Understanding and Designing for Perceptions of Trust in Rideshare Programs

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Abstract

Traffic congestion, high gas price and inadequate public transportation are major challenges for any country, business or individual. The traditional approach to solving these problems has been to improve public transportation and use greener energy. These approaches require huge investment, research and time, and can only be carried out by governments or businesses. An alternative solution seeks to reduce the number of vehicles on the road based on ridesharing. Nevertheless, ridesharing is not a popular form of public transportation.

A ridesharing application involves planning and collaboration in setting up rides. Some of the concerns of users of these applications are social discomfort that arises due to lack of trust amongst co-passengers and inconvenience in scheduling rides. In this work we are trying to understand the perceptions of trust in a software application that integrates collaboration and social networks. We conducted a rideshare needs assessment survey conducted within the Virginia Tech community. The purpose behind this survey was to understand commuters travel patterns, their needs and to identify their preferences for private vehicles and public transit for a variety of travel needs. The survey results indicate that users are willing to increase participation in ridesharing programs if three core issues are addressed trust, convenience and incentives. Based on the results and analysis of our survey results we present an iPhone based ridesharing application that would leverage social networks to embed trust. To overcome the complexity in scheduling rides, we have made our application available on mobile phones (iPhone) so that users are connected on the go and make use of GPS for location awareness to plan their rides instantaneously. Our social software application is easy and intuitive to use, helps users find trusted rideshares and reduces the carbon footprint of the individual.

Dedication

To my Mom and Dad for the wonderful education they have given me

To my family, who has supported me always

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Contents

1 Introduction **1**

1.1 Problem and Motivation 5

1.2 Contributions 6

1.3 Outline 7

2 Related Work **8**

2.1 Trust 8

2.1.1 Properties of Trust 9

2.1.2 Representation of Trust 10

2.1.3 Conclusion 11

2.2 Social Networks 12

2.2.1 Conclusion 14

2.3 Location Awareness and Mobile Phones 14

2.4 Social Software and Mobility 15

2.4.1 Conclusion 15

2.5 Existing Ridehshare Systems 16

2.6 Overall Conclusion 17

3 Methodology **19**

3.1 Gathering Requirements 19

3.1.1 Interviews with Existing Rideshare Services 20

3.1.2 Survey Design 21

3.2 Evaluation of InstaRide 24
3.2.1 Evaluation Technique and Procedure 25
3.2.2 Selection of Participants 25
3.2.3 Experimental Setup 25
3.2.4 Study Protocol 28
3.2.5 Usability Study 28
3.2.6 Trust Perception 31

4 Design and Implementation **33**
4.1 Design 33
4.1.1 Server architecture 34
4.1.2 Client architecture 36
4.2 Trust 36
4.2.1 Social Relationship 37
4.2.2 Affinity 37
4.2.3 Ride reviews 38
4.2.4 Number of rides together 38
4.2.5 Other factors 38
4.3 Implementation 39
4.3.1 Server 39
4.3.2 Client 41
4.4 Features 41

5 Results **50**
5.1 Survey Results 50
5.1.1 Existing rideshare systems 51
5.1.2 Travel Patterns 54
5.1.3 Social Networking 55
5.1.4 Trust Factor 56

5.1.5 Benefits of ridesharing . . . 58
5.1.6 Use of ridesharing . . . 59
5.2 User Study Results . . . 62
5.2.1 Usability of the Application . . . 62
5.2.2 Feature Evaluation . . . 64

6 Discussions **75**
6.1 Survey Discussion . . . 75
6.2 User Study Discussion . . . 76

7 Conclusions and Future Work **82**
7.1 Conclusion . . . 82
7.2 Future Work . . . 84
7.2.1 New Features . . . 84
7.2.2 Integration with Other Applications . . . 85
7.2.3 Analytics Tool . . . 85
7.2.4 Push Notifications . . . 86

Bibliography **87**

A Informed Consent Forms **94**

B Survey Questionnaire **97**

C Benchmark Tasks **101**

D Post Evaluation Questionnaire **110**

List of Figures

4.1 The server-client architecture for InstaRide 34

4.2 Models representing entities in a social network for ridesharing 35

4.3 The Client architecture 43

4.4 Relation between Friendship and User tables 43

4.5 Two rows of the friendship table showing friendship between A and B (a) when a request is sent and (b) when a request is accepted 44

4.6 Relation between Rideshare and User tables 44

4.7 Two rows of the rideshare table showing a rideshare between A and B (a) when a rideshare request is sent and (b) when a request is accepted 45

4.8 InstaRide User Interface 46

4.9 Trust Details User Interface 47

4.10 Create Ride User Interface 48

4.11 Friendship Invitation User Interface 49

5.1 Mode of transportation for daily commuting (Number of people versus transportation mode) 51

5.2 Problems with Existing Rideshare systems (a) Not user friendly (b) Complications in finding and setting up a ride (c) Does not handle end minute changes in travel plans (d) Can't trust co-passenger (e) Lack of awarenesss 52

5.3 Accepting rides from different individuals (a) Friends (b) Friends of friends (c) Community (d) VT Community (e) Stranger 57

5.4 Giving rides to different individuals (a) Friends (b) Friends of friends (c) Community (d) VT Community (e) Stranger 58

5.5 Motivating factors for ridesharing (a) Environment (b) Congestion (c) Parking (d) Convenience (e) Cost 60

5.6 Use of ridesharing (a) Likely to use carpool for local events and shopping (b) Likely to use carpool for commuting to work or school (c) Likely to use carpool for vacation and long distance trips 61

5.7 Number of people versus relationship preferences for accepting ride 69

5.8 Number of people versus relationship preferences for offering ride 70

List of Tables

3.1 Survey Constructs and Questions 22

5.1 Usability Evaluation Questionnaire with Results 63
5.2 Feature Evaluation Questionnaire with Results 65
5.3 Trust Questionnaire with Results 66
5.4 Trust and Ranking. 1 lowest 5 highest 74

Chapter 1

Introduction

The United States had 4.6 of the world population but consumed 21.8 of the worlds energy (102 quadrillion BTUs of energy) in 2007 [24]. The financial crisis that began in 2007 and continued through 2009 has impacted these numbers. World energy consumption reduced by 1.2 percent in 2008 and further down to 2.2 percent in 2009 [25]. Energy is mainly needed for industry, transportation, and residential and other commercial purposes. The share of transportation alone is almost 30 of the total consumption mostly in the form of liquid fuels. This consumption is expected to increase from 53 percent in 2007 to 61 percent in 2035 [25]. Urban life-style and steadily increasing demand in personal travel will be the biggest contributing factor in the energy demand from transportation.

