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Design of a Mobile Application to Enhance the User Experience with Ridesharing

Design einer mobilen Anwendung zur Erhöhung der Nutzererfahrung bei Mitfahrgelegenheiten

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Bachelor Thesis

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Declaration

I declare under penalty of perjury that I wrote this Bachelor Thesis entitled

Design of a Mobile Application to Enhance the User Experience with Ridesharing

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Abstract

The Share Economy is becoming more ubiquitous with more and more application domains. People share many things, for example, appartments, books and public transit. In addition, they also share rides in their private cars. These arrangements are usually made between friends, via special ridesharing platforms or social networks. However, as social networks are not specifically designed for the application of ridesharing, the users face a number of difficulties. On the social network facebook, there exist special groups for users searching and offering lifts on a special route or geographical area. Trip offers are published as manually edited posts with a text containing the most relevant information. Therefore, there are sometimes mistakes in the posts or important information about the ride is missing. Furthermore, the posts are not sorted chronologically by the date and time of the rides. In addition, time designations like 'tomorrow' or 'Sunday' have to be set in a relation with the publishing date which implies some mental effort on the user side. To address these issues, we present a concept for a prototypical mobile application in order to simplify the process of sharing rides on facebook. The application shows trip offers ordered by their scheduled date and time and provides a wizard for new trip offers to reduce mistakes and avoid missing information. In order to keep track of all passengers, a passenger management feature is provided. Although ridesharing is becoming more popular, people should be encouraged to use it. Therefore, we use a gamification design which is intended to increase the number of shared rides and passengers in a car. In order to evaluate our prototype, we ran a laboratory study. The evaluation revealed that it is more clearly and causes less mistakes than the normal use of facebook for ridesharing purposes. In addition, the app has been found useful for managing a driver's trips. However, arranging rides with our initial prototype was more confusing than the same procedure on facebook. Furthermore, there seems to be a potential for increasing the number of taken rides by our application, but barely for offering more rides. In addition, there is little statistically significant evidence that the app would lead to an increased number of shared rides or passengers in a car. Outgoing from the results of our study, we suggest further researches on the potential and success of gamification to change the users' behavior. Furthermore, we consider improvements in our prototype in order to reach significant improvements between app and facebook users on the easiness of arranging shared rides.

Kurzfassung

Die Share Economy wird mit immer mehr Anwendungsbereichen allgegenwärtiger. Menschen teilen viele Dinge, z.B. Wohnungen, Bücher oder öffentliche Verkehrsmittel. Außerdem teilen sie auch Fahrten in ihren privaten Autos. Diese Vereinbarungen werden in der Regel zwischen Freunden, über spezielle Portale für Mitfahrgelegenheiten oder soziale Netzwerke getroffen. Da soziale Netzwerke jedoch nicht speziell für die Anwendung für Mitfahrgelegenheiten konzipiert sind, sind die Nutzer mit einigen Schwierigkeiten konfrontiert. Im sozialen Netzwerk Facebook existieren spezielle Gruppen für Nutzer, die Mitfahrgelegenheiten auf speziellen Strecken oder in einer geografischen Region suchen und anbieten wollen. Fahrtangebote werden als von Hand verfasste Posts veröffentlicht, die einen Text mit den notwendigsten Informationen enthalten. Deshalb enthalten die Posts manchmal auch Fehler oder wichtige Information über die Fahrt fehlt. Außerdem sind die Posts nicht chronologisch nach dem Datum und Zeit der Fahrt geordnet. Darüber hinaus müssen Zeitangaben wie 'morgen' oder 'Sonntag' in Relation zu dem Veröffentlichungsdatum gesetzt werden, was einigen gedanklichen Aufwand vonseiten des Nutzers nach sich zieht. Um diese Probleme in Angriff zu nehmen, präsentieren wir ein Konzept für eine prototypische mobile Anwendung um den Prozess, Fahrten auf Facebook zu teilen, zu vereinfachen. Die Anwendung zeigt Fahrtangebote geordnet nach geplantem Datum und der Zeit an und stellt einen Assistenten für neue Fahrtangebote bereit, um Fehler zu reduzieren und fehlende Information zu vermeiden. Um den Überblick über die Mitfahrer zu behalten, wird eine Verwaltungsfunktion für die Mitfahrer einer Fahrt angeboten. Obwohl Mitfahrgelegenheiten immer beliebter werden, sollten die Leute dazu ermutigt werden, sie zu nutzen. Aus diesem Grund nutzen wir ein Gamification-Design, das die Anzahl der geteilten Fahrten und Mitfahrer erhöhen soll. Um unseren Prototypen zu evaluieren haben wir eine Laborstudie durchgeführt. Die Beurteilung unseres ersten Prototypen hat ergeben, dass er übersichtlicher ist und weniger Fehler hervorruft als die normale Nutzung von Facebook zum Zweck von Mitfahrgelegenheiten. Außerdem wurde die Anwendung beim Verwalten der Fahrten eines Fahrers als nützlich befunden. Allerdings war das Verabreden von Fahrten mit unserem Prototypen verwirrender als dasselbe Verfahren auf Facebook. Des Weiteren scheint durch unsere Anwendung ein Potential für eine Erhöhung der Zahl von angenommenen Fahrten vorhanden zu sein, aber kaum für angebotene Fahrten. Außerdem gibt es wenig statistisch signifikante Anzeichen dafür, dass die Anwendung zu einer erhöhten Anzahl von Mitfahrgelegenheiten oder Mitfahrern in einem Auto führen würde. Ausgehend von den Ergebnissen unserer Studie schlagen wir weitere Forschungen zum Potential und Erfolg von Gamification, um das Nutzerverhalten zu ändern, vor. Des Weiteren ziehen wir Verbesserungen an unserem Prototypen in Betracht, um signifikante Verbesserungen zwischen den Nutzern unserer Anwendung und Facebook, bezogen auf einfacheres Vereinbaren von Mitfahrgelegenheiten, zu erreichen.

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Chapter 1.

Introduction

Although people are individuals, they share many things with other people. This does not only happen on social media platforms, but also with things in real life. The Sharing Economy affects more and more our daily lives. For example, people share appartments in order to save money or share books with each other. The Sharing Economy also affects the transportation sector where people share, for example, buses or taxis.

However, people also share rides in their private cars. Therefore, special ridesharing platforms provide the possibility to offer, find and arrange their rides on the internet. However, these platforms usually charge a fee for their usage. Therefore, also big social networks like facebook are used to arrange rides. The advantages thereby are no costs for the trip arrangement and an easy communication as social networks are designed for communication between its users. Therefore, special ridesharing groups have been created on facebook. These are basically facebook groups like any other, but with the purpose to offer and find shared rides on a particular route or in a geographical area. Facebook users, who are interested in sharing a ride, can join these special groups. Group members intending to offer a ride usually publish a post with their trip offer in the group. The post typically includes the day or date, the departure time, the route and often also the number of available seats. The other group members intending to join a ride, can contact the driver when they have found a convenient post. Then the remaining necessary details for the trip are clarified, e.g. the exact venue or price.

Arranging shared rides on facebook is relatively simple to do. However, facebook groups are not designed for ridesharing. As the posts are sorted by parameters like recency, it is not always easy to find a convenient trip offer. With an increasing number of posts per time, this becomes even worse. In addition, time designations like 'tomorrow' or 'Sunday' have to be set in relation to the publishing date. Furthermore, important information is sometimes missing in the post as well as there can be mistakes.

Based on these problems, the motivation for this work is to simplify the process of arranging shared rides in the social network facebook and to motivate its users to use ridesharing more often. Furthermore, we want to increase environmentalism by showing which contribution people accomplish to protecting the environment and how much they save in general by sharing rides.

For these purposes, we have developed a concept and implemented it in a prototypical mobile application. Thereby, our research questions are the following:

(1) How can a mobile application simplify the process of arranging shared rides on social networks and managing them?

(2) How can a mobile application increase the willingness to build and use shared rides?

1.1. Overview

The work starts with the state of the art in section 2. In section 3, we present the concept which is implemented in a prototypical mobile application. The implementation of the prototype itself is described in section 4. Afterwards, we present the evaluation of our concept and prototype in section 5, including a discussion of the results. Finally, we summarize the results of this work and outline future research potential in section 7.

Chapter 2.

Related Work

As sustainablity moves more and more in our focus, we look at concepts for making transport more sustainable in this chapter. This also includes examining trends like car pooling, lifts and car sharing. As sharing a car with other people also requires social interaction, underlying social and psychological factors are investigated. Furthermore, people should be encouraged to use sustainable mobility modes. Therefore, we consider gamification as a concept for motivation at the end of this chapter.

2.1. Sustainable Mobility

As it is well known that CO_2 emissions increase global warming, reducing emissions is a logical and popular approach. In this context, sustainable mobility moves into focus, because about 13 percent of worldwide greenhouse gas (GHG) emissions are produced by transportation (Effective 2011)[1].

Therefore, a shift in paradigms in the transport sector is considered necessary. While in the past transport was based primarily on mobility, where important factors were higher speed, reducing time and longer distances, now mobility is replaced by accessibility which refers to people's ability to reach desired goods, services and activities [1]. In this new paradigm, multiple modes are considered, for example walking, cycling, ridesharing or public transportation, and demand management strategies like road space prioritization, pricing reforms and smart growth land use policies. Instead of travelling faster, policies and projects that increase transport system efficiency and diversity are needed [1].

As a consequence of this shift in paradigms, Banister and Hickman describe a sustainable mobility paradigm [2]. In their work, they outline four main principles: reducing the need to travel, transport policy measures, land use planning measures and technological innovation. Table 2.1 shows these principles and some corresponding problem-solving approaches by them towards sustainable

[1]Worldwide Resources Institute, http://cait2.wri.org/profile/World, last accessed 2014/7/16

mobility. However, in order to make a shift towards this sustainable mobility paradigm, it has to

Principle	Solution
Reducing need to travel	Replace travel activity with non-travel activity or technology
Transport policy measures	Promotion of cycling and walking, easy access to public transit
Land use planning measures	Make travel unnecessary, locate necessary facilities nearby
Technological innovation	Sustainable vehicles, less emissions, increase effectiveness

Figure 2.1.: The principles for a sustainable mobility paradigm and suggested solutions to reach it by Banister and Hickman [2, 3]

be accepted by the public and be promoted accordingly [2].

In his socio-technical analysis on low carbon transitions, Geels concludes that we are only at the early phases of a low-carbon transition in the transport domain [4]. In addition, he outlines a stable car dominanted mode of transport and predicts that the car-based transport will stay dominant for the next 20 years. However, he agrees with Banister [2] that major changes in attitudes and radical and systemic changes should be made for reaching a sustainable mobility paradigm.

As the car has still a dominant role, transport planners try to change the user's behavior. Some examples for this are park and ride, traffic calming, priority lines for buses and high occupancy vehicles (HOVs), alternative work schedules, promoting bicycle use, car sharing, enhancing pedestrian areas, improving public transit and parking management [5]. In addition, road pricing and fuel taxes for car owners and subsidies for public transportation are taken in consideration in order to encourage people to use public transit instead of the automobile [5].

Despite these transport policies, the choice of a mobility mode mainly depends on spatial components (e.g. density, diversity, design), socio-economic components (e.g. age, gender, education, income) and personality components (e.g. lifestyle, attitudes) [6]. Thus, measures like road pricing will not consequently result in a lower number of single occupant vehicles (SOVs). Furthermore, leisure travel is influenced by objective and subjective factors (like lifestyle, attitudes) and there is mainly the decision between car use and non-car use [7].

2.2. Ridesharing

As described in the previous section, public transport, cycling and walking are an approach to a more sustainable mobility. However, in some places like rural areas, these travel modes are not available, only poorly developed or not applicable. Therefore, people living in these areas have to use other forms of sustainable mobility. Ridesharing is one of them.

2.2.1. Definition

According to Morency, "ridesharing exists when two or more trips are executed simultaneously, in a single vehicle" [8]. The car usually belongs to one of them. This person offers the ride and other people can join it as passengers. Rides are usually shared when people have the same or similar routes, e.g. the way to work. Bruns and Farrokhikhiavi distinguish two different forms of ridesharing: (1) car pooling as ridesharing on a regular basis especially for commuting and (2) offering or needing a lift as ridesharing on an irregular or a one-time basis mainly for leisure or other private activities [9].

2.2.2. Motivation

As there are different modes of sustainable mobility, we take a closer look on why people especially choose ridesharing as a transport mode.

Based on the data of a mobility survey by the German Federal Ministery of Transport, Building and Urban Development, Bruns and Farrokhikhiavi revealed three main factors why people share rides: reducing costs, protection of the environment and poor public transport connection [9]. A survey in Texas revealed access to HOV lanes, enjoying travel with others, environmental and social consideration, travel time saving and vehicle cost sharing as above-averagely reasons for building car pools [10]. In a survey in Switzerland on the reasons why people car pool, the main reasons therefore were environmental relief, saving CO_2, decongestion of roads, decongestion of parking lots and saving expenses [11]. On the other hand, possible barriers for using car pooling were tied to a fixed departure time, risk of not being picked-up, uncertainty about fees, risk of not finding a passenger at the venue and safety risks.

Altogether, the most important reasons for ridesharing seem to be protection of the environment, decongestion of the roads and saving expenses. However, the different results give the impression that the motivation for sharing rides depends on the particular environment.

2.2.3. Participation

Having laid out the reasons why people participate in ridesharing, we characterize the participants in the following paragraphs.

