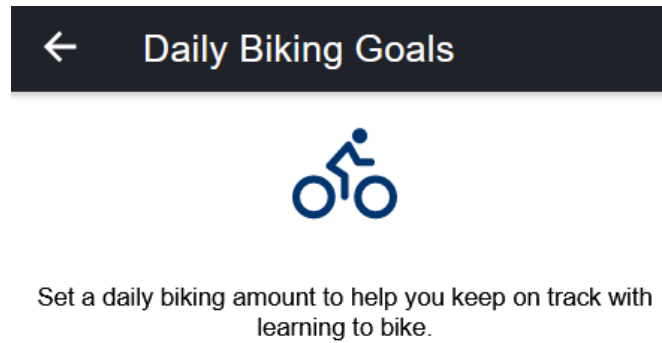
Figure 18: Bicycle icon on the daily goals page

Finally, the interface has changed aesthetically as well to fit more with the general visuals of the University of Twente. The first obvious change is in the color scheme. The white and blue palette of the lo-fi prototype is now black and white to match the University's other web services such as their website [44]. Furthemore, all other colors in the lo-fi prototype were replaced with ones from the palette provided by the University of Twente House-style, which provides an overview of the different visual elements of the institution [43]. The colors themselves are used in a similar way to the lo-fi prototype, but are now more in line with the rest of the UT. The font used by the UT was also considered, but as it is a paid font beyond the budget of the hi-fi prototype, the official free alternative listed was used (that being Arial [43]). Overall, the look and feel of the interface was generally made to match the other available web services as closely as possible. An example of how it looks can be seen in the "Post new challenge" page, showcased in Figure 19.

Figure 19: Posting a challenge page of the hi-fi prototype

8.4. Comparison of hi-fi prototype and requirements

A similar table will be presented as the one in Chapter 5.3, only this time the table will focus on the hi-fi prototype and its requirements. Afterwards, a brief analysis of how well the hi-fi prototype delivered on its requirements will be done.

Must have	
A home page displaying a dynamically generated visualization of the amount a user has biked today	🟩
A page giving a step-by-step guide of how to learn biking on your own	🟩
A dynamically generated page listing example events organized to teach biking	🟩
A page containing a dynamically generated leaderboard	🟩
A help request submission page that allows users to submit a help request	🟩
A dynamically generated Volunteer page where users can see mockup requests they can pick up	🟩
A dynamically generated challenge dashboard showcasing mockup challenges that users can pick up	🟩
A challenge submission page that allows users to submit a new challenge	
Should have	
Text displaying the current daily goal and the ability to change said daily goal	🟩
Mentions of steering, balancing, adjusting the bike seat and traffic rules in the biking step-by-step learning guide	🟧
An events page that features mockup event titles and details instead of placeholders	🟩
A field that asks users for their location when submitting a help request	🟩
The ability to sort the Leaderboard page by speed, longest distance biked in one go or total distance biked this week	🟩
Could have	
The ability to dynamically add, remove and edit help requests	🟩
The ability to dynamically add, remove and edit challenges	🟩
The ability to complete quests and indicators of how far a quest is to completion	🟩
.json file input for all dynamic data	🟥
.json file output for dynamic data storage	🟥
Will not have	
Any chat or social media functionality	🟥
Any backend functionality involving a server	🟥

Table 3: Fulfillment of the hi-fi prototype requirements

As can be seen from the table, every requirement in the Must have category is fulfilled, which means the system is sufficiently functional. The Should have's are also all present, with the exception of one element of the second requirement listed. The hi-fi prototype does not feature an expanded section for traffic rules. The reason for this is that the step-by-step guide did not seem like an appropriate place for this information, as its focus is more on teaching the act of cycling rather than the rules for it. This means that a new placement would be necessary for such a section, which would involve substantial changes in design beyond the time scope of the prototype.

The Could have section also misses two requirements for the same time constraints reason - the .json file input and .json file output. Ideally these would be present as a way to both retrieve information from the server in this file format and send information to the server in this file

format. This functionality could have been present despite the lack of a server, but this is not essential. Rather it is a way to 'future-proof' the system so that it is more easily coupled with a server in the future. This is obviously not necessary for evaluation, therefore, it was omitted due to lack of time.

Finally, the Will not have's are also, naturally, not present in the hi-fi prototype.

Overall, all requirements that are essential for the system to function are fulfilled, with only non-essential features missing. Therefore, the system is ready to be evaluated as described in the following chapter.

9. Evaluation of Hi-fi Prototype

The approach taken for evaluating the Hi-fi prototype was significantly different from the one for the Lo-fi prototype. This is because the goals of this evaluation were also different. In this section of the paper, an overview of said goals is given, followed by a description of the evaluation method and concluding with an analysis of the evaluation results and a discussion about the limitations and future recommendations for further testing of the Hi-fi prototype.

9.1. Goals of evaluation

As mentioned previously, the goals of this evaluation are significantly different from the goals of the Lo-fi prototype's evaluation. It would have been possible to have a very similar evaluation, with very similar goals, however, a conscious decision was made against this. This is because the previous evaluation session already provided sufficient information about the topics it covered. In the researcher's opinion, another evaluation focusing on the same goals would have possibly led to very similar results, especially considering most of the feedback received was overwhelmingly positive and quite extensive. This is further supported by the fact that most of the changes in design for the Hi-fi prototype are not core changes that alter things substantially, but rather expanding and making the prototype more functional and representative of the final system. Therefore, the feedback received may have been very similar in nature.