The biggest challenge by such large energy consumption is green house gas emissions, mainly carbon dioxide (CO2) that are considered to be the major cause of global warming [24] The total US carbon dioxide emission in 2006 was 5,890 million metric tons, with the transportation share being 34 of the total. World carbon-dioxide emission is expected to rise from 29.7 billion metric tons in 2007 to 33.8 billion metric tons in 2020 to 42.4 in 2035. Contribution of transportation is more than 30 and these numbers indicate that in order to reduce carbon

dioxide emissions and its dangerous consequences, making transportation more efficient is a crucial step.

Government policies and individuals travel preferences are two effective ways that can have a big impact on the environment. In the United States, automobiles are the preferred mode for short distance travel [23]. Passenger transportation is dominated by automobiles, which account for 86 of total passenger miles traveled [23]. Government can create laws for strict emission norms that result in energy efficient vehicles. Some environmentally conscious individuals have changed their travel habits resulting in the success of hybrid and electric cars.

We can define *public transportation* as a mode of passenger travel that is available to the general public. Thus commercial airplanes, trains, buses and taxis can be considered public transportations. Ridesharing or carpooling is a privately organized shared use of a passenger vehicle for commuting purposes. The arrangement for ridesharing may involve paying the vehicle owner a small fee or sharing of gas costs. A more popular arrangement amongst regular commuters involves rotational sharing of their vehicle by different owners, without exchange of money. Since ridesharing involves giving rides to the general public, it can also be considered a form of public transportation.

ZipCar [22] and *UCarShare* [19] are another form of public transportation. These systems claim to redefine the way people think about transportation. All that a user has to do is join the service, go to the car parked in a parking lot that has been reserved by these services, unlock the car through a card that works as the key and drive. The only glitch here is these parking spots where the cars are parked are not always found in locations closer to residence or office, one still has to pay the service charge some times based on hourly usage (e.g. *UCarShare*) and availability of vehicles in peak hours. The advantage is that users are free from hassles of ownership insurance, parking and automobile maintenance.

Several web-based rideshare applications exist today that help individuals plan and share rides [10, 21, 14, 8]. General features of these applications include ride posting by providing location and time details, display of ride posts and their filtration based on location, time etc. Additional features such as maps, user profiling, and rating of the driver or passenger are provided by these applications to improve user experience. The need for integration of a rating feature in a rideshare application is of interest to us. Rating is done for a drivers driving skill, environment in the car such as music, smell of cigarette smoke and passengers behavior. The co-passengers of these applications in most cases do not really share any social relationship; i.e. they could be complete strangers. Other than the rating or the basic profile information associated with each user the whole deal could turn out to be a complete blind date. This is a perfect situation to raise social discomfort and trust concerns.

Social relationship and trust play a major role in many co-operative endeavors. Web-based social networks also commonly known as social network sites have exploited this theory by integrating social preferences and trust. A very common definition of social network sites given by Boyd and Ellison [32] is: "We define social network sites as web-based services that allow individuals to (1) construct a public or semi-public profile within a bounded system, (2) articulate a list of other users with whom they share a connection, and (3) view and traverse their list of connections and those made by others within the system". Social network sites are now available on other platforms as well such mobile handsets thus it is no longer restricted as a web-based service.

Social software has seen a tremendous increase in its usage with blogs, social networking sites, collaborative filtering etc. Facebook alone has more that 400 million active users [16] and more than 100 million active users using Facebook through their mobile devices. These statistics indicate how more and more people are adopting mobile social software and that people like being connected on the go. Location aware services have given a whole new

definition to the usage of social software from finding my near by friend to recommendation systems. Some of the mobile social software are *DodgeBall* [54], *Loopt* [13], *Friendster* [33], *Twitter* [18] etc.

A users social network consists of their friends, friend-of-a-friend, acquaintances, relatives, colleagues, classmates, member of their university community overall it consists of people whom the user knows either directly or indirectly. Social network analysis helps in deriving the relationship between two users in a social network graph. A social network graph consists of nodes that represent users and paths that represent relationship. These paths can have weights indicating the strength of the relationship [71]. We call these weights a *trust value/level*.

Although trust is a very subjective notion and can have various meanings we try to explain as Diego Gambetta [45] suggested: "When Alice says she trusts Bob she implicitly means that the probability that Bob will perform an action that is beneficial or at least not detrimental to her is high enough for her to consider engaging in some form of cooperation with him. Correspondingly, when she says that Bob is untrustworthy, she implies that that probability is low enough for her to refrain from doing so". We will discuss about various attributes of trust in detail in our related work section.

The trust value should be computed on users preferences and can be further broken down into various levels such familiarity, affinity etc. Integrating a rideshare application with social networks can cater to trust concerns of the users mainly because of the relationship and trust that is inherent in social networks. In a system like rideshare additional levels should to be added such as driving skill, dependability.

1.1 Problem and Motivation

In most American cities, single-occupied automobiles make the majority of commutes [23]. Assuming that most cars can seat 4 passengers, every car in the street is being utilized only 25%. This fact motivated us to try to identify the problems that prevent commuters from fully utilizing the passenger capacity of a car, which will help reduce the number of cars driven and consequently reduce pollution that contributes to global environmental problems. We conducted a survey to understand the travel habits of individuals for a variety of their needs. Through our survey, we wanted to understand the peoples concerns about using ridesharing as a means of public transportation. We are aware that several ridesharing systems and tools exist, but we wanted to explore the problems faced by users in organizing and coordinating a rideshare using these systems.

Although the rideshare system sounds like a fairly simple concept, it is not so, and hence not used widely. There are three main reasons why these systems have not gained many users in the past. First, there are system level difficulties in scheduling a ride; it involves enormous planning and complexities. Second, there is social discomfort that arises due to lack of trust amongst co-passengers. It turns out that trust in co-passengers is the most important factor why people are not willing to give or take rides from others. We learned that users prefer choosing their co-passenger. Finally, there seems to be lack of incentives or motivation for people to share rides.