As car pooling is ridesharing on a regular basis, it is perfect for commuters on their way to work and vice versa. Thus, commuters are the main group participating in ridesharing. However, sharing rides to work depends on the social background and demography. Workers with less income are more likely to build car pools for their way to work [12]. This can be derived from saving expenses as a reason for participating in ridesharing.

Furthermore, Vanoutrive et al. found out that car pooling in Belgium is popular in the construction and manufacturing, wholesale and retail sectors, whereas it is rather unpopular at universities, in the health sector and in public transport companies [13]. Furthermore, they revealed that regular work schedules and a smaller number of employees at a site result in a higher share of car pooling among employees.

The influence of working hours has also been revealed by other studies. Buliung et al. report typical schedules as a reason for a higher participation in car pooling [14]. Bruns and Farrokhikhiavi have detected that most participants in ridesharing for work were working full time in a work time model with flexible hours [9]. However, there was no correlation between work time model and success in finding a car pool.

According to the results of a study in Germany [9], people sharing rides are compared to the general population in Germany above-average much younger and are highly educated. The study also revealed differences between lift and car pool users. While people using lifts usually live in one- or two-person households, are unmarried and childless, and have a low income as students or career entrants, car pool users normally are in a later phase of life as they are more frequently married, have children and a large income. Buliung et al. reported a similar user demography in their study [14].

2.2.4. Measures to Support Car Pooling

As car pooling is still not too popular, measures should be adopted in order to make this sustainable mode more interesting, especially for people using SOVs.

Vanoutrive et al. conclude in their work on the situation in Belgium that measures discouraging car use, like parking charges, seem to be more effective than soft carpool-promoting initiatives [13]. In addition, except the guaranteed ride home, they could not find any evidence on effectiveness of car pool promoting measures.

There are also concepts in order to encourage SOV drivers to share their rides. For example, some cities have created high occupancy vehicle (HOV) lanes for cars with at least 2 occupants. These are usually created at places where commuting traffic causes congestions in order to give HOVs an incentive in form of the advantage of being faster. However, the impact of HOV lanes on welfare, driven distance and air pollution are discussed contrarily and seem to depend on the particular environment [10, 15].

A very interesting form of car pools are casual car pools. It works as described in the following: People are waiting at a casual car pooling station similar to a bus station. When a car arrives, it is a 'first-come first-served' principle[2], where the waiting passengers enter the car just like a

[2] http://sfcasualcarpool.com/, last accessed 2014/07/17

bus or other public transport. In the case of San Francisco, the cars have then the advantage of using the HOV lane, reducing travel and waiting time (especially at the toll station). Another advantage is saving money as a small optional fee (usually 1$) for fuel is recommended but not mandatory. The ride ends at another fixed station identical to the starting station. Estimating the impact of casual car pooling in San Francisco, Minett and Pearce estimate that 1.7 to 3.5 million liters of gasoline are saved per year which corresponds to a saved amount of 200-400 liters for each participant [16]. Casual car pools are also considered in New Zealand if fuel prises rise [17].

Another idea is to price roads in order to make car users pay for their caused effects on society and environment [18]. This measure is supposed to improve traffic flow, reduce emissions and increase the use of walking, cycling, transit and car pooling as sustainable travel modes.

2.2.5. Ridesharing and Social Networks

Homophily is responsible for people interacting with each other and building homogeneous groups of people with similar ethnics, social background, attitudes, lifestyles, etc. [19]. As this includes also same interests, homophily has influence on ridesharing behavior.

One of the most importants factors when building car pools is trust, especially if the driver is a total stranger [20, 21]. Accordingly, it is not surprising that most car pools are built between household members [8]. However, it seems as a higher level of relationship makes people more likely to build a car pool. Chaube et al. could find a very high level of trust on taking rides from friends, a high level on friends of friends and their community members and a medium level of trust on the university community [20] (see figure 2.2). Only very low trust was found on strangers. It seems as the strength of relationships between people influences their car pool behavior. As taking rides from strangers seems to be low-trusted, car pool clubs or platforms have to establish a certain level of trust between total strangers [21].

As the status of relationships seems to influence the trust in taking and offering rides, social networks like facebook can be a good alternative to a ridesharing platform. Members of social networks can take offers from friends or friends of friends whom they trust. In addition, there exist special ridesharing groups on facebook. As a community seems to be trusted more than total strangers [20], members of such groups are supposed to be more likely to share rides with each other. Furthermore, social networks have the advantage of user profiles. These profiles can contribute to establish trust if the person looks trustworthy or shares interest with one. Even if one does not know a person, he can usually look up, if and which friends they have in common. This again could lead to a high level of trust as the person then is probably a friend of a friend.

Furthermore, there are also approaches to use social networks more efficiently for ridesharing. Therefore, dynamic ridesharing can be combined with social networks [22]. Thus, friends in social

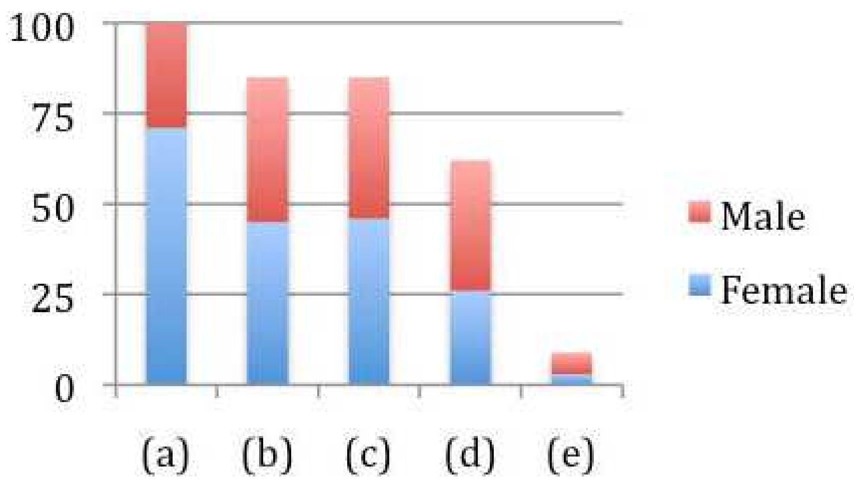


Figure 2.2.: Accepting rides from different individuals (a) Friends (b) Friends of friends (c) Community (d) University Community (e) Stranger as described by Chaube et. al [20]

networks are supposed to become more encouraged to share rides and to share them more often.

2.3. Car Sharing

Although ridesharing has many advantages, there might not always be a ride available when one needs a trip by car. Therefore, car sharing can be a solution. Car sharing means that people share a car which does not belong to them. They can book a reservation for the car and then use it for their purpose. For their usage, they pay a fee to the provider.

The main reason why people join car sharing is, according to a study by Martin et al., that their household did not own a car before and they gained additional personal freedom [23]. This reason was given by about half the participants. In the same study, only 13% participants joined car sharing for the reason to get rid of the car. All other aspects reached less than 10%. Altogether, most people (about two third) joined car sharing, as they needed a car or an additional car.

Not only sharing rides, but also sharing cars helps to reduce GHG emissions. Martin et al. ran a study if car sharing has a positive effect on GHG emissions [24]. They reported a mean observed impact of -0.58 t GHG/year per household, whereas the mean full impact was -0.84 t GHG/year per household. Also Baptista et al. see a big potential of reducing GHG emissions by car sharing [25].

Martin and Shaheen have also revealed an increasing use of walking, bicycling and car pooling after households have joined car sharing [23]. However, they have also detected an increasing use of public transport, which comes, as they argue, from car owners having joined car sharing and now having to use different ways of transport. In addition, Martin and Sheen revealed an overall decrease in the number of cars after people had joined car sharing. Such a decrease saves space in urban areas which would otherwise be needed for parking lots or road capacities. This space can then be used to support more sustainable forms of mobility like cycling and walking by building, for example, cycling ways or pedestrians [5].

To conclude, car sharing contributes like ridesharing to sustainable mobility.

2.4. Gamification

In order to fulfill the claim of the sustainable mobility paradigm, convincing people to change their travel behavior is necessary [2]. Therefore, gamification as a concept for motivation moves into focus.

Gamification was defined by Deterding as "the use (rather than the extension) of design (rather than game-based technology or other game-related practices) elements (rather than full-fledged games) characteristic for games (rather than play or playfulness) in non-game contexts (regardless of specific usage intentions, contexts, or media of implementation)" [26] or more shortly as the "use of game design elements in non-game contexts" [27]. According to this definition, gamification can be used in the context of sustainable mobility.

However, in order to use it successfully and efficiently, the principles of games and gamification should be understood.

2.4.1. Player Types

As every person has its own personality, it is not surprising that there are different types of players. Bartle divided them in 4 categories: achievers, explorers, socialisers, and killers [28]. Achievers are players who want to gather points and rise levels whereas explorers want to discover interesting features and the mechanics behind the game. Socialisers want to interact with the other players and have to deal with them, while killers want to win and see the other players losing. However, not every player is one of these types. Instead, every player is a mixture of these player types, but usually one type is dominating [29].

2.4.2. Points

People like being rewarded for something they have done. It suggerates them that they have done something good and thereby they feel good. Thus, it is very important to reward players and keep on rewarding them for special tasks and achievements, because "once you start giving someone a reward, you have to keep her in that reward loop forever" [29].

There are different kinds of points: experience points, redeemable points, skill points, karma points and reputation points [29]. The purpose of each type is shown in table 2.1.

Point type	Role	Purpose
Experience points	Rank of player	Reward for executing actions
Redeemable points	Currency	Virtual economy
Skill points	Bonus points	Subgoals, Gaining experience/rewards
Karma points	Points given away	Create a behavioral path for altruism and user reward
Reputation points	Player reputation	Trust between two or more parties

Table 2.1.: The different kinds of points with their role and purpose by Zichermann and Cunningham [29]

As the experience points are according to Zichermann and Cunningham [29] the most important type of points, we have a closer look on how they characterize them in this paragraph. Experience points (XP) are not used as a currency. They are rather how a player is watched, ranked and guided. The player will earn XP for executing actions in the system as points are the reward for it. Therefore, the player will gain XP as long as he plays the game.

2.4.3. Levels

Levels are a marker where the player stands in a game and they usually indicate the player's progress [29]. At a higher level, the game normally becomes more difficult or it takes more points to reach the next level [29]. Therefore, players at a higher level are considered as better or playing longer and therefore having more experience than players at a lower level.

2.4.4. Leaderboards

The purpose of leaderboards is to make comparisons between players [29]. Such a highscore list usually shows the player names and the score of the subset of players with the highest number of points over a certain period of time [30]. Therefore, the player can see the players who are ranked in front and behind him. Thus, the player knows what he has to do to beat higher ranked players [29]. As players usually want to beat better players in leaderboards, winning or losing conditions have influence on the motivation to play a game [31].

2.4.5. Gamification and Sustainable Mobility

As gamification is a concept for motivation, there are already approaches for sustainable behavior in the mobility domain. For example, McCall et al. have published a concept to avoid congestions by changing the driving behavior [32]. A contribution to safe driving behavior should be reached by the game named 'Driving Miss Daisy' where the driving behavior is evaluated [33]. However, there are also approaches to drive cars more ecofriendly. The car manufacturer Fiat[3] provides a little game which can be used in competition with other drivers of the community. With their game 'EcoChallenge', Ecker et al. show that users can be encouraged to adopt a driving style closer to a given driving strategy [34].

Kuntz et al. try to change the user's behavior towards the environment in their game-based approach to environmental sustainability [35]. Approximately a quarter of its ecofriendly actions are located in the transportation sector. Actions in this sector are intended to change behavior towards sustainable transportation. This includes, for example, avoiding sudden starts and stops, slowing down on the highway or removing excess weight from the car.

Wells et al. have created a game-based model for travel planning [36]. It does not only show the user sustainable options, but also tries to change his travel behavior towards them. This is done by points gained for finishing challenges which are reached by choosing sustainable transport options instead of the usual mode of travel.

2.5. Classification of our Research

As sustainability in the transport domain is an important aim, we want to contribute to the sustainable effects of ridesharing with this work. As with ridesharing trust plays an important role and thereby relationships between people, we focus on ridesharing at the social network facebook. However, this is not a real ridesharing platform. Therefore, we want to simplify the process of finding and offering rides in facebook groups. Another aim is to contribute to more sustainable car use by sharing rides more often and using passenger capacities more efficiently. Therefore, we want to know if we can use gamification in order to motivate people to share rides more often instead of driving alone and to take along more passengers. As we focus on ridesharing at facebook, we keep the communication ways offered by facebook instead of building our own communication system or ridesharing platform. Furthermore, we do not create a matching system [37] or use crowdsourced concepts for less effort on arranging rides [38]. Our goal is to research on how we can improve ridesharing on facebook groups.

[3] http://www2.fiat.co.uk/ecodrive/, last accessed 2014/07/27

Chapter 3.

Concept

In this chapter, we present the concept for our system and prototype. As relationships between people play an important role for trust when sharing rides, we focus on ridesharing on the social network facebook. However, facebook is designed rather as a communication platform than a ridesharing platform. Therefore, the concept is intended to solve or reduce existing problems with ridesharing groups on facebook. One goal is to simplify the process of finding convenient trip offers. Furthermore, the concept should reduce mistakes and missing information in trip offers. In addition, we want to motivate users to use ridesharing and the application prototype itself more often by using game elements. Furthermore, an aim is to increase the awareness of saved resources by user statistics.