For these reasons, a new set of goals was established. These goals focus on obtaining the opinions of the other stakeholders involved in the system: the supervisor, the critical observer and most importantly - the client. These opinions are important for a variety of reasons. For one, all three of these people are experts in their field, therefore, they can provide a perspective on what needs to change to improve the system that the average user will not be able to give, due to their relative lack of knowledge of application and user-centered design. Furthermore, these stakeholders, and in particular the client, are crucial for deciding on the state of the system at this point and if the potential is there for a fully-fledged system to be developed. This decision is crucial because the importance of this research and product stems beyond just the scope of this thesis and further work will need to be done on it. Finally, these stakeholders can provide opinions on how well the system fits within the UT's sustainability agenda and what they think needs to be done to continue the project forward.

Due to the aforementioned perspectives and opinions holding so much weight, the Hi-fi evaluation has the primary goals of:

1) Finding out the opinions of the Supervisor, Critical observer and Client on the system
2) Finding out what is missing and could be improved about the system in its current state
3) Finding out what needs to be done to continue the system's development in the future, beyond the scope of the thesis

9.2. Methods of evaluation

The methods of evaluation are once again different as to accommodate the new goals and people involved. Instead of a standardized lengthy survey, a semi-structured interview is conducted with the participants involved. Essentially, the interview is conducted as follows: a certain section of the Hi-fi prototype is demonstrated by the researcher, after which the participants are asked a set of questions relating to what they just saw. These questions aim to find out what they thought was done well, what they thought was done not so well and what is missing or could be changed. After the Hi-fi prototype's functionality has been shown off completely and sufficient feedback has been gathered, this provides enough information to fulfill the first two goals of the evaluation session. Afterwards, a more unstructured discussion is had about the continuation of the project and how well it can fit within the UT's sustainability agenda.

The entire interview is audio recorded, after which the recording is examined by the researcher, who makes a generalized summary of the main points in the form of notes. These notes then serve as the basis of the results of the evaluation and the core information used to fulfill the goals set out at the beginning of this section.

There are various reasons for choosing this type of evaluation method over others. For one, surveys naturally provide more standardized data that loses out on a lot of context and subtlety that opinions tend to need and have. Conducting an interview instead allows for the opinions and feedback to be recorded without such a loss. Furthermore, the number of participants this time is much smaller (just three), which allows for such a method to be viable to begin with.

A semi-structured interview was chosen in particular, because of its various advantages that fit the goals of the evaluation best. Mainly, such interviews allow for a degree of freedom that a structured interview simply would not, while still keeping some form of structure that allows for

focus on the primary goals. This freedom and flexibility are essential here, because the participants are experts and their unaltered opinions are extremely valuable. They should be given the possibility to take the discussion into a different direction if necessary and expand on points where it is needed. They also generally need less guidance on the topics due to their deeper knowledge than the average user of the system. Therefore, it is best to conduct such an interview, instead of a heavily regulated structured form of interviewing.

9.3. Evaluation results

Over the course of the interview various pieces of feedback were obtained. Some of them have to do with specific features of the application and some of them with general issues the application could face. Furthermore, suggestions about integrating the application within the UT's ecosystem were given and a general discussion was had about the future of the app. The primary points from all these topics have been summarized in this section.

Firstly, some feedback was given about the Home screen and the visualizations there. The participants find the graphics clear and understandable, particularly highlighting the use of imagery instead of a lot of text. A good amount of white space is present, although the amount of content on the page makes it so it has to be scrolled on smaller phone screens. Moreover, the color choices are not well-received, as too many colors are present on the screen at the same time. What's more, some elements are colored the same (for example: the profile icon and time cycled, the streak icon and calories burned, etc.). This creates an association between said elements in the participants minds despite the fact that these elements are not related. A more neutral color choice such as black would be better in this case. Moreover, the daily goal text does not need to be in all capital letters and it was suggested that the abbreviated 'km' is used rather than the full word 'kilometers'. This is because most users would be most familiar with the former, as it is more commonplace. Finally, the cycling level was not immediately clear, but became so after a brief explanation from the researcher. A participant also thought that the level would drop down if the user doesn't cycle for a certain period of time. Although this is a misunderstanding, it is a possibly interesting avenue to explore for the way the system functions.

Secondly, the cycling step-by-step guide still has room for improvement. Participants thought it was too much textual information all at once. The images were also not well-received for various

reasons. Firstly, they would not always match the target demographic of users trying to learn with the app. Children were shown in the photos, as well as sports cyclers, which both do not match the intended adult commuter user base. Furthermore, the images showcasing cycling gear were also too sports-focused and a more casual and less overwhelming set of images could be used, maybe even just showing a helmet. On a final note about visual content, it was also suggested that videos could be used instead of text and images to make this section more engaging and easier to manage.

There was also some crucial information still missing. For example, participants suggested a more detailed overview of the different bicycle parts and how to adjust them. Moreover, information about where and how to get a bicycle was also requested. This information is available currently only at the beginning checklist when initially starting the app, so it should either be added here or a link to it should be included.

When it comes to the Leaderboard, participants also had suggestions for improvement. It was not really clear that the Leaderboard was changing via the menu that allows users to reorder it based on speed, longest distance cycled in one go or total cycled this week. Participants indicated they don't feel strongly about this, but they do think some animations or color change would make things more clear. Furthermore, it was suggested that more options for customizing the Leaderboard are added. In particular, the ability to show a weekly, monthly or all time Leaderboard, depending on the user's preference.

Some privacy issues were pointed out as well. Participants may not want to take part in these Leaderboards and have their profile be viewable by everyone who looks in the Leaderboard. To counteract this issue, it was suggested that more customization is given to users when it comes to how they want to use the Leaderboard. For example, give them the ability to opt out of the Leaderboards altogether, or to only have a small mini-leaderboard group amongst them and their circle of friends. The latter was also suggested as a way to make friends for International students, by setting up these mini-leaderboard groups during the kick-in for example or at other events. A potential issue with this is, however, that such groups may be too small in size or a hassle to set up for users.