The current state-of-the-art with technology advances in location sensing, wide adoption of mobile phones and ubiquity of social networks was encouraging and promising enough for us to propose a design for a mobile phone based rideshare software that would leverage social networks to embed trust in it and use the location aware services to schedule rides instantaneously.

1.2 Contributions

In this research we have tried to identify perceptions of trust of users of a collaborative system such as ridesharing. The information on the perceptions and interpretations of trust when integrated with these applications can enhance user experience.

Based on the results of our survey, we designed an instantaneous ridesharing system for members of an online social community. Our mobile device based system not only leverages social ties, but also make use of features such as GPS to provide rides available in the vicinity and phone numbers to negotiate meeting places and incentives. Ideally, our users would be able to post and view rides as soon as the mobile device is out of their pocket. Finally, we would like to provide incentives and motivation to people to consider ridesharing as a good alternative to their personal vehicles. Incentives can be financial, environmental or simply convenience in setting up rides. We call this ridesharing system *InstaRide*.

To cater to the trust concerns of the users we are proposing a model for trust broadly based on metrics such as ride rating, affinity level, social distance, familiarity, recommendation and rating. The trust value would help users of these systems make an informed decision about their drivers or passengers thereby reducing the social discomfort in ridesharing. We plan to determine users perceptions of trust in a ridesharing scenario. Through our usability-study questionnaire and benchmark tasks we have determined the weights of the metrics mentioned above. These weights could vary for each user based on their preferences. The numbers that we suggest here were learnt during the usability study of the InstaRide prototype. It represents the common views of the users who participated in the study. We are considering users preferences at deepest level of granularity such as gender, ride offer, ride accepting and social relationship, driving skill.

This application would serve as a platform to build a users rideshare network that is evolved

from their online or offline social networks. It is important to identify what factors play a major in making a collaborative application a success. In case of ridesharing trust happens to be a major factor along with ease of use and we believe our design provides that.

1.3 Outline

The rest of the thesis is organized as follows. Chapter 2 presents the background, describes the related work in this area. Chapter 3 presents the methodology and approach. Chapter 4 explains the software design. Chapter 5 shows the results of our survey and user study. We conclude the thesis with some discussions in Chapter 6. Chapter 7 summarizes the thesis and discusses future work.

Chapter 2

Related Work

In this chapter we are going to discuss some of the previous work done in the area of trust, social networks and mobile social software. We begin with the definition of trust.

2.1 Trust

Trust as defined by Mayer and Davis [62] "is the willingness of a party to be vulnerable to the actions of another party based on expectations that the other will perform a particular action important to the trustor, irrespective of the ability to monitor or control that other party". Trust has been mentioned as the willingness to take risk. Cook and Wall [38] have defined trust in terms of confidence as the extent to which one is willing to ascribe good intentions to and have confidence in the words and actions of other people. Trust has also been defined in terms of predictability; both together reduce uncertainty [62]. People have their preferences in trusting another individual. Familiarity has been considered an important condition for trust [60]. For example, a stranger is considered less trustworthy than parents [62]. People tend to trust their family members, friends and acquaintances more to establish mutual

dependence compared to others [44]. Trust plays a major role in establishing cooperation for society to work productively [44].

Trust has been studied in various disciplines including Computer Science. It has been used in the context of Cryptography and Authentication [43], P2P systems [57], as a metric in Attack Resistance [59] and many more.

Our trust model is based on familiarity, mutual dependence and predictability. Cooperation is important for a system like ridesharing and points mentioned above play a key role.

2.1.1 Properties of Trust

Trust can be of various types and it can have different meanings for each person. The perception may also vary in different situations. For example, Alice trusts Bob as a friend but not his driving skills. Different representation of trust makes it difficult to define it generally. We argue that different systems should provide trust models based on its characteristics. To trust a physicians skill one would think of number of years of experience, number of patients he or she attended and recommendations etc. In this scenario one would devise a trust model considering these.

Trust is not transitive i.e. the assumption that (Alice trusts Bob) and (Bob trusts Cathy) implies (Alice trusts Cathy) is not always true. We can however, assume that Alice would rely on her trust in Bob to trust Cathy. Abdul-Rahman et al [27] mention this kind of transitivity as conditional transitivity.

Trust can be passed along chains of relationship between two individuals. However, there may be degradation as the size of chain increases. Guha et al. [47] have studied trust along directed network of people connected by ratings and trust scores. They used trust and distrust score to establish a trust value between any two people in a system. Similar

principles can be applied to social networks as well. As the path from one users increases and moves along a friend, friend of a friend the degradation in trust should be expected.

Alice trusts Bob does not imply Bob trusts Alice thus trust is not bidirectional. But we can assume that trust is mutual with some degree of difference in both directions [49]. Cooperation demands mutual trust. If only one directional trust exists then cooperation will fail and if it is blind just as in case of strangers then it leads to deception [45]. This is an important point that we need to consider when dealing with social networks or any system that involves trust for its proper functioning. Freedom should be given to users to express their preferences accordingly. Our model uses affinity level to handle this.

2.1.2 Representation of Trust

Absolute value of trust doesn‘t reveal much about a persons trust towards another person. It would make more sense if we break it down into different levels as done by Abdul-Rahman et al. [27]. To handle the situation Alice trust Bob more than Cathy we need some kind of level scheme. Abdul-Rahman et al. [27] have represented trust in 5 levels each showing different degree of association. A negative value indicates distrust. Guha et al. [47] have studied the importance of distrust in detail. It can be argued that sometimes-negative value or a feedback plays a major role in making a decision and is as important as a positive one as seen in systems like eBay [6], Epinions [7] and Amazon [1]. Our model treats negative value as distrust.

Binary value of trust such as 0 for distrust and 1 for trust may also not clearly explain the relationship between two individual. However, with a voting scheme it may work well where a user either likes or dislikes something. Voting can also be used as one of the affordances to trust. They are frequently used in filtering information [58]. They are also used to express

individuals preferences [46]. Many applications like Youtube [20], Digg [5] use a thumbs up, thumbs down scheme for voting or rating. In a ridesharing application driving skill can be considered as a voteable attribute either a passenger likes a drivers driving skill or dislikes it.