The concept is implemented in a prototypical mobile application for smartphones which shows trip offers from facebook groups in an appropriate order, lets users post new trip offers on facebook and provides a trip management system. Furthermore, the mobile app provides a trip screen while driving and rewards users for participating in shared rides. The rewards are shown on a statistic page in the app. In addition, this page shows statistics on the user's rides with the app in order to increase the awareness of positive effects of ridesharing. Therefore, a statistic server is used to store this data at a central place and make it available to the app users.

In the course of this chapter, we have a detailed look on the system's components and the different parts of the concept.

3.1. Social Network Data

The social network facebook is the data source for trip offers and demands. It provides them in the form of posts in special facebook groups used for ridesharing.

Although the user's whole facebook data could be accessed, only information from groups relevant for ridesharing is needed for our purpose. Therefore, the user can choose his ridesharing groups from all his facebook groups as shown in figure 3.1. This gives the user control over the groups which are accessed by the app. In addition, he has to deal with less groups within the app which should increase clarity and speed when accessing them. Furthermore, the app provides the possibility to choose a preferred group which is always pre-selected or shown as first. Thereby, the user is supposed to find his ridesharing groups easier and faster.

Figure 3.1.: Selection of the user's facebook groups which he wants to use as ridesharing groups in the app

As we want to present trip offers from facebook in our app, we have to retrieve this information. Therefore, we download all posts from the selected ridesharing groups. If the posts of a group have already been downloaded at least once, only new posts are requested as the others are already stored in our app. This approach reduces fetching time and needed data volume. In order to control the usage of mobile data by himself, we let the user update the group posts manuelly. This has the additional advantage that he has control over when the trip offers are updated.

The trip offers on facebook consist of a user name, a profile picture and a post text. The profile pictures are important as people usually want to know how one looks like or if one looks trustworthy. Therefore, the app shows the same elements as the facebook post. For this purpose, the app downloads the required information on the group members. This includes among others the user name and the profile picture. Thus, the profile pictures can be shown immediately without fetching time or data connection.

3.2. Presenting Trip Offers

Trip Order Searching for a convenient trip offer in facebook groups seems to be a complex and difficult task for users. A reason therefore might be facebook's post order which sorts posts by parameters such as the publishing date and recently commented. Facebook groups do not even allow to view a strict chronological order of posts. Therefore, we give the posts our own order which meets more the user's needs. In order to do so, we try to detect the scheduled date and time of a trip offer. Therefore, the post text is set in relation with the publishing date. Thus, also time designations like 'tomorrow' or 'Sunday' can be assigned to a certain full date and thereby inserted in our order. For example, a post published on July 4 with 'tomorrow' in the post text would be inserted at July 5. Posts, which do not provide any scheduled day, are not shown in our app. Although we could show them in a special section, the amount of posts would increase steadily. In addition, our experience shows that not all posts in a ridesharing group really have to do with sharing rides.

As the scheduled date for a trip is derived from the post text, the posts can be assigned to a day. This makes it possible to show the user all trip offers for a certain day at once as shown in figure 3.2. This should make it easier and faster to find a convenient trip offer as the user is expected to look for a trip offer on a certain day. From the list of posts scheduled for this certain day, then the user can choose between offers which match his preferred time. To help him with that, the posts, where a concrete time has been detected, are ordered additionally by time.

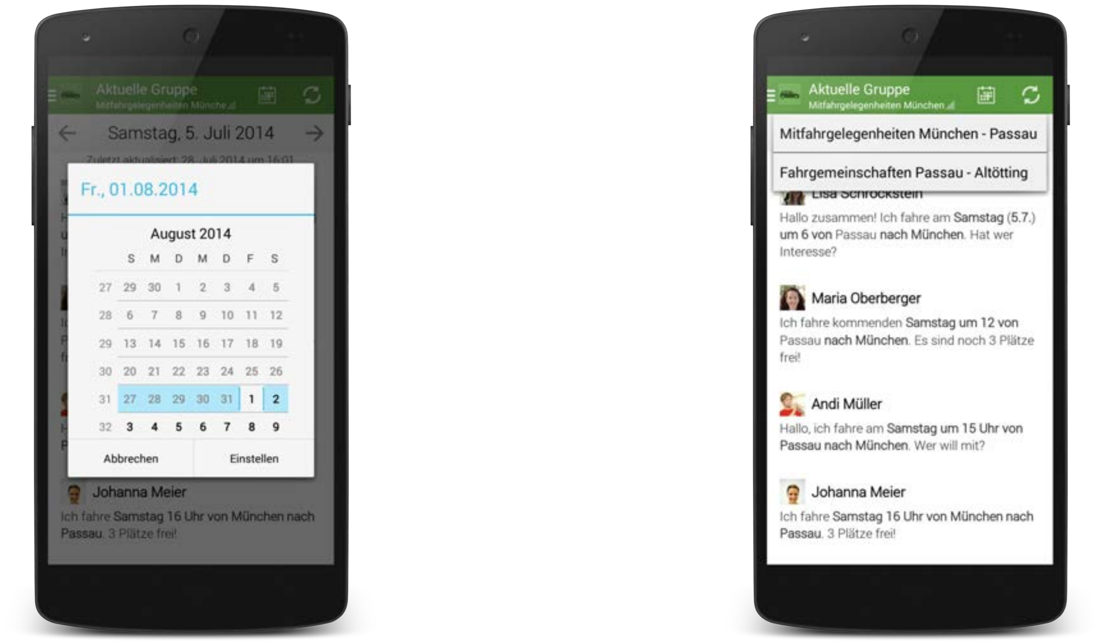
Altogether, the orders by day and time are intended to reduce complexity and cause less confusion. As a consequence, the user should be able to find a convenient trip offer easier and faster.

Presenting Trip Information In order to simplify the process of finding a convenient trip, the app supports the user with reading out the most important information of a post. As our experience shows that not all posts in ridesharing groups provide all necessary information such as date or day, time and route, we present the whole post text instead of a standardized trip entry with time and route. In addition, as there are also posts from people asking for trips, this approach makes it possible for the user to filter between trip offers and demands. Otherwise, these demand posts would look indifferent to the user. Another advantage of our approach is the possibility to detect more information as our app will probably not be able to detect all provided or misspelled information. However, in order to support the user, all recognized information like time and route is highlighted (see figure 3.2). Thus, he does not need to read the whole post. Therefore, the user is expected to extract important and relevant information faster and thereby to find a convenient trip offer more quickly.

Figure 3.2.: Presentation of trip offers from facebook ridesharing groups in our app prototype

Accessing Dates As the user is expected to search for a trip offer on a certain day, the app provides two ways of switching between dates: (1) stepping day by day through the current week and (2) choosing any existing date (figure 3.3(a)). Day by day steps are provided, because the user may have a preferred day when he wants to join a trip, but would also take a trip on the following day if it would fit better. Reasons therefore could be that he knows the driver or the final stop would fit better. As users often know an exact date in the future on which they want to travel, we provide our second option. Thereby, they can access the desired date more quickly. As users sometimes want to know with whom they have travelled the last time, they can also choose dates from the past. In addition, this makes it possible to look up if a driver drives on a regular basis.

Switching Groups As there are users which are members in different ridesharing groups for similar routes, we provide the possibility to switch easily between these groups. That means, the user can look for trip offers in one group for a certain date and then switch to another group if he has found no convenient trip offer (see figure 3.3(b)). After having changed groups, the app



(a) Selection of the date for which the trip offers are shown

(b) Switching of groups feature for fast access between trip offers for the same date in different groups

Figure 3.3.: Accessing dates and groups

presents all trip offers for the same date in the chosen group. Thus, the user does not need to select the date again after having switched between groups.

Additional Trip Information The post text usually does not contain all information on a trip. From the comments of a post, the user can often read out additional information such as precise venue or how many people are interested in sharing this ride. Therefore, we provide the possibility to show the post and all its comments inside the app as shown in figure 3.4. Furthermore, the user can comment the post directly in the app. Therefore, the user does not need to switch to the facebook app when he wants to comment a trip offer.

3.3. Offering Trips

To avoid switching between apps, also new trip offers can be created inside the app and be posted on facebook. As trip offers in facebook groups sometimes miss relevant information or are misspelled, misunderstood or confusing, our app does not support free text for new posts.

Figure 3.4.: Facebook post with comments as displayed in our prototype

Instead, the app provides a wizard in order to prevent mistakes. It consists of 3 steps where the user chooses and fills in necessary information (see figure 3.5).

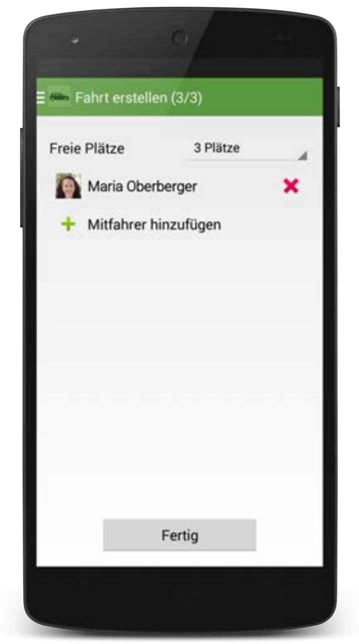
Step 1 At first, the ridesharing group has to be selected in which the post should be published. The user can only choose between his ridesharing groups. In addition, the preferred group is pre-selected. Then, the user has to choose the date and the time when the trip is going to take place.

Step 2 The user has to fill in the route for the trip. Filling in the locations manually does not limit the locations, as it would be the case if the app would offer only known places. However, this makes the procedure much more slowly. Therefore, if the user has previously created a trip with the same location and enters it, he is supported with auto-completion in order to offset this effect.

Step 3 In this step, the user has to provide information on the number of available seats. This information is published in the post as additional information. From the number of commenting users, other users can imply in some cases if there is still a seat available on this trip or not.

(a) Step 1

(b) Step 2



(c) Step 3

Figure 3.5.: Wizard for new trip offers on facebook

This spares the question on free seats and the corresponding answer. If the driver already has passengers before he creates the trip, he can add them in this step. The available seats are automatically reduced by the amount of existing passengers.

After the user has completed the wizard, he can choose whether he wants to create a new post on facebook or if he wants to associate the created trip with an existing post. If he chooses the first option, a standard post is created out of all provided information and posted in the selected facebook group. If the user wants to associate his trip with an existing post, he has to choose the corresponding post from a list of his previously published posts in this group. If the number of passenger matches the number of available seats, the trip can be created without a facebook post, because this action is useless in this case. However, if the user removes a passenger later on, he is asked if he wants to publish the trip on facebook. This again would post an auto-generated facebook post.

We conclude, that this wizard could reduce mistakes in trip offers (e.g. wrong direction) and prevent from missing information (e.g. no departure time or direction). Furthermore, the user does not have to write a text by himself regarding all important information.

3.4. Arranging Trips

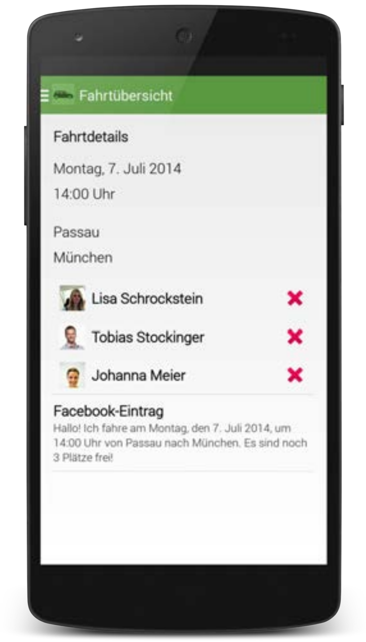
We keep the original facebook concept for arranging trips. That means, a driver has to post a trip offer in a ridesharing group. Then prospects ask the driver usually via comments or private messages if they can join the ride. As this behavior seems to be quite effective, we do not change this in the app. However, we allow the user to read and post comments for a trip offer inside our app. This is done in a facebook similar style to avoid confusion and increase awareness that the post and comments are facebook data. In addition, the user can switch to the facebook app and send a private message to the driver. Thus, both ways of communication are offered by the app.

As the trips are still arranged via facebook, group members not using the app are able to communicate with the app users. This would not be possible if we had our own messaging system. Thus, all group members can be sure that all trip offers are shown and available for all. Furthermore, this allows the app users to arrange their trips on facebook when sitting at home at their computer. To conclude, we do not force people to use our app or separate ridesharing groups into two factions as the arrangement system stays the same.

3.5. Trip Management

As it is not always easy for the driver to keep track of all passengers writing comments and private messages, the user can add and remove associated passengers for a trip. This can be done via a simple add and remove feature (shown in figure 3.6(a)) which allows only as many passengers as the number of available seats (figure 3.6(b)). Thereby, the user should keep all arrangements in mind and not pledge more seats than there are available. The passengers can be chosen from the members of the user's ridesharing groups. This has the advantage that users from different groups can be added to one trip. That is useful in cases of groups with similar routes and several posts for the same trip.