The challenges tab also received a fair amount of feedback from participants. They like the idea and would like to see exciting and fun challenges. Some suggested challenges that are meant

to take users along interesting routes or to interesting locations nearby the University, allowing international (and national) students to discover new places, as well as get to cycle some more. This is a valuable suggestion, but due to the competitive nature of the Challenges, it would be best suited for the Quests section instead. There is also a small visual critique, regarding the color of the challenge text. Red is deemed too extreme of a color for it by participants, with blue or magenta suggested as alternatives.

When it comes to integrating the application in the UT's existing ecosystem, various suggestions were given. Firstly, the app could be integrated within the Bachelor / Master Kick-in event at the University, the Intercultural jams or Workshops. Here the app could be introduced to internationals in particular as a way to learn or just have fun cycling. Secondly, a cycling course is considered which could be promoted via the app and be integrated with it. Similarly, a deal with the local company Swapfiets could be made to provide internationals with access to rented bicycles for cheaper via the app. The app could also be introduced to the cycling club or during sustainability week.

Finally, when it comes to the next steps of the project, my client, supervisor and critical observer indicated that such a system is definitely needed at the UT. Therefore, it should be developed further into a functional application. The suggested way to do this is through collaboration with other (student) developers to make work faster and smoother. Moreover, the involvement of someone knowledgeable about the systems at the UT and the possibilities with them is also suggested. This could ease integration, but also ensure that the resources already available are used to the fullest before having to develop anything new from the ground up. Privacy issues should also be kept in mind, as they may slow down development significantly. Ultimately, it was agreed that the app would continue to be developed in the near future with the goal of delivering a functional product.

9.4. Evaluation conclusions

Returning to the goals of the evaluation, some conclusions can be drawn based on the results.

For goal 1) and 2):
The participants have an overall positive opinion of the Hi-fi prototype and system in general. Some issues are still present, but they are mostly visual at this point. The only substantial point

of improvement left is ensuring that the step-by-step guide is both extensive enough, but also engaging and not overwhelming.

For goal 3):

Many possibilities exist for integration of the app within the already existing services, technologies and events at the University of Twente. Furthermore, such a system is definitely needed. Therefore, development will be continued in the future in collaboration with other developers and staff at the University.

9.5. Evaluation limitations

As with all research, the evaluation also has a variety of limitations. Although, as mentioned before, the opinions of the client, supervisor and critical observer are important, doing an evaluation only with them does not give a representative view of what the actual target group thinks of the prototype. Furthermore, due to the fact that these people are already involved and familiar with the system, biased answers may have been given. This could be even further amplified by the fact that the prototype was only showcased by the researcher. The participants did not get to actively interact with it at their own pace, which without a doubt has an impact on their opinions and feedback.

10. Conclusions

In this section an overview of the main findings of the paper will be given leading to the answers to the two primary research questions obtained via doing this research.

Generally, the University of Twente is making a large contribution to the carbon footprint every year. A significant amount of those contributions are due to unsustainable local commuting. This means a solution that aims at teaching and persuading people to cycle more is necessary. During this Graduation Project and Bachelor's thesis such a system was researched, developed and evaluated. The result was a concept for a smartphone application that uses various persuasion techniques, primarily Gamification. A lo-fi prototype was made of this concept and evaluated with users. The prototype was well-received and additional valuable information was gathered about users' preferences in learning and what motivates them generally and specifically to cycle more.

Based on this evaluation and with the general goal of coming closer to a functional system, a hi-fi prototype was made. This hi-fi prototype was evaluated with the primary stakeholders of the GP and the system developed for it (those being the supervisor, critical observer and client). The goal of the evaluation was to gauge general opinion on it and to see which steps need to be taken towards the continuation of the system development. The hi-fi prototype was well-received and deemed fitting in the UT's general ecosystem and sustainability agenda. Based on this, the further development of the system was approved of, possibly in collaboration with other students or more knowledgeable parties about the systems at the UT.

Returning to the primary goal of this Bachelor's Thesis, it is to answer two research questions. Below these questions are presented, together with the answers obtained via the work done for this Thesis.

1. How can staff and students at the UT be taught to cycle with a smartphone application?
Generally, staff and students at the UT prefer active learning to passive learning. There is no preference in group vs. individual learning. However, learning activities that are most liked by them often involve challenges and rewards. Challenges to oneself and competitive challenges against others are equally well-received.

Based on this data gathered, it can be concluded that a way to teach cycling through a smartphone application is to focus on active learning activities, centered around challenges with rewards. Moreover, the app should feature both group and individual learning, as well as competitive and individual challenges.

2. How can staff and students at the UT be persuaded / motivated to cycle more with a smartphone application?
Staff and students at the UT are generally motivated by many factors, but primarily being interested and engaged, looking for a challenge or self-improvement, rewards and other people (both competing with them, but also helping them). Most of these factors align with either the value of Achievement or the value of Altruism. Furthemore, a social element was also deemed an important one when it comes to wanting to do something.

Based on this data gathered, it can be concluded that a way to persuade / motivate staff and students to cycle with a smartphone application is by making this application interesting and engaging, allowing users to participate in challenges and improve themselves and having a social element. The focus should be primarily on the values of Achievement and Altruism, meaning that the app should lead to a sense of achieving goals and getting rewards for them, but also allow users to contribute positively to the lives of others.

11. Discussion

In this chapter a discussion of the relevance and contribution of this research will be had. Furthemore, the application itself will be examined with a particular focus on how well it teaches and persuades users to cycle in relation to the findings outlined in the answers to the RQs and the literature.