Recommendation system can also be used in determining trust. It is communicated information of trust [27]. Alice recommends Bob to add Cathy as his friend because Alice trusts Cathy. Since, Bob trusts Alice he agrees to add Cathy as his friend. Social networking applications like Facebook [26] have been using recommendation feature to expand their users social networks either through "People You May Know" or a friend can recommend another friend. It would be interesting to note how a user would react to a recommendation made for a complete stranger. Orkut's *Ask Friends* application allows users to ask for opinions and recommendations on any topic from their Orkut friends [15]. FilmTrust [9] uses a similar approach here the system is associated with social networks for movie recommendations.

2.1.3 Conclusion

A rideshare system involves collaboration in setting up rides and dependence that passengers will reach their destination on time and safely. To establish this kind of association familiarity between passengers is important. The driver and passenger play the role of both trustor and trustee. Trust is one of the major concerns of users of ridesharing systems [63]. To address this problem, solutions have been proposed to localize a ridesharing application in a more closed environment like workplace or university campus [70]. These environments,eliminate the fear of sharing rides with complete strangers to some extent. Most of the systems Goloco [10], NuRide [14], ERideShare [8], provide features like user profile that give basic information about driver and passenger and a rating system that adds credibility to the users

and thus increases trust.

The proposed solution by existing rideshare applications is incomplete leaving a lot of scope for improvement. To establish trust between passengers a proper model is required which should consider various factors such as affinity, driving skill, social relationship in a social network graph and familiarity. Recommendation obtained from known source is much reliable than strangers. Preferences vary from one individual to another based on different scenario, across genders, culture. An in-depth study is needed per system. We suggest that a similar approach is required for any application that involves co-operation and mutual dependence between its users.

2.2 Social Networks

Social network sites allow individuals to organize themselves as a group or community based on shared interest, views and background [32, 28]. Common features of these sites are profiles, friends list, comments and testimonials.

Some of the widely used social network sites are *Facebook* [42], *MySpace* [65] and *Friendster* [33]. They allow users to interact with strangers and friends. However, the interactions are frequently between latent ties [50] that have pre-existing social connection of some form such as a shared workplace or a classroom. As suggested by Elison et al. [41], people use Facebook mainly to maintain existing offline connections. Most of the social networks today are built on users extended social network [32].

The display of social connections between users is a crucial component of social network sites [32] and has encouraged numerous research commonly termed as social network analysis.

Some of the associations used between two individuals in a social network are friend, friend

of a friend, member of your group etc. Out of these friend-of-a-friend is widely used by social networking sites as a recommendation system [35]. This is one of the ways users are recommended to add new friends to their social networks. Facebook has been using it for their application, People You May Know [26]. Trust again has a key role to play in this kind of recommendation as explained in the previous section. A person may prefer adding friend-of-a more trusted friend than an acquaintances. Friend-of-a-friend has been used in social network analysis to find paths between nodes in the network [71] and it is of particular importance to our application as well. Chen et al. [35] in their paper have done detailed empirical studies of the recommendation algorithms that help users find friends both online and offline and discover new friends. We plan to use the friend-of-a-friend algorithm to increase our users rideshare network. Our focus will be both on content similarity algorithms [35] that help in discovering new friends and on relationship-based algorithms [35] that help new users to find and add known contacts to their network.

Even though social network sites have a lot to offer, they are plagued by trust and privacy concerns [31]. In a study Dwyer et al. [39] compared two popular social network sites Facebook and Myspace, focusing mainly on trust and privacy concerns associated with usage of these sites. The study results indicate that users trust Facebook more when it comes to sharing information and developing new online relationship.

Jennifer et al. [61] show how social network sites can be used as a ground for educating users about their ecological impact on environment. According to them by displaying information on energy efficiency and consumption on these sites we can motivate users to reduce their ecological footprints. Recently, ZimRide [21] a ridesharing application on facebook started displaying the amount of “Carbon Dioxide Saved” and “Miles Carpooled”.

2.2.1 Conclusion

Integrating ridesharing with social networks can address the problem of trust related with ridesharing systems. Zimride [21] is one such application that has been integrated with social network sites like MySpace and Facebook. For example, Facebook users can request for rides or offer rides to members of their university community and friends.

A university community is huge and members of this community may not know each other directly or indirectly thus trust level would vary. For mutual dependence and predictability a direct or indirect association is needed to make a decision as described in section 2.1. Thus some feature is still needed to establish these associations for a successful collaboration. We plan to provide this in our rideshare application mainly through the friend and friend-of-a-friend.

2.3 Location Awareness and Mobile Phones

Mobile phones are the most widely used technology today. They have become an integral part of our daily life and activities. The technology has made many advances in terms of available processing power, size and versatility of use. Research is being done to determine the impact of these technologies in our daily life some of them are [73, 55, 72]. Mobile phones are not restricted to just making phone calls but are also used for recreational purposes [29, 48, 40].

Incorporation of Global Local Positioning (GPS) systems in mobile phones has given a whole new dimension to the usage of these devices. GPS is one of the most widely used location sensing system [51]. Bluetooth is another technology used to determine proximity between two users in a type of location sensing scenario [40]. Google Maps [12] is a famous location aware service that helps users find routes, places of interest based on users current location.

Eija Kaasinen [56] has studied location aware services from users point of view. Through her empirical study she found that users need location services that can serve them during their mobile activity such as planning, searching, finding routes. All these are needed in a rideshare application. She also mentions that users expect the interface to adapt based on changes in location.

2.4 Social Software and Mobility

Social software systems can also be mobile-specific, such as Dodgeball [54]. Given the ubiquity of mobile systems, the web-based systems also have mobile interfaces to continuously involve its users. The mobile devices range from simple mobile phones, smart phones, iPods and even laptops. Recent devices like the iPhone have changed the way people interact, work and have fun. These mobile handsets give another dimension to social software in the form of location awareness. Many social networking applications like FaceBook and Twitter are now available on mobile phones like the iPhone and Android. Some of the applications like Loopt [13], help in locating friends on a map. Sitting in a coffee shop, one can now find if their friends are nearby [40, 68].