(a) User can add and remove passengers



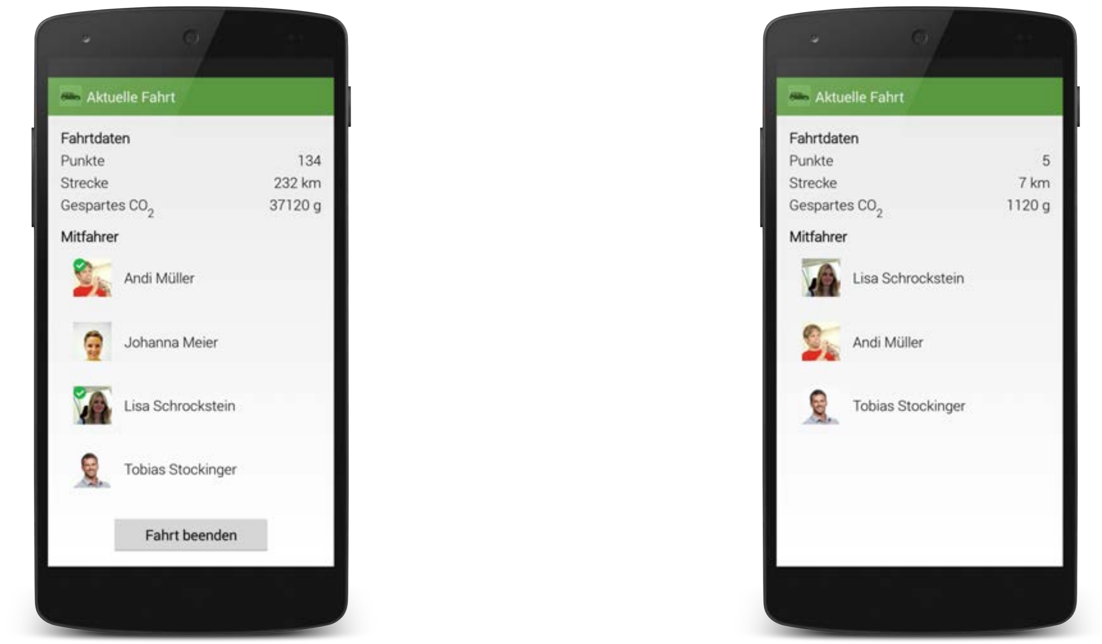
(b) User can only remove passengers as the number of available seats has been reached

Figure 3.6.: Trip overview with management feature for joining passengers

The app also provides a trip overview which consists of the trip details and the facebook post text (see figure 3.6). Thus, the driver can check again if all information is correct and read the generated post and its comments. This again should reduce trouble and mistakes.

3.6. Sharing Rides

As people using lifts usually do not know each other as trips take place irregularly or on a one-time base, our app shows who is in the car. Therefore, the driver has to start the trip in the app. This causes the app to broadcast periodical updates with information on the current trip. The other app users located nearby receive these updates from the driver. In addition, the passengers also broadcast their identity. Thus, the driver can detect attending passengers automatically as shown in figure 3.7(a). The information then can be displayed in the participating users' apps (see figure 3.7(b)). Thus, everybody in the car can look up the other persons' names and profile pictures. In this way, we want to encourage people to start talking with each other in order to make the trip more pleasant. In addition, the app shows the current score for this trip (see section 3.8), the distance and the saved CO_2 emissions as a kind of live monitor. Thus, the users can watch the numbers increasing during the trip. This could show them how points are gained in our app.



(a) The driver trip screen showing the attendance of the passengers

(b) The passenger trip screen showing the other car occupants

Figure 3.7.: The trip screen during a running trip

3.7. Statistics

One of our aims is to make the user aware of saved resources. Thereby, we want to show him the benefits of using ridesharing. This is intended to motivate the user to share rides more often. Therefore, the app has a statistic page with the user's overall saved CO_2 emissions, covered distance, passengers and saved money (see figure 3.8(a)).

The CO_2 emissions score shows the weight of CO_2 which the user would have emitted if he took a car alone by himself. However, these are not the real saved CO_2 emissions, but the score should make the user aware of the emissions one car emits. Therefore, the user is shown, how many trees there are needed to consume the emissions or how long a tree needs to consume this amount. This should help the user to set the emissions in a relation, so that he realizes what effect driving alone has on the environment. The overall distance is intended to give the user a positive feeling. As the distance increases with each ride, the user shall be satisfied and be motivated to go on with this behavior. The same aim is behind the number of passengers which the user has taken with. To encourage the user to take as much passengers as possible, the rate of passengers per offered trip is shown. In order to show the user another positive effect of sharing rides, the app presents the amount of money the user has saved on the contrary to driving alone. The displayed money value is the approximate cost for fuel for the driven overall distance.

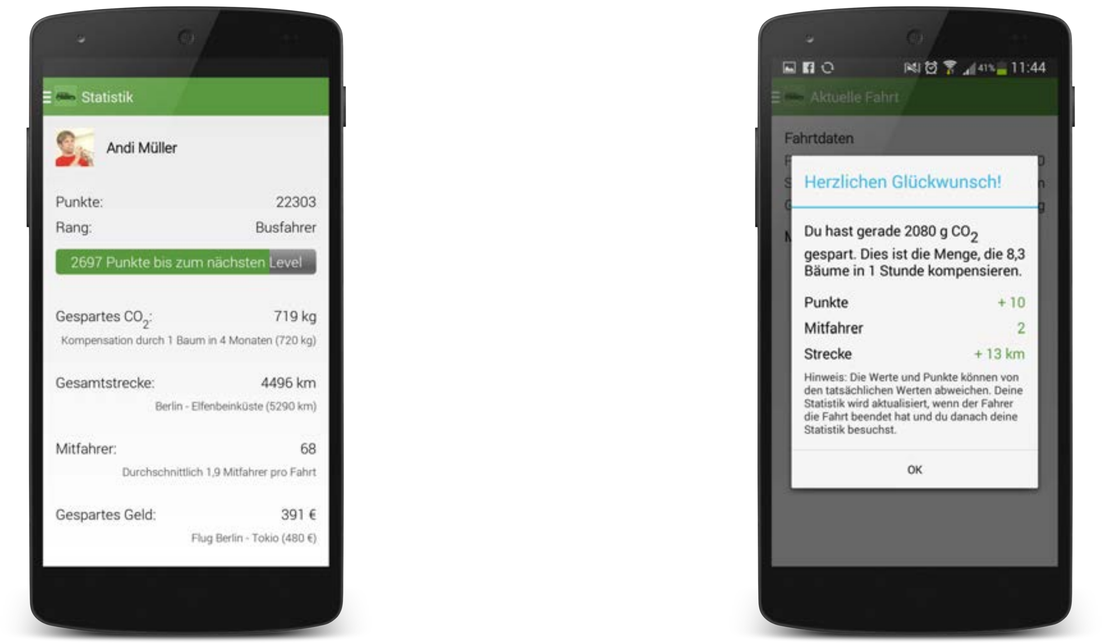
Although most of the presented values can be taken into relations and imagined by the user, every score has an equivalent to support setting the values in context anyway. For each value, an equivalent is shown next to the score. The equivalents are not only intended to make the user aware of covered distances or saved CO_2 emissions, but also to motivate him to go on saving and collecting scores [39]. Therefore, the equivalents are even or higher than the current score.

Users are probably interested in things like who is their most frequently driver, or who is the most frequently user they have travelled together. Therefore, the app has a ranking after trips for a user's drivers. The same could be done with all users. The ranking itself includes the user's profile picture, his name and the number of trips. This element could contribute to choose the same driver more often. As a consequence, drivers and passengers would get to know each other better and sharing a trip could become more pleasant. This would also increase the social effect of sharing rides. In addition, the users can become friends and it could become easier and more comfortable to arrange their rides as they know each other and, for example, the usual venue.

3.8. Gamification

The principle of saving ressources plays also a central role in our point system. For each trip carried out with the app, the user collects points, saved CO_2, distance, passengers (if he is the driver) and saved money.

It works as described in the following: At first, the driver has to create a trip in the app and then add all passengers. When starting a trip, the driver starts the created trip in the app. After that, the passengers are automatically detected by the driver's app. From this point on, all recognized passengers and the driver himself will gain points depending on the covered distance and the number of passengers. During the trip, all occupants can watch the current distance, saved CO_2



(a) Statistics page with points, level, progress, saved resources and their corresponding equivalents

(b) Statistic information on a currently finished trip with gained points and saved resources

Figure 3.8.: Statistics page and information on last trip

and gained points for this trip. In addition, all occupants are shown with their names and profile pictures. When a passenger leaves the car or the driver ends the trip, the passenger is shown the statistics of this single trip (figure 3.8(b)). These statistics are similar to the overall statistics page. It tells the user how much CO_2 emission he has saved and shows him the gained points as well as the covered distance and number of passengers.

Thus, the app rewards the user for each trip with at least one passenger. As the user knows that this will happen for each trip, he should be motivated to share rides more often and to increase the number of passengers in a car. To keep the game on running, there are levels which are reached with a certain amount of points. Each level gives the user a special title. Starting from a pedestrian, the user will reach titles like car driver, taxi driver or bus driver. Thus, these titles are an extra reward and are expected to cause talks about the titles and statistics between the users. This again would lead to competing with each other.

The trip's points are calculated with the formula $points = distance * passengers^{scoring\_factor}$ where $scoring\_factor = 0.9$. This formula was chosen as it should be fair for users driving different distances. Therefore, it depends linearly on the distance. In addition, longer distance also saves more CO_2, so the users should gain more points. As the number of passengers influences the saved amount of GHG, the points are increasing with an increasing number of passengers. To reduce the effects of carrying one passenger more a little bit, the passenger factor is not linear, but a little smoothed as an exponential function with an exponent $0 < scoring\_factor < 1$. If a driver has a trip with no passengers, he will gain points, because not all passengers may own the app or be capabable of using it because of limitations by the operating system. However, in this case the user's passenger rate will decrease. Therefore, this could also prevent cheating a little bit, as the user would have a passenger rate less than 1 if he drives alone quite often.

As with ridesharing both the driver and his passengers contribute to saving CO_2 and less cars on the road, both groups are rewarded with the same amount of points. In addition, if the driver gained more points than his passengers, the passengers could be encouraged to drive by themselves in order to gain more points instead of using the available capacities efficiently. This would turn upside down, as our game elements would lead the users to use more cars altogether. Therefore, the benefit of sharing the trip is given equally to the whole trip community.

Sometimes it is annoying if people are late. Therefore, our app has a feature in order to punish them. The driver can decide if a passenger is late. This is necessary because although the driver's app can detect when a passenger is nearby, passengers picked up later would be marked as late and be punished for no reason. For being late, the passenger will gain less points and be shown the amount of points he has lost. This feature is intended to make passengers more punctually.

In order to encourage the users to gain more points (which is intended to increase the usage of ridesharing and the number of passengers per ride), a leaderboard is available at a website to support competing between users. The leaderboard shows the top five users with the most points. As other users can see the leading users' scores, they are expected to try to gain more points for themselves. In addition, they should appreciate the sustainable ridesharing use by the leading users. This could lead to a higher motivation to protect the environment.

Altogether, the users are able to compete with each other which should cause an increased use of ridesharing and/or an increased number of passengers in a car.

3.9. Persuasion Methods

In order to encourage the users to use our app, we use some persuasion methods. One of them is that facebook data is presented in facebook similar style. As a consequence, users should be aware which content in the app is facebook content. In addition, the user has always the full control over the communication between the app and facebook. To make him aware of this control, facebook login and logout is always accessible. Furthermore, the app explains the use and purpose of required permissions needed to request data from facebook. The user is still able to decline permissions (also after he has granted them), but has limited app experience in this case.

As people like to see how the other users look, wherever a user name appears, the app shows the user's facebook profile picture next to the name. This should make the app more pleasant and in addition more social. The user can also recognize previous drivers via the profile picture even if he has forgotten a driver's name. Furthermore, the users see how the other passengers or the driver looks like which should make it easier to find each other at the arranged venue.

Chapter 4.

Implementation

This chapter describes how our concept has been implemented in our prototype. We give a short overview on our system and go on with the most important design decision which have been made. After that, we describe how we tried to make all parts of our concept accessible in the app. We will end this chapter with a discussion on concepts which have not been implemented.

4.1. System Overview

Our system consists of three main parts: facebook, a statistic server and the mobile application. A visual representation of the system, its stored data and the communication links is available in figure 4.1.

Components

Facebook is the social network which acts as the source for ridesharing data. It provides the trip offers and user information needed by the app. In addition, it is used as the communication platform for arranging trips inside (posting comments directly) and outside our app (writing private messages in the facebook app).

The statistic server stores all started and ended trips. In addition, it calculates the users' scores after a trip has been finished. As a consequence, it also hosts the users' statistics. These are downloaded when the user accesses his statistic page in the app. As an extra feature, the server provides a leaderboard with the top five users of all time in a web page. The server was implemented by using node.js.

The app is the main part of our system. The user is expected to interact most of the time with this component only. The app shows the trip offers from facebook and the score data from the statistic server. The facebook posts are parsed for trip data like date and/or day, time and route. If a date is detected in the post, the app is able to show this post as a trip offer. The app provides

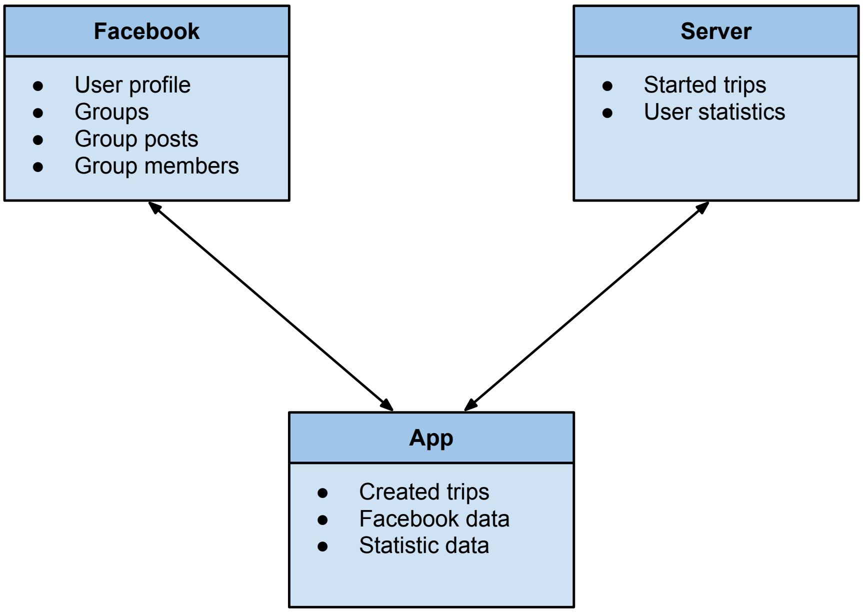


Figure 4.1.: System overview with the components, their stored data and the communication links

an overview of all trip posts from a selected group for a selected day. The app has got a wizard to create new trips easily. When a new trip has been created, the trip can be managed in the app. The user can add or remove passengers in the trip management. The statistics show the user's current score, level and overall trip statistics. The app itself has been written for Android.