Firstly, the research is relevant for a variety of reasons. As stated several times throughout the paper the carbon footprint is a huge worldwide issue that the University of Twente is contributing to yearly, not in small part due to unsustainable commuting [3]. Cycling is the natural solution to this, but there is lacking knowledge as to how to get staff and students to cycle more to and from University. What's more, this lack of knowledge means that there is currently no system to achieve this goal either. Therefore, doing research about developing such a system is crucial. This is to lower the carbon footprint, but also make internationals feel more welcome in the Netherlands and integrate into Dutch society better. Moreover, the client (who is an expert on sustainability at the UT) also agrees that such a system and research centered around how to best develop it is of the utmost importance.

The knowledge contributions of this thesis are also several. For one, research about cycling at the University of Twente specifically is often very statistical in nature, focusing more on percentages and raw data. This research offers a more grounded perspective on cycling at the University, with a focus on changing the data in the future for the better (i.e. increasing the amount of cycling at the UT). In a more general sense, there do not seem to exist many cycling applications that target the two target groups of people wanting to learn and people wanting to be more engaged with cycling at the same time. Furthermore, the app is more casual in nature than the more sports-oriented applications that seem to be currently available. This thesis adds knowledge as to how to develop such a particular type of application.

The application itself only exists as a lo-fi and hi-fi prototype as of the time of writing, however, it is still worth discussing how well these prototypes perform in terms of teaching and persuading / motivating. As the prototypes are not different in core features or design, they will be discussed as one whole throughout this paragraph. Generally, the system's learning features were well-received and they do a good job of matching what users expect, want and need in an application that would teach them cycling. This is because they offer a lot of possibilities for

active learning, centered around challenges. Furthermore, they accommodate both users that prefer individual learning (the step-by-step guide) and users that prefer group learning (the cycling events and 1-on-1 help requests). The same can be said about users who prefer self-challenge (Quests, Daily goals, Streaks) and those who prefer competitive challenges (Leaderboards, 1-on-1 Challenges). Therefore, it can be concluded that the application design matches what users indicate as desirable and effective when it comes to learning to cycle.

When it comes to persuasion and motivation, the data gathered shows that staff and students are motivated primarily by wanting to satisfy the values Achievement and Altruism. This aligns with some of the primary values found in literature [14]. The application design accommodates for both values to be fulfilled. Achievement is at the core of Gamification, which is applied all throughout the design in the form of goals and rewards for achieving them. Altruism comes into play with the ability to help people learn to cycle via the application. Overall, because the design appeals to both of these values, as well as provides other motivating factors such as being engaging and interesting, a sense of competition and social factors and other persuasive elements found in literature, it can be said that it does a good job at persuading / motivating people to cycle more.

12. Limitations and Future work

No research is without limitations and this point naturally holds true for the research done in this thesis as well. Firstly, time constraints are the primary limiting factor. The allotted time for the bachelor's thesis and project is only roughly six months. Given more time a more extensive literature review could have been done, more fleshed-out prototypes could have been developed and evaluations could have been conducted in a better way. For the last point in particular, there are several avenues for improvement. For one, the sample size of both evaluations is rather limited - eight and three people respectively. This is not so much a problem for the latter evaluation, as the goal was to find out the opinions of those three people in particular, but the former could have definitely benefited from a larger sample size to be more representative and statistically significant. Furthermore, all participants in this evaluation indicated that they already knew how to cycle, so the data doesn't truly reflect the opinions of one of the target groups. Moreover, biases may exist in the data of the other evaluation due to the fact all three people interviewed are involved in the project and know about it beforehand.

Based on these limitations, as well as the possible avenues for further research, some recommendations can be made about future work. Firstly, in the context of the project, the hi-fi prototype should be evaluated with both the target groups in a manner similar to the first evaluation. In a more general context, far more research should be done about teaching cycling through e-solutions in general. This could help this and other systems like it do a better job at not only motivating and persuading, but also teaching in a better way. Finally, it may be useful to explore if other ways of persuasion are better suited as the core of such systems. Gamification was chosen for this research, but perhaps other methods are more effective, or better fitting.

Appendix

Appendix A. Creative technology design process
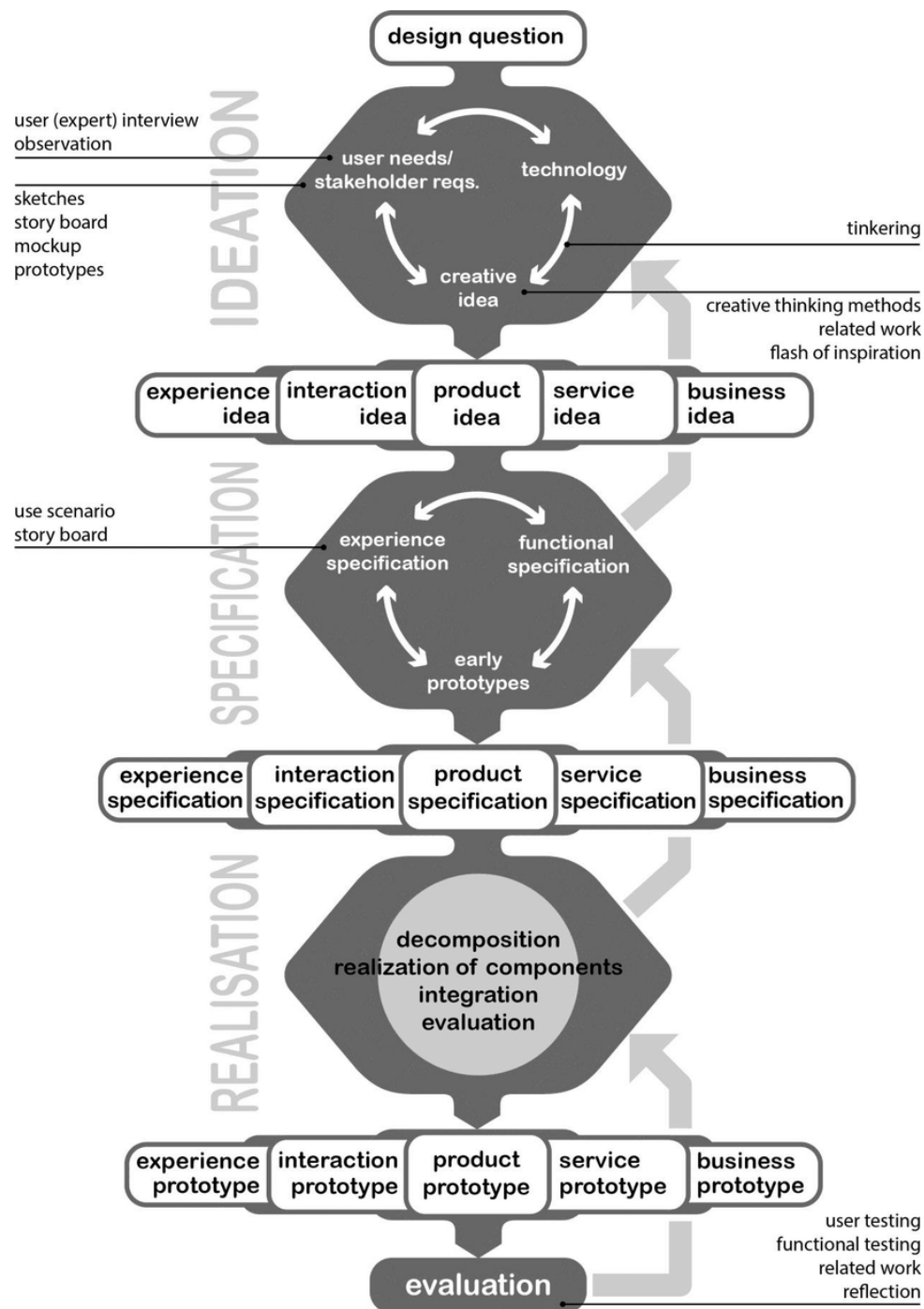