2.4.1 Conclusion

Location aware services have made users life easy when they are dealing with varying plans and mobility [36, 69, 37]. The existing ridesharing applications require planning ahead to set-up rides making it difficult to handle end moment travel changes. Through our survey we found that users mostly use ridesharing applications for long distance trips that happen once in a while. One of the important reasons why ridesharing applications are not widely

used is the complexity in scheduling rides. We need to provide a framework for location aware ridesharing such that planning and matching can be done instantaneously. In this thesis we propose the design for an Instantaneous rideshare software application.

2.5 Existing Ridehshare Systems

A number of software tools exist that can help users find and setup rides. Some of these are Goloco [10], NuRide [14], ERideShare [8], ZimRide [21]. Goloco provides features where users can invite their friends to use ridesharing applications which does solve the concern of sharing rides with unknown people. However, the trust feature represents trust as a binary value for example Alice either trusts Bob and she does not trust Bob. Binary representation of trust is most suitable for applications where one either likes or dislikes something. We have already discussed that trust is conditionally transitive, so if Tom is friends with Alice and if Alice trusts Bob we cannot assume that Tom will trust Bob. There should also be someway to determine whether Alice trusts Bob for ridesharing,

In the ERideShare system users can send anonymous mails to other users and can meet them in public prior to taking rides. Not everyone would be comfortable in setting up such meetings. It also doesn't provide a way for users to build their rideshare network which would consist of known people that helps in building trust. A ride request and ride offer matching is done by the system thus users have no control over it [8].

Zimride is another ridesharing application that is available on facebook. It shows the rides available by a community or a group member. There is however, no way to determine if my friends or friends-of-friends are using this system. It doesn't show the list of existing users. Also, users profile information doesn't reveal much information in terms of rating, social distance etc. The only way to learn more about a user is by viewing their facebook profile

which may be hidden by various security settings.

Each of these systems have tried to cater to trust concerns by either providing rating, recommendation, social network integration and comments. In ridesharing systems it is important to determine what factors are important to build trust. Would a recommendation or rating system suffice or users are looking for something else? The answer to these and many other trust related questions can be determined through a proper study focusing on perception of trust. The results would be helpful in designing a model of trust.

2.6 Overall Conclusion

The relationship between users of a social network could be a direct one such as a friend or distant relationship such as friend-of-a-friend. We are confident that members of a social network express trust not only in direct relationships but also in indirect ones. Thus we can leverage these social ties when designing a ridesharing system. A social networking tool that connects these slight distant relationships when integrated with a rideshare system can increase the number of potential participants in the ride-sharing program. However, a simple integration of a rideshare system with social networks is not enough [21]. The display of social connection between users is important i.e. how one user is related with another as that will aid in increasing trust between passengers. A connection through acquaintance may not be as trusted as the one through a very good friend. This leads to the need for a feature that would allow users to express their closeness/affinity towards their friends. Apart from displaying basic information on the user profile as done in existing rideshare programs, we should provide more information in terms of a trust details such as recommendation, social distance, rides together, affinity and driving skill rating. It is often difficult to arrange for a ride mainly due to lack of information on available rides and pre-planning. Mobile

devices such as cell phones and internet-enabled music players are the perfect means for obtaining information instantaneously and on the go whenever required. Based on these principles, we have designed an instantaneous ridesharing system for members of an online social community. This tool will leverage social ties to embed trust amongst users.

Chapter 3

Methodology

In this chapter we discuss the methodology used towards gathering requirements for this research and the usability evaluation of InstaRide prototype. We used a preliminary survey to determine the problems with existing ridesharing systems and user's expectations from them in terms of features and usability. Based on the results from our survey we designed and implemented a prototype of a ridesharing system, *InstaRide*. Prototype evaluation procedure and methods will be discussed in detail in the following sections.

3.1 Gathering Requirements

Surveys represent one of the most effective methods for quantitative social science research [67]. We chose to conduct a survey over other methods because of limited availability of primary data dealing with relationships between social networks, ridesharing systems and mobile devices - the three basic embodiments of our research.

We conducted the survey with the goal to understand a commuter's daily travel requirements

and patterns and to understand the role of trust in the context of shared travel. Surveys have been conducted in the past on traffic congestion, pollution, transportation cost and role of ridesharing in alleviating these problems but the underlying problems of trust and inconvenience have not been studied in detail. We wanted to capture and assess the problems preventing people from using public transportation like buses, trains and ridesharing. We had questions that captured the level of awareness on existing ridesharing services and the factors that prevented people from using such services. We discussed in section 2.1 how trust can have different meanings in different situations and how its measure can vary with different social relationships. We wanted to find out these variations of trust in a ridesharing system. Users perceptions in terms of accepting and giving rides to different types of individuals in their social network, role of gender and scenarios in which user would prefer sharing rides are determined through this survey.

We used Microsoft Excel 2008 to perform statistical analysis and descriptive statistical procedures to analyze and summarize the results. We used both univariate analysis where the results are examined across a single variable and correlation analysis where we examine the results involving the relationship between two variables. We used Frequency distribution method to describe the variables and displayed the results through bar charts.

3.1.1 Interviews with Existing Rideshare Services

Prior to designing the questionnaire, fir our survey we conducted interviews with representatives of some of the rideshare services available in Virginia Tech. We wanted to find out how successful these services were, whether users were motivated to use them, and other problems these services were facing. The three main issues identified from the interviews and literature related with this research were: 1) lack of awareness about the availability

of ridesharing services, 2) hesitancy among users to form rides with strangers, and 3) loss of freedom while participating in such programs.This helped us to tune our questions. The interviews combined with the related work helped us frame an initial set of questions for our survey.

3.1.2 Survey Design

The target population for our survey was Blacksburg, a small university town(population about 47,000) composed of students, faculty and staff. We used a random sampling method and divided the population into separate groups based on gender and age. This was necessary since perspective of these groups is expected to vary widely. The survey was hosted online and participants were notified through email. Though the Internet based questionnaires provide little control over respondent selection, it is fast to conduct, inexpensive and avoids interviewer bias or distortion.