Communication

App - Facebook The communication between the app and facebook is established via Facebook Graph API 2.0. Facebook is in the role of a server. The app is in the client role and requests all needed data from the facebook servers. The user's groups are requested in order to let the user choose the groups he wants to access in the app. Then all posts and members of selected groups are downloaded from facebook. When a new trip is created, the app sends a post request to the server in order to publish the post in the respective group.

App - Statistic server The app and statistic server communicate through http requests with JSON objects. When a trip is started, the app sends a post request to the server with the complete trip data telling the server that the trip has been started. After the trip has been finished, the app sends the complete trip data to the server. The statistics, which are calculated by the server after a finished trip, can be requested with a get request by the app. The server then sends the user's statistics back to the app.

4.2. Design Decisions

In the course of the implementation of the prototype many design decision had to be made. In this section, we discuss the most important ones.

4.2.1. Detecting Users

As the app has to be able to detect other users running the same app nearby, two solutions were taken into consideration.

The first solution was to use Bluetooth Low Energy (BLE). As the name already says, it is a version of Bluetooth which only consumes very little energy. In addition, the range of a few meters would be enough for our scenario. The disadvantages of BLE are a small data packet size and that sending BLE beacons is not yet possible on Android.

Thus, we had to take another solution into consideration: Wifi Direct. The advantages of this solution are a larger range and the possibility to build connections. However, the power consumption is much higher than it would be with BLE.

As Android does not yet support BLE, Wifi Direct was chosen to detect nearby users. Wifi Direct is fully implemented in Android, thus no extra devices are needed. Although there is the possibility of establishing connections, we use the header of the discovery packet to broadcast the trip data. As the header is limited, only the important information is transmitted. When Android supports BLE, a migration to BLE and if necessary sending the data through the statistic server should be taken into consideration.

In order to detect devices all the time even if the app is not active, the discovery service runs in the background. Thus, the passenger does not even have to start the app when entering a car but is detected anyway. Thereby, the driver's device is able to detect all nearby passengers without any circumstances.

4.2.2. Contacting Drivers and Passengers

Facebook users usually use two ways to arrange their rides: commenting the post with the trip offer or sending a private message to the post author. As a consequence, these two ways had to be considered.

As the app shows existing posts and allows the user to read the comments, it is logical that the user is offered an input box for writing a new comment. However, sending private messages should also be possible. As the Facebook Graph API does not allow to send private messages, we had to find a workaround. There were different possibilities to open facebook at a particular page. The main advantages and disadvantages of each option are shown in table 4.1. None of these solutions was perfect. However, opening the post in the facebook app was chosen as the best solution. This has the advantage that the user would go on with the same situation in the facebook app as he had in our app. Furthermore, the other solutions were not intuitive or too inconvenient (e.g. login on facebook first).

Option	Advantages	Disadvantages
Group member page	All members available	Search for member
Post in group	Equal situation as in app	No direct private message
Search function	Search instantly available	Hidden accounts, duplicate names
Message inbox	New message option	Search for strangers
User profile	Direct private message option	Additional browser login

Table 4.1.: Advantages and disadvantes of facebook linkage for private messages

4.2.3. Presentation of Trip Offers

For presenting the trip offers, another decision had to be made. Two ways of presenting the offers were balanced against each other.

The first solution was to have the same layout for all trip offers with the driver's name, the time and the route for this trip. This would have resulted in a consistent list of entries. The problem was, that most trip offers do not provide all relevant information. Thus, the time for the trip would often lack. In addition, it can be that not all provided information is really recognized by the app. Furthermore, the app would have to distinguish between offers and demands for trips.

So the second way was to show the original facebook post and highlight its most important information. This is done by regular expressions representing time or date patterns or looking for special keywords like 'from' and 'to'. The advantage is, that the provided information has not to be compellingly complete and no differences between offers and demands need to be made. In addition, the original text is available all the time to avoid mistakes and misunderstandings.

4.3. Accessibility

In order to easily access all features of the app, a navigation drawer is used to switch between features. It does not only allow to switch between finding trips, creating new trips, starting trips, watching created trips and the statistics, but it also shows the user's profile picture and score (figure 4.2). The last two items should make the app more pleasant to the user and make him

Figure 4.2.: The navigation drawer which is used as the main menu to access the different parts in the prototypical app

conscious of his current score.

Furthermore, switching between days while finding a trip was made easy. The user can browse through the current week by swyping the list of trip offers to the right or left. Furthermore, any date can be accessed by a calendar button or menu entry.

Switching between groups is always possible if a feature is used where the content is depending on the chosen group. The user can choose the group by using a spinner. This is also possible when searching for trips on a special date. The user can switch groups in the action bar and then the trip offers from the selected group for the selected date are shown.

4.4. Not Implemented Concepts

Delay In our concept, we wanted to reduce the amount of gained points if a passenger was late. As the size of information for the broadcast of the trip information is limited, we are only able to send the most important information. Otherwise, we would have to establish a connection between users sharing a ride or loading the data from our server which may be not possible because of lacking data connection. Therefore, the passengers' apps do not know if they were late or not. As a consequence, the amount of points, which has been lost due to being late, can not be shown. As the main idea was to show the user directly and clearly that he lost points in order to change his behavior next time, this part of the concept will not work as expected and is thereby in this shape almost useless.

Driver and Passenger Statistics The list of most frequently drivers and passengers has not been implemented completely. As collecting this data from the trip data broadcasts is not always reliable, we would have to load this data from the server. Therefore, the server would have to implement the possibility to download the list of drivers or passengers and the corresponding number of trips. This could be done by summing up the times when two users had shared a ride.

Chapter 5.

Evaluation

In the course of this chapter, we show the evaluation of our prototype. We present our hypotheses, our methods and then the results. After that, we discuss the results and show the limitations of the study.

5.1. Group Identifiers

In this chapter, we mention different groups of participants who have taken part in our study. Therefore, we reference them with the following identifiers in order to make clear which group is meant:

classEx participant A classEx participant is a participant in our study who was recruited via the classEx laboratory of the University of Passau.

Facebook participant A facebook participant is a participant in our study who was invited via a facebook ridesharing group.

App group The app group is the group in the study which used the app to perform their tasks.

Facebook group The facebook group is the group in the study which used facebook only to perform their tasks.

5.2. Hypotheses

Deriving from our concept, we had the following hypotheses:

H1 The app group finds it easier than the facebook group to find a convenient trip offer.

H2 The app group makes less mistakes (including incomplete information) than the facebook group when posting new trip offers on facebook.

H3 The app is useful for managing a driver's trips.

H4 The app causes drivers to take along more passengers.

H5 The app increases the awareness for saved resources and CO_2 emissions.

H6 Users are more likely to use the app because of gamification elements.

5.3. Methodology

5.3.1. Design

In order to test the hypotheses, we ran a laboratory study. Therefore, we had two groups: participants who used our app (app users) and participants who used facebook only (facebook users). As we wanted to know if and which improvements our prototypical app makes, the facebook users were our control group. The two groups had to carry out the same actions, but using different ways of interaction. The facebook users were using facebook only and the app users were using the app and for communication mainly the facebook app. The app users had some additional tasks which were app-specific and could not be carried out by the facebook users.

Every facebook participant had to arrange a lift in a specified facebook group. Therefore, he had to work with 2 different scenarios. In one scenario, the participant was in the role of a passenger seeking a trip offer for a special date and time. In the other one, he had to offer a trip in the role of a driver. To avoid any effects from the order of these two scenarios, we changed the order after each participant within this group. The same thing was done with the app group. They had the same tasks as the facebook group, but after each of the already mentioned scenarios there was a second one. These scenarios were following the preceding scenario temporally. In these scenarios, the participant went on the arranged trip, one time as a passenger and one time as a driver.

Facebook-Setup

For our experiment, we tried to get as close as possible to the real situation. Therefore, we created facebook test accounts for altogether 8 users. These accounts were all given an appropriate name and profile picture. In addition, we created 3 different facebook groups for the study: 2 groups for ridesharing and 1 group for cooking. The ridesharing groups were for different, not similar routes: Passau - Munich and Passau - Altötting. That means, our group design offered a 'right' ridesharing group for the study, a 'wrong' ridesharing group and a wrong group. From this design, we expected to be able to conclude if it is difficult to find the right group and if users choose wrong groups.

The posts in the wrong groups were only few. The cooking group had only two posts with meals and the wrong ridesharing group three posts for trip offers. These small numbers of posts were chosen in order to let the participants recognize faster that they were in the wrong group. Despite this, we were able to detect mistakes if the user chose the wrong group.

The 'right' ridesharing group contained 12 trip offers. They were (except one) all posted in the group on a Sunday. The missing one was posted on the next day as it was intended for 'today'. We tried to get our trip offers closely to the real situation. Therefore, we had posts with 'today', 'day after tomorrow', dates consisting of day and month, and days (e.g. on Saturday). The only limitation that we made to the real world was that we did not misspell words, omit required information or make mistakes. Nevertheless, we varied in our post texts. We wrote numbers as words and numbers, changed the sentence order and so on. However, the same characters in our facebook group posted the same or similar texts for authenticity reasons. The trips scheduled in the trip offers were placed around the expected trip date. As the trip which should be found was scheduled between 2pm and 4pm on next Saturday for the route Passau - Munich, we created a post for 3pm in this direction. In order to make it a little more difficult to find this trip, we created another 3 posts for this day. They were scheduled at different times and/or routes. One of these offers was scheduled in the required time interval but in the wrong direction. In order to approach a real situation, we also posted two posts for both Friday and Sunday. Furthermore, we had the previously mentioned posts with 'today' and 'day after tomorrow'. In addition, we had a post for the Saturday one week before our desired trip.

The setup of our facebook posts was created for a special date. As the study took longer as expected, we did not use the same posts again because all our trip offers would have been in the past. Therefore, we set up the same posts with the same post text for one week later. If a post contained a date, we changed this date to the date one week later. The posts with details like 'tomorrow' were posted on the same weekday as the original post. Altogether, we have only shifted the setting by one week. To conclude, the setting was the same for each user.

5.3.2. Participants

We ran the study with altogether 29 participants. The participants were asked if they wanted to take part in a survey on ridesharing taking about 30 minutes at the University of Passau. In addition, they were offered an allowance of 5€ for their participation.

The participants came from two pools. As our target audience are people who share their rides on facebook, we asked the members of three such groups via a post to participate in the study. We will call the participants from these groups facebook participants from now on. The other participants (classEx participants) were recruited via classEx laboratory, a pool of participants for experiments at the University of Passau. We actually wanted to have an equal number of 15 participants from each pool. However, as only 11 of the 15 facebook participants had shown up, we asked another 4 to participate. Finally, we had 13 facebook participants (2 male, 11 female) out of 19 commitments and 16 classEx participants (7 male, 9 female) who all showed up. This makes an overall participation of 9 males and 20 females. The high rate of female participants from facebook groups was neither intended nor expected.

As the chosen facebook groups are mainly used by students and most classEx pool members are students, it is not surprising that 27 (93.1%) of the participants were students and only 1 (3.4%) each was a student teacher and a librarian. Furthermore, the average age was accordingly 23.8 (MIN 18, MAX 53, SD 6.06).

Among our 29 participants, 24 (82.8%) had already used facebook to find or offer rides. All of our facebook participants had naturally used facebook for this purpose before, but also 11 (68.8%) of the classEx participants had done this. Almost every participant (28 of 29) had already offered a ride publicly or joined a ride. However, only 12 (41.4%) participants owned a car or had one for disposition durably.

We allocated the members of each group steadily to the facebook group, the first app group and the second app group. So one third of each group was intended to be in the facebook group and the other two thirds in the app group. Because of the higher and lower number of participants in the corresponding groups, 11 participants (37.9%) were allocated to the facebook group and 18 (62.1%) to the app group. From the facebook participants, 5 (38.5%) were allocated to the facebook group and 8 (61.5%) to the app group. The classEx participants were divided into 6 facebook users (37.5%) and 10 (62.5%) app users.

5.3.3. Apparatus and Materials

In order to conduct the study, we needed two laptops, two smartphones, a camera with microphone, a camera for the smartphone, 6 sheets of paper with the scenarios and 1 with a briefing.

The first laptop was needed to run the questionnaire. As our questionnaire has been created with LimeSurvey, it was run in the browser. In addition, the facebook group used this laptop to solve the tasks in their two scenarios on facebook. The laptop had a screen recording software, so that we were able to record the participant's actions on the laptop. The second laptop was used by the moderator to respond to facebook comments and messages. Furthermore, it was used to delete the facebook posts, comments and messages after each participant.