Figure 20: A design process for creative technology [26]

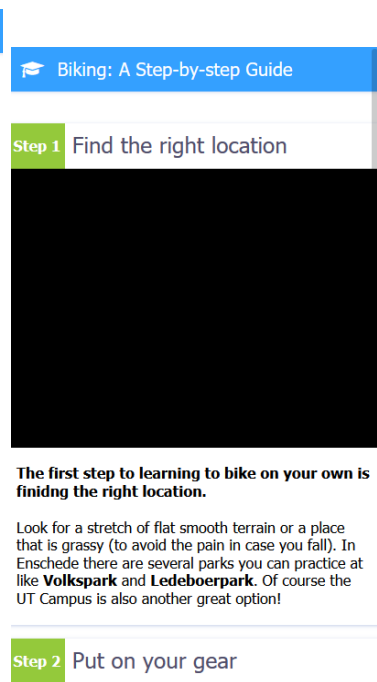## Appendix B. Lo-fi prototype tabs
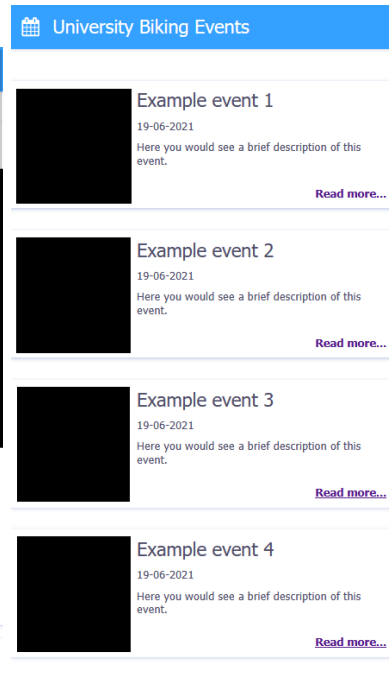