We posted a draft survey of 25 questions to a group of 10 people for pretest. The pretest was mainly conducted to verify whether the questions were formulated and phrased properly and the time required to answer it. The results and feedback from the pretest was used to rephrase, add and delete questions. On an average it took the respondents around 12 minutes to complete it. Data collection was done in the final survey and not during the pretest phase. The questions were formulated to capture perceptions of trust, travel modes and problems, general use of existing ride-sharing programs and the willingness to develop new relationships. The questions were mainly close-ended with ordered and unordered responses. A few questions were partially close-ended, giving the respondents extra flexibility to describe their response. The final questionnaire comprised of 26 questions. Please see Appendix B for details of the questionnaire. We used an online survey tool(survey.vt.edu) provided by

our university to post the survey. Posting was made through email invitation to faculty and student mailing lists (GLC-programs, hci-students, cs-gradstudents, cs-undergradstudents, international-students, cs-faculty, cs-staff). To ensure a large participation, we sent email reminders every week for three weeks while the survey was open, after which it was closed for analysis. Approximately, the total number of people who were invited for the survey were 4220 and 125 people answered it making the response rate to 2.96%.

The table below lists the main constructs of our survey and specific questions that operationalize these constructs.

Table 3.1: Survey Constructs and Questions

Construct	**Questions**
Existing Rideshare System	- Have you heard of available carpool programs at Virginia Tech? If yes, which one? - Have you used any carpool program (online or offline) before? - What do you think is the most common reason for people not using carpool/rideshare websites (e.g. Goloco, Ride Solutions, Zimride) ? (Check all that apply). - If you have used a ride-sharing/carpool system before, what are the features that make you use and trust these systems?
Travel Patterns	- Do you own a car? - How do you usually commute to work and/or school (campus)? - How often do you come across traffic congestion while driving by car?

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Table 3.1 – Continued

Construct	**Questions**
	- Which of these do you use? (For what? To go to work? Or shopping etc.? Please specify)
Social Networking	- Please specify how many community group or organization like a church, student or faculty organization etc are you a member of? - How often do you use social networking websites like Facebook, Orkut , Myspace, etc.
Trust Factor	- Would you be willing to ACCEPT a ride from the following types of individuals (Check all that apply) - To whom would you be willing to GIVE a ride ? (Check all that apply) - Imagine that the online rideshare system could tell you that someone who is OFFERING you a ride is a "Friend of one of your friends" or is also affiliated with a local community group youre involved in. How likely would you be, knowing this, to trust the person and accept a ride from them? - Imagine that the online rideshare system could tell you that someone who is ASKING for a ride is a "Friend of one of your friends" or is also affiliated with a local community group youre involved in. How likely would you be, knowing this, to trust the person and OFFER a ride to them?
Use of Ridesharing	- Would you use a carpool for going on vacation, or other long distance trips ?

Continued on Next Page...

Table 3.1 – Continued

Construct	**Questions**
	- How likely are you to use a carpool for daily or routine activities like commuting to work, school, etc. - How likely are you to use a carpool for local shopping and other local events?
Benefits of Ridesharing	- What are the possible reasons you would NOT opt to use a carpool? Check all that apply. - What are the possible reasons you would OPT for a carpool? Check all that apply.

The three main issues identified in the survey were: 1) lack of awareness about the availability of ridesharing services, 2) hesitancy among users to form rides with strangers, and 3) loss of freedom while participating in such programs. We learned that commuting expense is the biggest motivating factor for using ridesharing. The results of the survey are discussed in detail in chapter 5.

3.2 Evaluation of InstaRide

The data obtained in the survey provided us with an insight to design a ride-share system that facilitates quick and easy organization of rideshare while maintaining a high level of trust among the rideshare participants. We designed a prototype of the InstaRide application as explained in chapter 4. The next step was to conduct a usability study. The aim of the

study was to evaluate our interface and different features and above all gain an in depth understanding of perceptions of trust.

3.2.1 Evaluation Technique and Procedure

The evaluation technique used in this study was Formative in nature. A formative evaluation technique is used to identify usability problems and iteratively improve the design [66]. We wanted to carefully select our participants and use this evaluation process as a means to improve our application design.

3.2.2 Selection of Participants

We were targeting a population that was technology aware, used social networking sites and mobile phones and traveled a lot so that they could give us feedback on their experiences of using collaborative systems like ridesharing. 11 people participated in the study. The only inclusion criterion was prior experience with using an iPhone or iPod touch since the software used during evaluation was iPhone based and the participant's experience would help in conducting the study smoothly as participants would concentrate on evaluating our prototype rather than learning how to use the device. Also they were required to be 18 years and above to qualify for the study.

3.2.3 Experimental Setup

We conducted the evaluation in a meeting room in Knowledge Works II building at the Corporate Research Center of Virginia Tech, Blacksburg. The session was conducted in a closed environment.The role of the evaluator was to provide instructions and note down par-

ticipants' response. The participants were requested to think out loud so that the evaluator could understand the rationale behind their actions. Resources used in the study were 1) iPhone 3G with GPS and SDK 3.0 or higher 2) Departmental machine that hosted the server and database

The scenario based tasks in the study were divided into two parts based on functions and features that the user would evaluate. The first part consisted of creation of a simulated Social Network for the user. The second part of the tasks concentrated on users using the ridesharing features to post, view and perform various actions related to setting up the rideshare.

Social Networks Simulation

In order to create a social network, the user would first login and look for friends in the system. Then, the user would build a network of friends and friends-of-friends, pretty much like the way we extend our friends networks in social networking applications. We call this network a *rideshare network* based on the context of ridesharing.

Building a social network typically involves actions such as inviting/requesting friendship to add a user as a friend and responding to friendship requests made by others. These actions were part of our benchmark task. We tried to simulate the case where a user pretended to be the person requesting friendship from the participant and responding to friendship invitation made by the participant. Friendship requests were already created on behalf of the simulated users and participants were asked to either accept or deny these friendship requests. Whenever the participant would send a friendship invitation to one of the simulated user's, the evaluator who was logged in as one of these user's through the web-interface would accept the invitation. The whole process went on smoothly giving a sense of a real-life

scenario.

We simulated a community of users to conduct a meaningful study. These users had a predefined rideshare network. This network was purposely kept simple to avoid any confusion during the study. In the network graph the users represented the node and there was only a single path that represented friendship connecting the users. Each of them had set affinity level for their friends. Social connection between them was displayed on the user interface as a part of their profile. Participants were asked to assume that some of these users were best friends, good friends, acquaintances and strangers. This was mentioned in the benchmark tasks.