In order to run our prototype app, we needed a smartphone. For this purpose, we chose a Nexus 4. The app users were intended to solve their tasks with this phone. The other smartphone was used to simulate being on a trip because this is only possible if the app is running on another device nearby. Therefore, we used a Samsung Galaxy S3 (I9305).

The camera with microphone was located in front of the participant and recorded from above. The microphone was used to record the participants' voice as well. For recording the smartphone display and the user interactions, we used a Ziggi-HD High-Definition USB Document Camera. With the corresponding software, we were able to record all actions the participants carried out on the smartphone.

For each scenario, the particular participant was given a single sheet of paper. On this sheet, there was a description of the corresponding scenario and the related tasks. Thus, the participant could only see the current scenario. Additionally, a participant from the facebook group would never have seen that there existed a scenario for an app. The sheet with the briefing was used to inform the participants about the existence of ridesharing on facebook and how these groups look like.

5.3.4. Procedure

Although our participants were divided into 2 groups (a facebook control group and an app group), the procedure was for each group almost the same. There was only one participant at a time. We started the survey with a questionnaire with demographic questions and overall ridesharing behavior. After that, the participant had to arrange a trip via a facebook ridesharing group. Therefore, we had two different scenarios. In the first scenario the user was a passenger looking for a trip offer in a given facebook group for a given date, time slot and route. The second scenario was the other way round. The user had to offer a trip for a given date, time and route in a given facebook group. In each of these two scenarios the user had to arrange the trip and all necessary details such as the exact venue. Each participant had to do both scenarios. To avoid effects from the order in which the scenarios are tested, we changed the order of the scenarios within the groups.

The different groups had to solve the scenarios differently. The facebook group did its work on facebook using a laptop while the app users had to use a smartphone with our app. The facebook users started from the facebook home page of an already logged in user. The app users started from the corresponding situation in the app, where they were also already logged in on facebook and shown the first 'page' which appears after having started the app.

As our app has more features for ridesharing than facebook, the app users had extended tasks. In the role of a driver they had to add the passenger in the created trip after having arranged all details. Furthermore, in both scenarios we went on a trip afterwards. As a driver, the participant had to start the trip in the app and wait for his passenger. In the role of a passenger, he had to wait until the app had detected his attendance. After the trip had been finished, the participants had to watch the statistics.

After this experiment, the participants had to answer questions to the experiment. The app users had additional app-related questions including the statistics and game elements. Then, the participants were asked about their ridesharing experience and usage with facebook. The last question group was about smartphone usage.

5.4. Results

The results of the laboratory study are presented in this section.

5.4.1. Overall Ridesharing Behavior

The results show that it is important that the driver and passengers are punctual. Figure 5.1 shows the distribution of ratings. The answers from the 5 scaled Likert scale (1 = strongly disagree, 5 = strongly agree) show an average value of 4.71 at a standard deviation (SD) of 0.535.

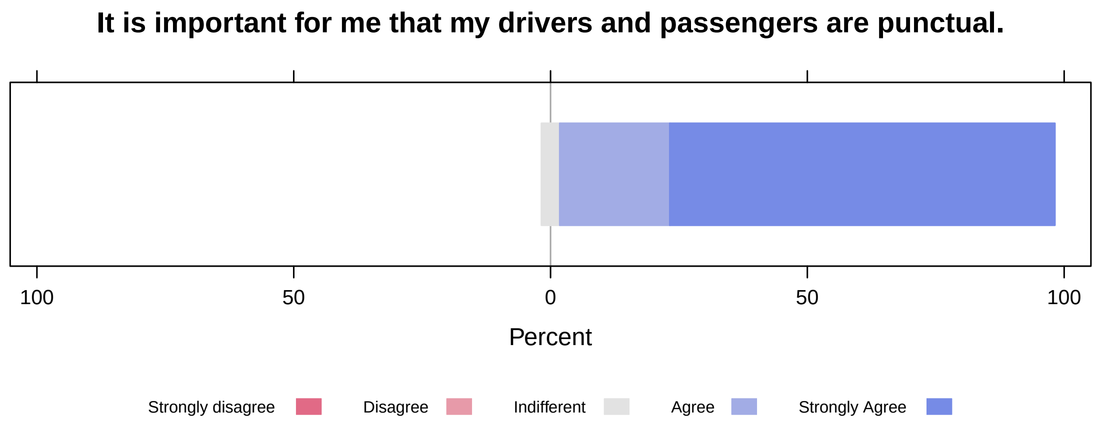


Figure 5.1.: Ratings on the importance of punctuality

The average number of persons in a car sharing a ride was 3.39 at an standard deviation of 0.737. The participants, who owned a car or had one for durable disposal (41.4%), had an average number of seats of 4.75 (SD 0.452, MIN 4, MAX 5) in their car. The difference between occupied and available seats is visualized in figure 5.2.

Out of 27 participants who provided information on the offers which they use for ridesharing, 17 participants (55.5%) used internet platforms (excluding facebook). The only social media platform, which was used by our participants, was facebook. All of the facebook participants used facebook for ridesharing and additionally 50% of the classEx participants. Altogether, 70.4% of the participants used facebook for sharing rides. The 27 participants who provided their ridesharing platforms used in average 1.63 platforms (SD 0.884, MIN 1, MAX 4).

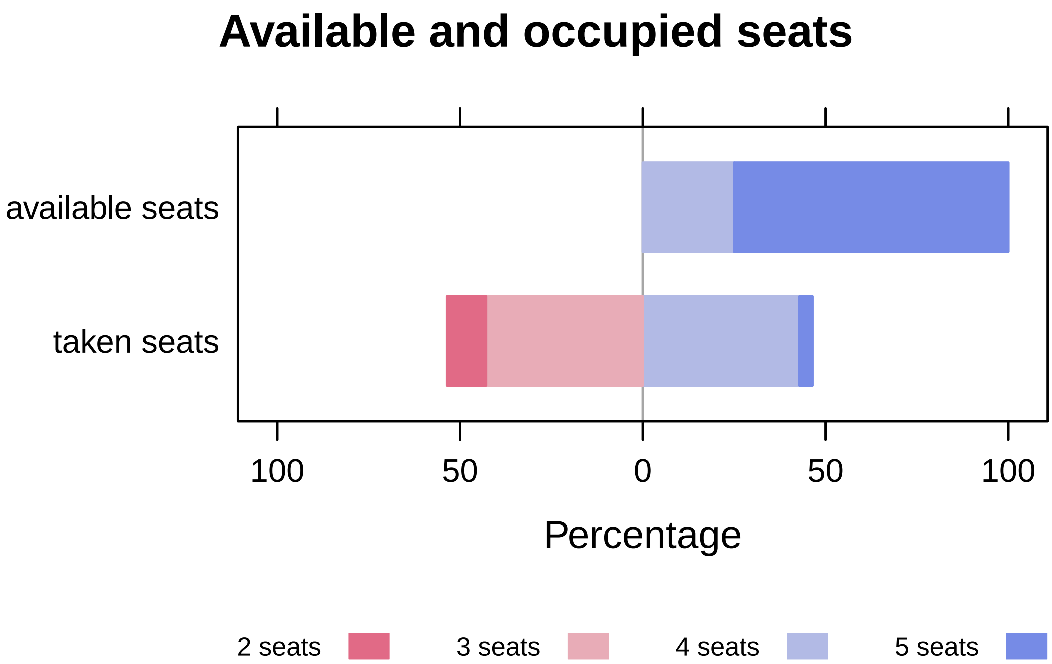


Figure 5.2.: Comparison between occupied and altogether available seats in a car on a shared ride

Of our participants, 92.9% use ridesharing for financial reasons, 85.7% as an alternative to railroads, 39.3% for protecting the environment, 35.7% for social reasons and 25.0% as an alternative to buses. The values are shown in figure 5.3.

5.4.2. Differences between Groups

In order to reveal differences between the app and facebook users when arranging their trips, we let them rate the shown procedure on a 5 scale Likert scale. All 29 participants had to answer these questions. The mean ratings of the groups on the procedure are shown in figure 5.4. The detailed results are located in the appendix (see A.1). For each of the attributes, we ran a Mann-Whitney test. In two cases, significant differences were detected. Facebook users $(Mdn = 5)$ and app users $(Mdn = 4)$ differed significantly in the extent to which they found the procedure comprehensible $(= 5)$ against incomprehensible $(= 1)$, $U = 41.5$, ns, $r = -0.55$. Furthermore, app users $(Mdn = 1)$ and facebook users $(Mdn = 3)$ differed significantly in the extent to which they found the procedure tidy $(= 1)$ against cluttered $(= 5)$, $U = 54.0$, ns, $r = -0.39$.

As the users of facebook ridesharing already knew the facebook procedure, we ran a Mann-Whitney test on each of the questions from the previous section with different groups of our participants. However, we did not find any significant differences when running the tests with the participants who had never used facebook for ridesharing before. Furthermore, the same procedure with only

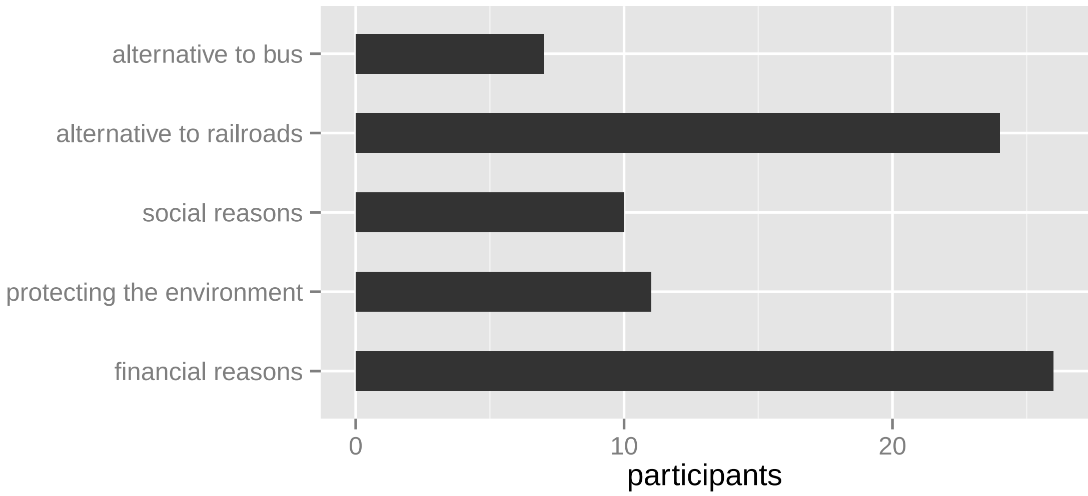


Figure 5.3.: Reasons why the participants share rides

letting out the ones, who had used facebook before and were in the facebook group, did not reveal any significant aspects.

We also let the participants decide on a 5 part Likert scale from 1 (difficult) to 5 (easy) if it was easy to find a trip offer, to offer a trip and to arrange a trip. The facebook group rated an average of 4.36 (SD 1.027) on finding a trip and the app group 4.83 (SD 0.383). On the easiness of offering a trip, the facebook users rated an average of 4.73 (SD 0.467) and the app users an average of 4.72 (SD 0.461). The facebook users rated 4.50 (SD 0.707) averagely on the easiness of arranging a trip. The app users rated 4.83 (SD 0.383) on average. A Mann-Whitney test on the easiness of each aspect did not reveal any significant differences.

Although the participants rated no significant differences on the easiness of the procedure, we observed several mistakes. 4 facebook users (36.4%) posted in the wrong group whereas none of the app users did that. A chi-square test was performed to examine the relation between the participant group and posting in the wrong group. The relation between these variables was significant, $\chi^2(1, N = 29) = 7.59$, $p < 0.01$. App users were less likely to post their trip offer in the wrong group. Exactly the same situation was observed with mistakes on missing information. A chi-square test on the relation between the participant group and missing information in the post text revealed that the relation between those factors was significant, $\chi^2(1, N = 29) = 7.59$, $p < 0.01$. The facebook group was more likely to create (or almost create) a post with missing information than the app group. In addition, there were misspellings in posts by facebook users in contrary to the app users. 1 of the 11 facebook users (9.1%) chose a wrong trip offer (scheduled for the previous week) whereas 8 of the app users (44.4%) did so. 7 of these 8 app users chose a trip on a wrong date. This wrong date was always the current date. A chi-square test was performed