Figure 21: Home tab

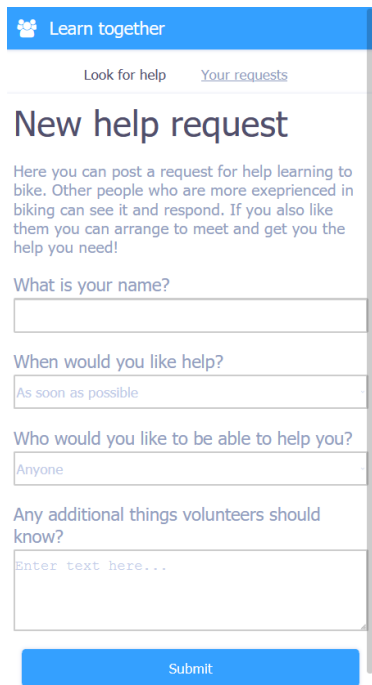

Figure 22: Self-learning tab

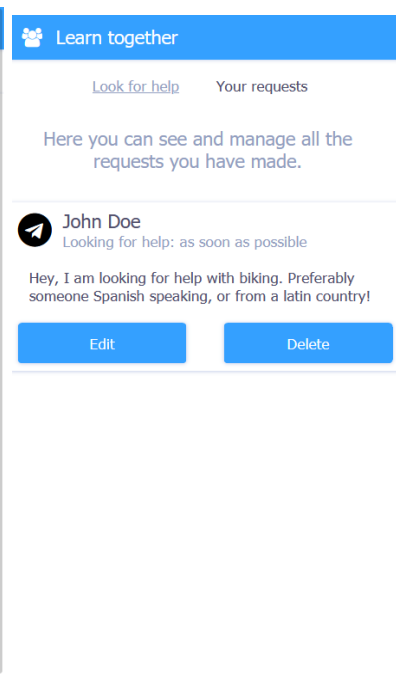

Figure 23: Events tab

Figure 24: New request tab

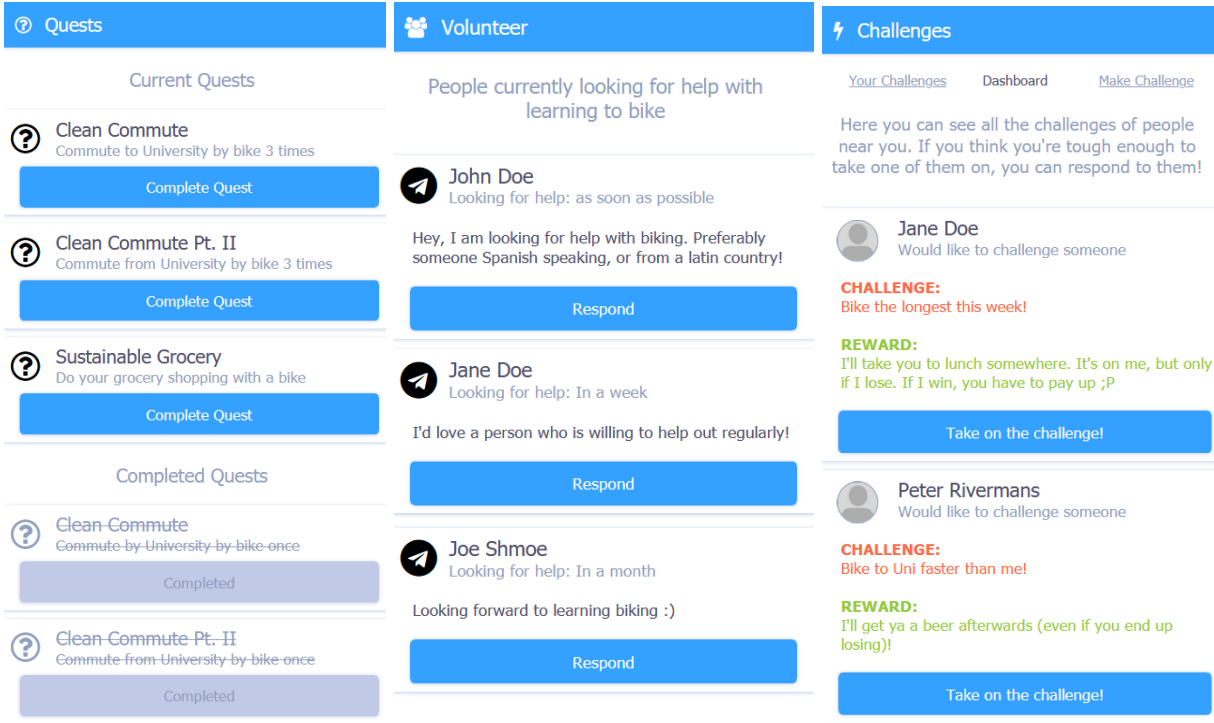*Figure 25: Your requests tab*

Figure 26: Leaderboard tab

Quests

Current Quests

Clean Commute
Commute to University by bike 3 times
[Complete Quest]

Clean Commute Pt. II
Commute from University by bike 3 times
[Complete Quest]

Sustainable Grocery
Do your grocery shopping with a bike
[Complete Quest]

Completed Quests

~~Clean Commute~~
~~Commute by University by bike once~~
[Completed]

~~Clean Commute Pt. II~~
~~Commute from University by bike once~~
[Completed]

Figure 27: Quests tab

Volunteer

People currently looking for help with learning to bike

John Doe
Looking for help: as soon as possible

Hey, I am looking for help with biking. Preferably someone Spanish speaking, or from a latin country!
[Respond]

Jane Doe
Looking for help: In a week

I'd love a person who is willing to help out regularly!
[Respond]

Joe Shmoe
Looking for help: In a month

Looking forward to learning biking :)
[Respond]

Figure 28: Volunteer tab

Challenges

Your Challenges   Dashboard   Make Challenge

Here you can see all the challenges of people near you. If you think you're tough enough to take one of them on, you can respond to them!

Jane Doe
Would like to challenge someone

CHALLENGE:
Bike the longest this week!

REWARD:
I'll take you to lunch somewhere. It's on me, but only if I lose. If I win, you have to pay up ;P
[Take on the challenge!]

Peter Rivermans
Would like to challenge someone

CHALLENGE:
Bike to Uni faster than me!

REWARD:
I'll get ya a beer afterwards (even if you end up losing)!
[Take on the challenge!]

Figure 29: Challenge dashboard

Challenges

Your Challenges   Dashboard   Make Challenge

John Doe **VS** Jane Doe

CHALLENGE
Bike more than the other person this week

REWARD
The loser buys the winner pizza
[Details]

John Doe **VS** Joe Shmo

CHALLENGE
Bike the single biggest distance in one trip this week

REWARD
The loser owes the winner a favor
[Details]

Figure 30: Your challenges tab

Challenges

Your Challenges   Dashboard   Make Challenge

New challenge

Here you can post a new challenge for people to take on. This will appear on their challenge dashboard.

What is your name?
[ ]

What is your challenge?
[Enter challenge here...]