Ridesharing Simulation

In this part of simulation we paid special attention to users perception of trust when accepting or denying rideshare requests. The user's social network consisted of 4 to 5 direct friends and several friends of friends.

We created some rides to begin with. These postings were for ride offer, ride requests made by the simulated users who were the part of simulated community described above. In our experimental setup some we had created some rides from the participants' login as well. This was needed to avoid the repetition of ride creation step for different benchmark tasks. We had also created responses from the simulated users. The responses were for a ride request or a ride offer depending on the type of posting. Our intention was to observe how participants responded to these ridesharing responses based on their trust preferences.

3.2.4 Study Protocol

This study was approved by Institutional Review Board (IRB) at Virginia Tech. Participants were invited to the study via posted advertisements: flyers, personal email and postings to mailing lists were the primary ways we used to encourage participation. When participants arrived at the venue they were thanked for their participation. The purpose and background of the study was explained to them. The informed consent form was handed out to read and sign if they were willing to participate in the study. A copy of the consent form was given to the participants for them to keep. A short demonstration was given to the participants that walked through the basic features.

After the demonstration we gave a set of scenario-based tasks to the participants. These tasks were not timed. The tasks are described in the next section. Following the tasks the participants were asked to fill out a post-evaluation questionnaire to determine their experience with the software in terms of usability and trust features. The questionnaire will be described in the next section.

3.2.5 Usability Study

The usability study consisted of two parts 1) Scenario based tasks and 2) Questionnaire.

Scenario Based Tasks

Each participant was given a set of scenario-based tasks. Each of these tasks was designed to match closely with a real life scenario. We created two sets of benchmarks tasks, one for each gender. The scenarios were similar except for the cases where we wanted to observe participants' responses to ridesharing with a opposite sex. These were mainly for responding

to ride requests and ride offers. A detailed description of benchmark tasks is attached in Appendix C. The tasks were designed to do the following.

1. View/Edit logged in user's profile
2. Build rideshare social network
    a. Add/Invite friends/contacts to the rideshare network
    b. View another user's profile
    c. See the list of pending invitations and pending friendship request
    d. Accept/Deny friendship request from another user
    e. Set the affinity level for a friend
3. Search for the rides near your current location
4. Search rides based on your preferences such as from location, to location etc.
5. View and request rides
    a. Contact the poster of the ride to offer or request the ride depending on the type of ride (drive, ride)
6. Post a ride offer
    a. See the ride details for the requests made for this ride by other users
    b. See the user's details
    c. See the trust details of the responders
    d. Now accept ride request from the responders
7. Post a ride request
    a. See the ride details for the offers made for this ride by other users
    b. See the user's details
    c. See the trust details of the poster
    d. Now accept ride offer from the poster

Post Evaluation Questionnaire

Our post evaluation questionnaire intended to measure, effectiveness (the extent to which the task is completed using the system and the quality of output of those tasks), efficiency (the number of errors or critical incidents encountered) and satisfaction (user's subjective reactions to using the system) [30].

The evaluation questionnaire was divided into two sections 1) Usability Questionnaire and 2) Feature Evaluation Questionnaire. These questionnaires are attached in Appendix D.

The usability questionnaire section focused on the interface evaluation. Questions were related to the navigation, layout, button labels, readability and consistent terminologies. We wanted to learn whether the application encouraged users to explore it and maintained high learnability with "ease-of-use". The feedback in the questionnaire was used to iterate and make changes to our application. We used Likert Scale phrases such as "Strongly Disagree", "Disagree", "Neutral", "Agree", "Strongly Agree" for user feedback. A Likert Scale approach is generally used in evaluating interfaces [52]. An additional option of "Other Comments" was also provided to add more flexibility as it is understood that the Likert scale is based on forced choice questions [34].

The feature evaluation questionnaire section mainly focused on how usable the features such as trust level, search, rideshare etc. were, whether they worked as expected and how helpful was the outcome. This was also a subjective questionnaire and the focus was a ridesharing scenario. There were questions to capture users' perceptions of trust. Apart from the notes taken down during the study on user trust preferences we also wanted them to reiterate their thoughts on trust under various scenarios in the questionnaire. Questions were framed to determine the factors participants considered most important while taking rides from an individual. We asked them to rate the social relationship, driving skill, gender,

recommendation by a friend and the ratings given by other passengers on a scale of 1-5. The intention was to determine the weights of each of these factors empirically and apply the same in a trust model for rideshare applications. There were questions to determine user's tendency to extend his/her social network after a rideshare was setup with people who were not direct friends. Details can be found in Appendix D.

3.2.6 Trust Perception

We designed benchmark tasks for ridesharing to capture participant's perception of trust in rideshare scenarios. Let us consider the scenario where a participant requests for a ride and different users respond to this request. These users could be friends, friends-of-a-friend-of-a-friend or complete strangers. To understand whether a user would accept their offer we repeated this scenario three times, each having either a friend or a friend-of-a-friend-of-a-friend or a stranger offering the ride. We were looking for answer to the following questions through the observations made during scenario-based task:

1. What role does trust level play to accept the ride request by the stranger, friend and friend-of-a-friend? To break down a friendship relation further we added adjectives like best friend, good friend and acquaintance. This breakup is captured through the affinity level setting

2. What role does trust level play in offering a ride to a stranger, friend and friend-of-a-friend?

3. Do these perceptions vary across gender?

4. Does affinity level for a friend determine a ridesharing decision with a friend of this friend?

5. In ridesharing scenario which is more important driving skill, familiarity, social relationship or something else?

6. Can ridesharing help establish familiarity and reduce the distance in a social network

graph between users?

Chapter 4

Design and Implementation

In this chapter we discuss the design and implementation of our ridesharing system, *InstaRide*. We will discuss the client and server side architecture along with database design. The implementation of different features such as ridesharing, friendships and trust model is explained in this section.

4.1 Design

The Instaride application is meant to run on any mobile device with a certain minimum requirements. This includes ability of the mobile device to connect to the internet and must have a GPS device. For this thesis, we chose the iPhone, a popular smartphone from Apple Inc.

This ridesharing system is a client-server architecture where the server stores all information pertaining to a ride. As seen in Figure 4.1, the server hosts a database and provides information to the clients through the internet or cloud.