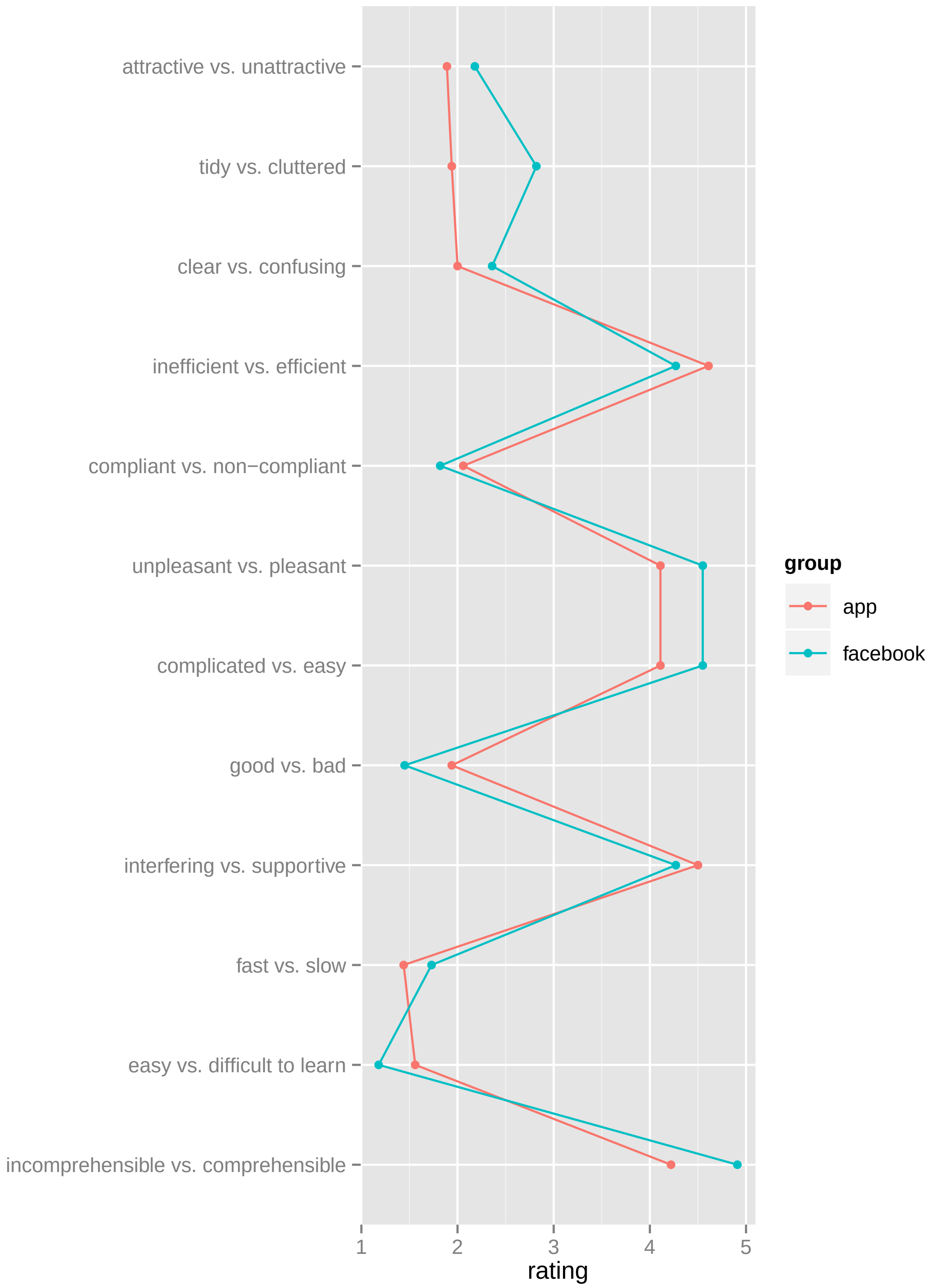


Figure 5.4.: Means rated by the groups on the procedure

on the relation between the participant group and choosing a wrong trip offer. The relation between these variables was significant, $\chi^2(1, N = 29) = 3.99$, $p < 0.05$. The facebook group was less likely to choose a wrong trip offer. The same test on the relationship between participant group and choosing a trip offer for the wrong date was not significant, $\chi^2(1, N = 29) = 3.04$, $p > 0.05$. The facebook users were not less likely to choose a trip offer for the wrong date.

5.4.3. App-specific Results

As positive aspects on the app prototype, 9 participants (50.0%) mentioned clarity and 8 participants (44.4%) statistics and/or points. Furthermore, every participate had found something positive about the app. In contrast, 3 participants (16.7%) each mentioned the facebook-app linkage and start-up difficulties as negative aspects.

When the participants were asked about missing features, there was only one accordance between two participants: pricing.

The management feature was valued as helpful. 8 participants (44.4%) strongly agreed, 9 (50.0%) agreed and 1 (5.6%) did neither agree nor disagree with the statement that the passenger management feature was helpful (see figure 5.5).

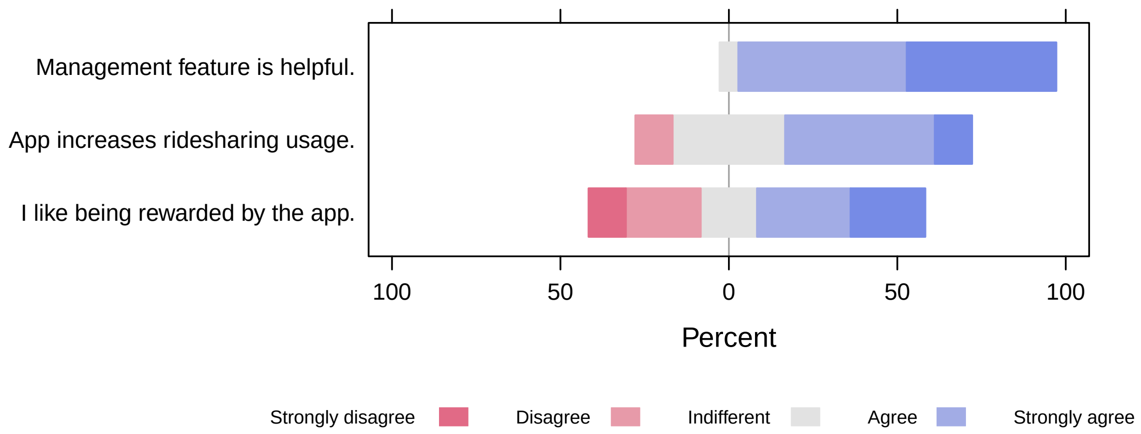


Figure 5.5.: Ratings on the questions (1) 'I think the trip management in the app for organizing my trips is helpful.', (2) 'The app could contribute that I use and offer shared rides more often.' and (3) 'I like being rewarded by the app for using ridesharing.' on a Likert scale

For 12 participants (66.7%) it is important that the app shows the driver or passengers. 5 of them (41.7%) gave trustworthiness as reason for it. The same amount mentioned keeping names or recognizing their driver/passengers.

The 18 app participants stated that the app could contribute to using and offering lifts more often. 2 (11.1%) strongly agreed, 8 (44.4%) agreed, 6 (33.3%) neither agreed nor disagreed and 2 (11.1%) disagreed with the statement (see figure 5.5). This makes an average score of 3.56 (strongly disagree = 1, strongly agree = 5, SD 0.856).

When the app group was asked about positive aspects of the statistic overview, 11 participants (61.1%) mentioned saved CO_2, 10 (55.6%) money, 6 (33.3%) eqivalents, 5 (27.8%) distance and 3 (16.7%) points or levels (see figure 5.6). 1 participant did not mention any specific aspect, but said that it displays different aspects which can be interesting. In the corresponding question

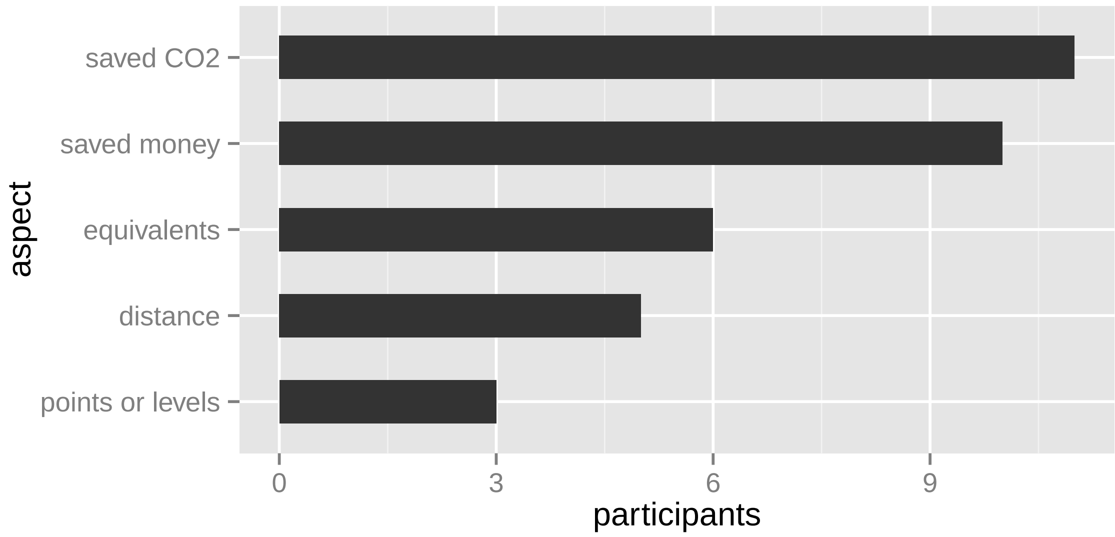


Figure 5.6.: Positive aspects on the statistic page mentioned by the participants

about negative aspects, this participant mentioned no negative aspects.6 participants (33.3%) mentioned the points and levels as annoying or unnecessary, 4 (22.2%) had questions to the statistics or parts of it as they were confused by some parts.

On a scale from 1 (very likely) to 5 (very unlikely), our 18 app participants rated an average of 2.44 (SD 1.042, MIN 1, MAX 5) if they were likely to talk with their friends or fellow passengers about their statistics.

When asked what they were willing to do in order to gain more points, our app participants would use ridesharing more often (72.2%), recommend the app to their fellow passengers (33.3%), followed by more fuel-efficient and more secure driving (both 27.8%). 4 participants (22.2%) would offer lifts more often.

On a likert scale from 1 (strongly disagree) to 5 (strongly agree), our 18 app participants rated an average of 3.28 (SD 1.364, MIN 1, MAX 5) if they like it to be rewarded by the app (see figure

5.5).

5.4.4. Smartphone Usage

Of the participants who owned a smartphone and had already shared a ride before (27), 23 (85.2%) used a computer, 20 (74.1%) a mobile phone, 2 (6.9%) a tablet and 1 (3.4%) a fixed phone for arranging their trips.

Only one participant did not own a smartphone, but the other 28 (96.6%) did. Among the smartphone users, 20 (71.4%) used Android, 7 (25.0%) iOS and 1 (3.6%) Windows Phone as operating system on their device. The time using their smartphone was several hours a day (60.7%), 1 hour a day (35.7%) and 1 time a day (3.6%).

Only one (3.4%) of our 29 participants had Bluetooth usually enabled. Of the other ones, 56.0% had it disabled because of energy consumption. 4 participants (13.8%) had GPS enabled and another 4 mentioned location services as a reason for disabling this function. However, 3 of them (75.0%) had wifi activated. 27 participants (93.1%) had mobile data enabled. All of them, who explained their choice (7 participants), mentioned internet connection as the reason for activating it. 20 participants (69.0%) had wifi activated.

5.5. Discussion

In this section the results are discussed. This includes what effects they have on our concept and how they contribute to our research questions.

5.5.1. Compliance with Concept

There were some results which meet our expectations and assumptions from the concept. When the participants were asked which platforms they use for ridesharing, the only mentioned non-ridesharing platform was facebook. This approves our choice of using facebook as the social network for the concept and prototype. Additionally, the number of 50% of classEx participants, using facebook for ridesharing purposes, is an argument for this choice.

As 70.4% of the participants use facebook for sharing rides and altogether the average number of used platforms is between 1 and 2, most of the participants are in our target group. In addition, 71.4% of the participants already use their mobile phone for arranging shared rides without our special app. This is in conformity with our choice to build a mobile application for smartphones, although 3 participants more use the computer. However, using mobile phones in our concept has many advantages. As our app requires activated WiFi, it is good that 69% have it already enabled by default. It would be interesting to know if the users would activate Bluetooth (3.4% in our study) if we used the connection solution with Bluetooth instead of WiFi. Therefore, the main concern of big energy consumption by using Bluetooth would should be removed. In addition, 93.1% had mobile internet connection activated, which is required by our app to start and end trips. To conclude, most of our users already have the required components activated. The choice of using Android was right in our eyes, as 71.4% of our smartphone users' devices run on Android. As 96.4% of them are using their smartphone at least 1 hour a day, we assume that they would be likely to install and try our app. This could show us if our concept works and is adopted by the users.

Another part of our concept is to promote punctuality. However, the punctuality feature has not been implemented completely. As there was a very high rating on the importance of punctuality with no disagree, this seems to be a very important factor for sharing rides. Therefore, this part of the concept should be implemented completely in the next iteration of our prototype.

5.5.2. Differences between Facebook and App Procedure

The results on the comprehensibility showed that our facebook users found the process of finding, offering and arranging a trip significantly more comprehensible than the app users. If we looked at the same questions with users who had never used facebook for ridesharing before, there was no significant difference. Therefore, we assume, that the facebook group rated the comprehensibility higher as they were already familiar with the procedure. However, this should be tested again with a larger amount of participants not knowing ridesharing on facebook as we had only 3 of them, which is not representative.

The app users rated the procedure significantly tidier than the facebook group. In addition, 50% of the app users mentioned clarity as a positive aspect in our app. We conclude that in this aspect our concept is successful as one of our aims is to make it easier to find trip offers via sorted posts. In addition, we provide a wizard to create a new facebook post which allows an easier view on the information in the later post text.

All the other aspects on the procedure showed no significant differences between the two modes facebook and app. However, it is striking that the values on the Likert scale are always higher than 4 or lower than 2 for all these remaining aspects. We assume that both groups wanted to rate the aspects high or low, but there were not enough gradations for this.

On the easiness of our facebook and app procedure, no significant results were detected, although there seems to be a slight tendency in favor of the app. This could perhaps be changed by increasing the number of participants or with the same setup, but with participants who are already familiar to the app.