Who are you challenging?
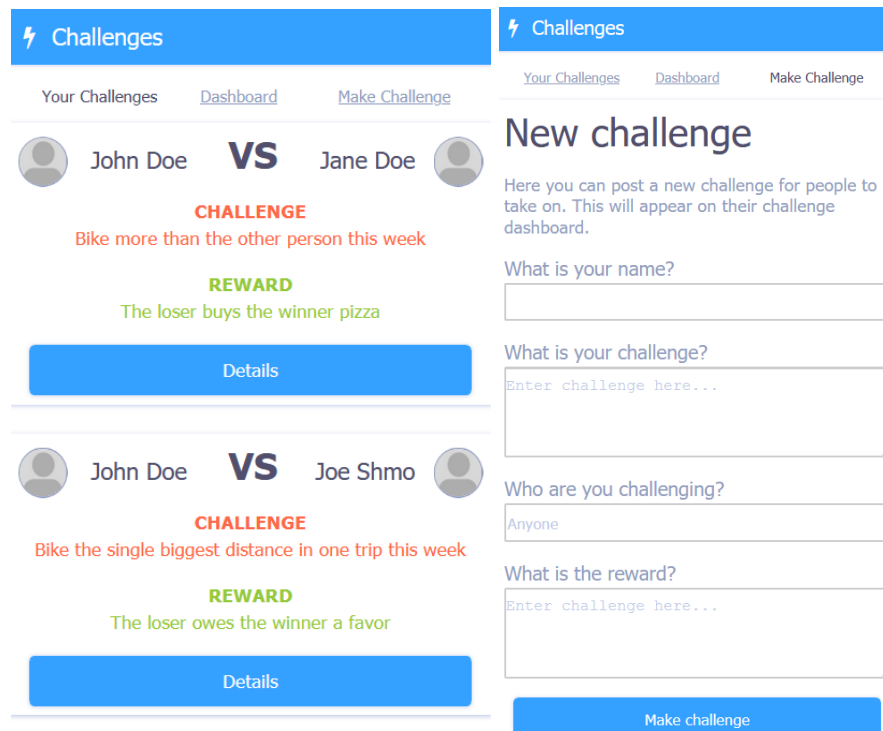[Anyone]

What is the reward?
[Enter challenge here...]

[Make challenge]

Figure 31: New challenge tab

Appendix C. Lo-fi prototype palette

Figure 32: Lo-fi prototype color palette

Appendix D. Calculating S.U.S score

The S.U.S. test contains 10 statements. They are as follows [30]:

1. I think that I would like to use this system frequently.
2. I found the system unnecessarily complex.
3. I thought the system was easy to use.
4. I think that I would need the support of a technical person to be able to use this system.
5. I found the various functions in this system were well integrated.
6. I thought there was too much inconsistency in this system.
7. I would imagine that most people would learn to use this system very quickly.
8. I found the system very cumbersome to use.
9. I felt very confident using the system.
10. I needed to learn a lot of things before I could get going with this system.

For each statement users are asked to indicate agreement on a scale of 1 to 5, with 1 being 'Strongly disagree' and 5 being 'Strongly agree' [30]. For the lo-fi prototype evaluation, the average score was taken for each question among all answers and rounded to the nearest non-decimal number. From there, for each odd numbered question (1, 3, 5, etc.) one is subtracted from the score [31]. For each even number question (2, 4, 6, etc.), their score is subtracted from five [31]. This gives a new set of 10 numbers. These ten numbers are added together and their sum is multiplied by 2.5 to get the final System usability score [31].

Appendix E. Lo-fi evaluation survey questions

How old were you when you learned to bike?

Your answer

How did you learn to bike?

Your answer

If you are not from the Netherlands, could you bike before you moved here?

○ Yes
○ No
○ Not applicable

Who helped you learn to bike?

○ A parent / guardian / caretaker
○ Another relative
○ A friend
○ A partner
○ Nobody, I learned on my own
○ Other:

How would you describe your experience learning to bike?

	1	2	3	4	5	
Extremely negative	○	○	○	○	○	Extremely positive

What emotions did you feel when learning to bike? (more than one option possible)

☐ Anger
☐ Sadness
☐ Calmness
☐ Satisfaction
☐ Excitement
☐ Joy
☐ Happiness
☐ Shame
☐ Empowerment
☐ Hopelessness
☐ Struggle
☐ Other:

What gave you motivation to learn?

☐ My own internal drive
☐ The desire to save money on travel costs
☐ Encouragement
☐ The desire to learn
☐ Having fun
☐ The desire to fit in
☐ The support of others
☐ The desire to be more environmentally friendly
☐ Other:

Figure 33: Questions part 1

What made you less motivated to learn?

☐ Lack of support from others
☐ Physical difficulties
☐ Lack of clear information on how to do it
☐ Not having a good teacher
☐ Feeling insecure about not being able to bike
☐ Accidents
☐ Other:

What was the hardest moment for you when learning?

Your answer

And what was the most enjoyable?

Your answer

Figure 34: Questions part 2

Figure 35: Questions part 3

Figure 36: Questions part 4

The flow makes sense for someone who wants to start learning

	1	2	3	4	5	
Strongly disagree	○	○	○	○	○	Strongly agree

The items that are listed are sufficient

	1	2	3	4	5	
Strongly disagree	○	○	○	○	○	Strongly agree

If not, what is missing in your opinion?

Your answer

It is clear where you can find more information about each item

	1	2	3	4	5	
Strongly disagree	○	○	○	○	○	Strongly agree

The amount and type of information about each item makes sense

	1	2	3	4	5	
Strongly disagree	○	○	○	○	○	Strongly agree

I understood on first glance that this section shows my biking statistics of the day

	1	2	3	4	5	
Strongly disagree	○	○	○	○	○	Strongly agree

The choice of data to visualize is logical

	1	2	3	4	5	
Strongly disagree	○	○	○	○	○	Strongly agree

The way data is visualized is clear

	1	2	3	4	5	
Strongly disagree	○	○	○	○	○	Strongly agree

I would want to meet my daily goal of biking each day

	1	2	3	4	5	
Strongly disagree	○	○	○	○	○	Strongly agree

Figure 37: Questions part 5

How likely do you think it is for someone to learn biking on their own, using the 'self-learning' page?

	1	2	3	4	5	
Very unlikely	○	○	○	○	○	Very likely

How motivational would a structured guide be to learn biking?