Altogether we assume, that our approach is easy, but seems not to be easy enough. Perhaps the approach should be simplified even more. Therefore, we reject hypothesis H1.

One of our hypotheses was that the facebook group makes more mistakes than the app group when posting new trip offers. Although there were no significances in the easiness of the procedure, we have observed significances in the number of mistakes. At first, the app users had no missing information in their posts, but this is significantly less than the facebook users had. Furthermore, the same thing happened with posting in the wrong group. In addition, the app users did not make any spelling mistakes in posts in contrast to the facebook users. On the other hand, the app users chose significantly more often the wrong post. As in almost all these cases the participant chose a post for the current instead of the desired date, we assume that our participants did not recognize that they were starting at the wrong day. They often chose the only available post at this day very quickly or after a long time of experimenting. We argue that they did not notice the date for the shown posts. Therefore, it would be necessary to question if this is only a start-up difficulty or changes in the prototype are necessary in order to increase the awareness of the current date. Altogether, we conclude that we have reached our aim of reducing mistakes, especially when posting new trip offers. Therefore, we keep hypothesis H2.

5.5.3. Passenger Management

In order to help the user with managing his trips, our app provides a passenger management feature. This feature was rated positive only, except one indifference. We conclude that it seems to be helpful at the first sight. A long-term study could show if this is still the case after having used the app for a longer time. However, we keep for now the hypothesis (H3), that this feature is useful for managing a driver's trip.

5.5.4. Taking more Passengers

Another hypothesis was that the app causes users to take along more passengers. The results show that there are often free seats left on a trip. Thus, there would be enough capacities to take along more passengers.

Additionally, there seems to be a potential of changing the driver's behavior towards an increased use of ridesharing. 72.2% of the app users would draw on lifts more often in order to gain points. This is in accordance with our current reward design as users gain more points if they use shared rides more often. Thus, we would need to promote this kind of gaining points as there seems to be a high potential. This could be done by explaining for which actions points are gained or offering extra points for a certain monthly distance or number of use.

However, offering trips more often seems to have a relatively low potential. We ascribe this to the fact that less than the half of all participants owns a car or has one for durable disposal and that they might already offer trips whenever it is possible. Despite this, slighty more than the half of our participants valued that the app could contribute to offer and use shared rides more often. Therefore, we assume that the app has the potential to make a shift towards more sustainable travel behavior as only 2 participants (11.1%) did not agree with this statement. Despite this, we have to reject hypothesis H4, because there is no evidence that drivers would really take along more passengers. For this purpose, we could run a long-term study in order to reveal differences on the number of passengers caused by the app.

5.5.5. Awareness for Saved Resources

When asked on positive aspects of the statistics, more than the half mentioned saved CO_2 and money. In addition, about a third stated equivalents and distance. These statistic elements seem to be more interesting and important than the points and levels (16.7%). The statistic elements are intended to increase the awareness of the saved resources by sharing rides. Thus, when the users watch their statistics or receive them after a trip, they would be directly faced with the saved resources. Therefore, we assume that the app could increase the awareness for saved resources and especially CO_2 emissions (see H5). In order to test this assumption, we could run a user study on it.

5.5.6. Gamification Elements

The statistic page revealed a rank in the most important factors from saved CO_2, money, equivalents and distance down to points and levels which reached only 16.7%. Because of this low value, we conclude that either the awareness of saved resources is more important to the users or they are not interested in gaming in the application. As 44.4% of our app participants mentioned statistics and/or points as positive aspects of our app by themselves, the statistics seems to play an important role. As 33.3% of the participants mentioned points or levels as unnecessary and only 16.7% rated positive on them, it seems as if the statistics are interesting to people, but the points in majority not. This can be underlined by the fact that the average user is indifferent if he likes to be rewarded by the app or not, although there is a broad distribution. Therefore, we would need to increase the attractiveness of reaching points or a certain level. For example, we could rename the points to 'Eco-points' or 'Green points' to stress that they are gained mostly through sustainable travel behavior. In addition, we could offer rewards for reaching new levels like unlocking features (e.g. changing the app's color theme) or a fuel gift card for the best player of the month. As 22.2% of the app participants had questions on the statistic, we should perhaps make clearer that these are the overall gained scores. This could also be done by a contextual help in the menu.

Furthermore, our participants seem not to be much encouraged to talk with others about their statistic. As we do not want them to be happy for themselves but also to compete with each other, we could encourage them to share their trip results with the other users. This could be done via facebook with posts including the statistic for a finished ride. Thus, the user's friends could see the achievement and thereby be motivated to beat it.

To conclude, the participants seemed not to be much encouraged by the gamification design. Therefore, we reject hypothesis H6. However, a long-term study could reveal if users of the app are really not interested in competing or if they start it when using it for a while.

5.5.7. App Feedback

In our concept, we described that we want to make the app more social and pleasant. This aim seems to be reached as for two third of the app users it is important that the app shows the driver or passengers. As the reasons were trustworthiness, keeping names and recognizing each other, we assume that this principle helps to make the app more pleasant and useful to the users.

As our aim is to improve the current situation, we have to look also at negative aspects in the app. 16.7% of the app users mentioned the facebook-app linkage as a negative aspect. This problem was already known before running the study. However, there is only low scope to change this, as facebook does not allow to send private messages directly via the API. We consider the possibility of changing the linkage from the message inbox back to the post in the group, as this seems to work again at the moment. Thus, we cannot do much against this, except building our own messaging system which would exclude non-app users as described in 3.4.

The other most relevant negative aspect was start-up difficulties. The users needed some time to cope with our app. However, until they have found the main menu, there were no further noticeable difficulties. This was especially the case when an app user had to solve the driver scenario first. Therefore, we assume that this difficulties might be gone after having used the app and its features once. However, in order to make it user-friendly for new users, we have to consider a kind of tutorial explaining the most important features of our app.

As two participants mentioned pricing as missing features, we agree that this would be helpful and easy to implement. On the other hand, there is a law in Germany that you are not allowed to earn any money when offering trips (and you do not have a license for passenger transportation). Thus, this could be even illegal and it is better for us to let the users arrange this between each other. Furthermore, facebook posts usually do not contain this information.

5.5.8. Other Interesting Findings

The reasons why the participants use ridesharing are similar to the reasons stated out by Bruns et al.[9]. The three most important reasons were the same. However, the alternative to railroads in our results was rated much higher (82.8%) than in the other study (49%). An assumption is that the train connection is above-averagely bad in the examined area. Therefore, it would be interesting to run a study on this aspect in order to reveal if this is a coincidence or which reasons there are especially in this area why people are above-averagely using ridesharing as an alternative to the train. Furthermore, protecting the environment was only chosen by 37.9% participants in our study as against 78% in the other one. A possible reason therefore could be the demography of our participants as the average age was 23.8 and almost all participants were students. It would be interesting if or how this reason depends on the age, profession and/or social background. The results would have been perhaps different if a prioritization of reasons was considered or the users gave the reasons by themselves.

A very interesting fact came up on location services. Only 13.8% had GPS activated whereas the same amount deactivated it because of tracking concerns. But 75% of the participants with privacy concerns had WiFi activated which allows almost similar accurancy on getting the current location. We assume, that users are not aware of this fact. However, to retrieve sure information on this, we would have to run an extra study.

5.6. Limitations

The participants in our study had almost all the same age and were students. This could have influences on the results, especially on the reasons why they use ridesharing and the contact with facebook and smartphones.

In the practical experiment, we tested an unknown procedure against a procedure which was already known by almost 80% of the participants. Therefore, this knowledge could have had influence on the results between the two procedures. In addition, there was no long-term study which would have made the unknown procedure to a known procedure. Furthermore, we do not know how users would interact with the prototype after having used it for a while.

In addition, due to facebook's post order, we were not able to create the exact same conditions for every facebook user. Although the post which had to be found was (almost) in the same place in the order, the rest of the post order could not be controlled to be always the same. Therefore, the facebook setup could lead to different outcomes for every participant. The fact, that posts which are frequently commented are ranked higher even if the comments are deleted, was not taken into consideration when creating the facebook setup. Therefore, not all participants in the facebook group had the exact same setup. Furthermore, the order of posts can have influence on the differences between the app and facebook group, because the order changes the degree of difficulty for the facebook group whereas it stays the same for the app group.

Chapter 6.

Lessons Learned

When starting the implementation of the prototype, we were not aware of the fact that facebook Graph API 2.0 does not support private messages between users. In addition, the profile IDs inside the app are differently from the usual facebook IDs. Therefore, it is not possible to start the facebook app or messenger with the ID from the app as a parameter in order to, for example, open a new message to a pre-selected user.

As we have recruited members from facebook groups for the study, we faced some other problems. The facebook participants were not very reliable. Only 11 of 15 participants showed up. After that, we asked again 4 participants to participate. 2 of them actually came to the study. Altogether, 13 of 19 members from facebook groups attended the study. Furthermore, some of them did not respond to our e-mail message with all details to the study. However, also people who have answered this e-mail did not show up. In contrast, all participants from classEx came. We have also revealed that one cannot control who takes part if one posts an invitation for a study on facebook. One participant was invited by an e-mail, although we did not send any invitation e-mails. Therefore, we should have asked the participants before selecting them for the study if or in which facebook ridesharing groups they are a member.

In the study, we had to restore the same order of posts for each participant of the facebook group. This was actually not possible, because facebook ranks posts higher which have recently been commented. Therefore, we were able to rank other posts higher by commenting them. However, it is very difficult to restore the exact same order. Therefore, it would be perhaps easier to delete and post again all posts instead.

Chapter 7.

Conclusion

7.1. Summary

In the course of this work, we have looked at sustainable modes and paradigms for transport including trends like car pooling, lifts and car sharing. Furthermore, gamification as a concept for motivation was shown as well as approaches to use gaming in the non-gaming context of sustainable mobility. Deriving from these topics, we presented our concept for a prototypical mobile application for ridesharing groups on facebook and the therefore needed system. The concept was developed to meet the two research questions: (1) 'How can a mobile application simplify the process of arranging shared rides on social networks and managing them?' and (2) 'How can a mobile application increase the willingness to build and use shared rides?'.

Therefore, the concept describes a mobile application which shows the offers for lifts from facebook groups in an appropriate order, lets the users post new trip offers on facebook and provides a management system for created trips. Furthermore, the app tries to motivate the users extrinsically as they gain points and statistics for each trip carried out with the app.

Herafter, we have shown how and which parts of the prototype we have implemented. After that, the prototype was evaluated. We tested the procedure of finding, offering and arranging a lift on facebook with two different test groups consisting of altogether 29 participants: a control group using facebook only and an app group using our prototype. The results show almost no significant differences between the two groups. One of two exceptions is that the facebook group finds the procedure more comprehensible than the app group which we interpret as an effect of knowing the facebook procedure already. The other exception is that the app seems to be tidier than facebook. In addition, there were less (no) mistakes and misspellings in post texts when using our app prototype. However, finding, offering and arranging trips seemed not to be easier by using our app. Therefore, we suggest further improvements in the prototype. Furthermore, the app seems to increase the awareness of saved resources, especially CO_2 emissions. However, the participants were not really convinced of the game design (except statistics).

7.2. Further Research Potential

As the participants in our study have only rated the first impression of our prototype, we could research on the same questions with participants who are familiar to the prototype. This could also avoid effects from testing a known against an unknown procedure. Furthermore, this approach could lead to more meaningful results as the participants know the whole system. In addition, it could reveal different results on the comparison of the app with the facebook procedure. In order to estimate the impact of the prototype, a long-term study in the field could give us more qualitive feedback on this.

As our study revealed that it is not easier to find and arrange trips with our app yet, we could make improvements to the prototype. Potential improvements are another mode of presenting trip offers, an order of trip entries by route, automatic determination of starting location by location context, an own messaging system between the app users or an arrangement system without writing messages. These improvements could then be tested by a long-term study in the field in order to reveal potentially significant differences between app and facebook users.

Furthermore, our study has only revealed a potential for changing the users' behavior. Therefore, it would be interesting to research if this potential is exhausted by our concept and prototype or how this could be done better. As the point system does not seem to be very popular in our study, research could be done on the influence of 'real world rewards' such as fuel vouchers funded by sponsors for the best players of the month.

Appendix A.

Result Tables

Attribute	Mean FB	SD FB	Mean App	SD App	Significance
Incomprehensible vs. Comprehensible	4.91	0.302	4.22	0.732	$p < 0.01$
Easy vs. Difficult to learn	1.18	0.405	1.56	0.856	
Fast vs. Slow	1.73	0.905	1.44	0.784	
Interfering vs. Supportive	4.27	0.674	4.50	0.618	
Good vs. Bad	1.45	0.522	1.94	1.110	
Complicated vs. Easy	4.55	0.522	4.11	1.023	
Unpleasant vs. Pleasant	4.55	0.522	4.11	0.963	
Compliant vs. Non-Compliant	1.82	0.982	2.06	1.162	
Inefficient vs. Efficient	4.27	0.467	4.61	0.502	
Clear vs. Confusing	2.36	0.809	2.00	1.372	
Tidy vs. Cluttered	2.82	0.874	1.94	1.305	$p < 0.05$
Attractive vs. Unattractive	2.18	0.874	1.89	0.676	

Table A.1.: Ratings on attributes of the procedure with the average rating (mean) and standard deviation (SD) of the facebook (FB) and app group and the significance if available

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List of Acronyms

EISLab Embedded Interactive Systems Laboratory

GHG greenhouse gas

HOV high occupancy vehicle

mdn median

SD standard deviation

SOV single occupant vehicle

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