	1	2	3	4	5	
Not at all motivational	○	○	○	○	○	Very motivational

I would want to see my experience level go up

	1	2	3	4	5	
Strongly disagree	○	○	○	○	○	Strongly agree

How effective would it be to learn biking?

	1	2	3	4	5	
Not at all effective	○	○	○	○	○	Very effective

I would want to keep up an everyday streak of biking

	1	2	3	4	5	
Strongly disagree	○	○	○	○	○	Strongly agree

Do you think the step-by-step guide presented is detailed enough?

○ Yes

○ No

Any additional comments for this section?

Your answer

If not, what would you add to it?

Your answer

Figure 38: Questions part 6

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How appealing to find the idea of an organized group event to learn biking?

	1	2	3	4	5	
Very unappealing	○	○	○	○	○	Very appealing

How do you imagine such an event?

Your answer

How much do you think it could help someone learn?

	1	2	3	4	5	
Not at all	○	○	○	○	○	A lot

What would it need to have to be appealing and useful?

Your answer

This section of the application would be one of the first you go to, if you wanted to learn biking

	1	2	3	4	5	
Strongly agree	○	○	○	○	○	Strongly disagree

You would feel motivated to regularly check the section for new events

	1	2	3	4	5	
Strongly disagree	○	○	○	○	○	Strongly agree

You would prefer to go to such an event on your own rather than together with another person

	1	2	3	4	5	
Strongly disagree	○	○	○	○	○	Strongly agree

You would be most likely to attend if such an event was held by the University

	1	2	3	4	5	
Strongly disagree	○	○	○	○	○	Strongly agree

Figure 39: Questions part 7

You would be most likely to attend if such an event was held by another institution (ITC hotel, the Municipality, etc.)

	1	2	3	4	5	
Strongly disagree	○	○	○	○	○	Strongly agree

You would be most likely to attend if such an event was held by volunteers (e.g. students)

	1	2	3	4	5	
Strongly disagree	○	○	○	○	○	Strongly agree

Do you think enough information is presented about the events on the events page

○ Yes
○ No

Do you think the amount of events displayed is enough?

○ Yes
○ No

How appealing do you find the idea of 1-on-1 help with learning to bike?

	1	2	3	4	5	
Very unappealing	○	○	○	○	○	Very appealing

You would find outside help useful when learning to bike

	1	2	3	4	5	
Strongly disagree	○	○	○	○	○	Strongly agree

Who would you be more likely to seek help from on the app?

○ Your friends
○ Strangers

You would be likely to trust a stranger on the app to help you learn to bike

	1	2	3	4	5	
Strongly disagree	○	○	○	○	○	Strongly agree

Figure 40: Questions part 8

Competing with others is motivational

	1	2	3	4	5	
Strongly disagree	○	○	○	○	○	Strongly agree

Comparing your progress and achievements with others is motivational

	1	2	3	4	5	
Strongly disagree	○	○	○	○	○	Strongly agree

Placing higher on the in-app leaderboard is motivational for biking more

	1	2	3	4	5	
Strongly disagree	○	○	○	○	○	Strongly agree

You would feel safe posting ads looking for help on the app

	1	2	3	4	5	
Strongly disagree	○	○	○	○	○	Strongly agree

Does the ad submission allow for enough customization when posting an ad?

○ Yes
○ No

If not, what would you add?

Your answer

Figure 41: Questions part 9

How likely would you be to develop a "personal rivalry" with someone on the leaderboard (e.g. wanting to place above a particular someone who you are very close to currently)?

	1	2	3	4	5	
Not at all likely	○	○	○	○	○	Very likely

Is the leaderboard personal enough to be engaging?

○ Yes
○ Not

If not, what would you change?

Your answer

Wanting to achieve quest is motivational

	1	2	3	4	5	
Strongly disagree	○	○	○	○	○	Strongly agree

You would try to achieve all the available quests you currently have

	1	2	3	4	5	
Strongly disagree	○	○	○	○	○	Strongly agree

How often should you get new quests?

○ Every day
○ Every week
○ Other: _____

How many quests should be available to you at one time?

Your answer

Figure 42: Questions part 10

Do you think there should be a maximum number at all, or would you prefer it if you just get a certain amount of new ones every so often?

○ Keep a maximum number

○ Just add X new quests every so often

○ Other: _____

What type of quests would you like to see?

Your answer

You would be willing to help out a stranger with learning to bike via the app

	1	2	3	4	5	
Strongly disagree	○	○	○	○	○	Strongly agree

You would be willing to help out a friend with learning to bike via the app

	1	2	3	4	5	
Strongly disagree	○	○	○	○	○	Strongly agree

You get enough information on the dashboard for you to make a decision if you want to help a certain person

	1	2	3	4	5	
Strongly disagree	○	○	○	○	○	Strongly agree

You would feel safe helping a stranger with learning to bike via the app

	1	2	3	4	5	
Strongly disagree	○	○	○	○	○	Strongly agree

Figure 43: Questions part 11

Do you think that the concept of challenges is understandable without an explanation?

○ Yes

○ No

○ Other: _____

A personal challenge on the app would motivate me to bike more

	1	2	3	4	5	
Strongly disagree	○	○	○	○	○	Strongly agree

What would be a challenge you would post?

Your answer

What would be the reward you offer?

Your answer

How would you prefer choosing challenges / rewards?

○ Type them completely freely as it is now

○ Choose them from a pre-determined list (drop down menu)

○ Type them completely freely, but have some suggestions for them offered

○ Other: _____

You would challenge strangers

	1	2	3	4	5	
Strongly disagree	○	○	○	○	○	Strongly agree

You would challenge your friends

	1	2	3	4	5	
Strongly disagree	○	○	○	○	○	Strongly agree

Figure 44: Questions part 12

Figure 45: Questions part 13

The last 10 questions are simply the ones for the S.U.S test, as described in Appendix D.

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