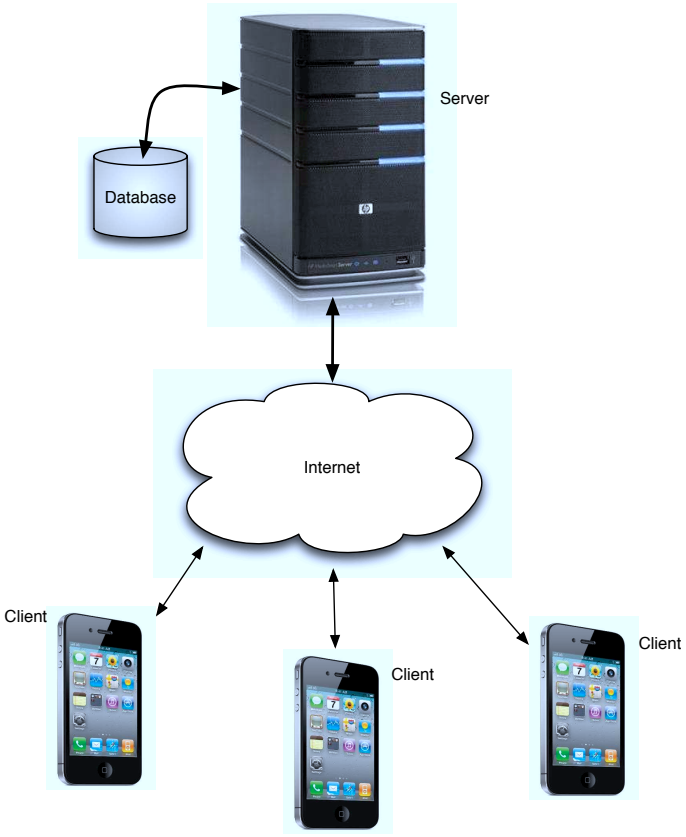

Figure 4.1: The server-client architecture for InstaRide

4.1.1 Server architecture

On the server side implementation follows the Model View Controller (MVC) architectural pattern. We manage all information by creating models for every entity in our system. Models are required for *User*, *Ride*, *Friendship* and *Rideshare*. The User model represents InstaRide users and the Ride model represents a ride posted by a user. We need the Friendship model to create a social network of friends. It is used to store the relationships between two users in the system. A relationship status of *accepted* between two users means they are friends. Similarly, a Rideshare model connects a ride between users. Only after this connection is established, we can have rideshares in the system. The details of attributes of these models are displayed in Figure 4.2.

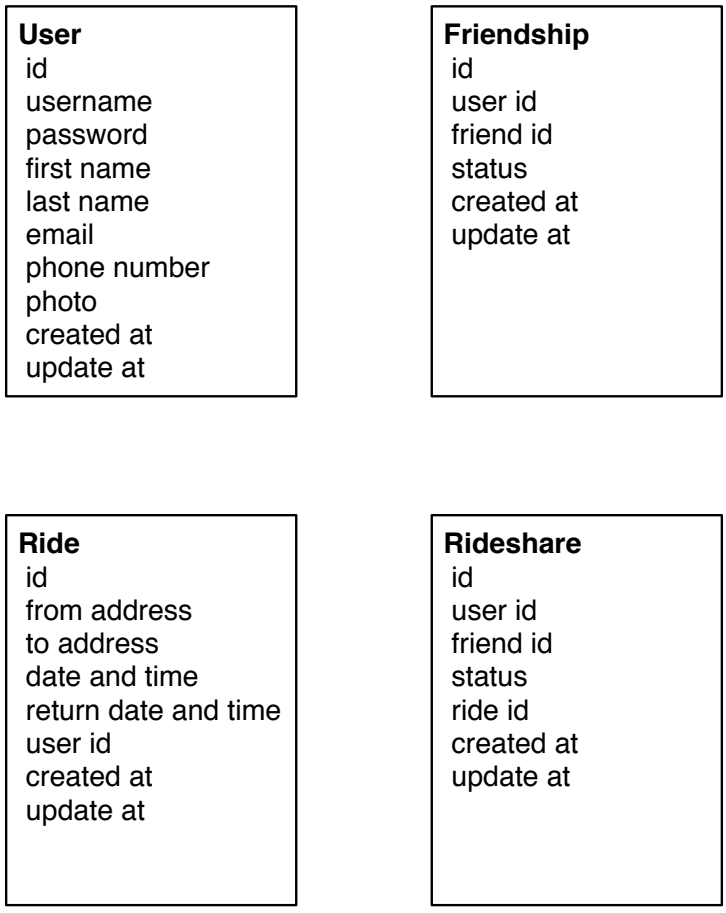

Figure 4.2: Models representing entities in a social network for ridesharing

The Controllers receive input from the client and prepares a response that may involve making calls to the model object and then it sends information to the client to make changes to it's views. Each model in our design typically has a controller. The *trust controller* is an exception. It retrieves data from all 4 models in our class and calculates trust information for a user. This information is then pushed to the client for display.

4.1.2 Client architecture

The client follows a layered design pattern, where each layer communicates only to the layer above and below it. Figure 4.3 shows this design pattern. When a user action results in information request from the server, it is placed though one of the managers - the *Friend Manager*, *Ride Manager* or the *User Manager*. The Friend Manager is responsible for performing any action or request that relates to users who are friends of the logged in user. This could be displaying list of friends or viewing the profile of a friend. All friendship requests and actions are handled by the Friends Manager. The Rides Manager performs actions related to viewing rides, setting up rides or requesting rides. We introduced the User Manager to handle cases where you must have information about a user that is not your friend. For example, when viewing profile for users in the social network who are not your friends.

When a manager pushes a request, it is serialized by the *Serializer* and handed over to the *REST Interface* which places an appropriate request through the network layer or the *TCP/IP* layer. When a response is received, it is passed on to the XML parser, which creates objects and hands them over to one of the managers. The managers in turn trigger events to update the user interface.

4.2 Trust

Trust between occupants of a car in a rideshare is one of the major concerns that we are focusing in this paper. We would like to numerically determine the level of trust one has when making a decision to accept a rideshare offer or deny a rideshare request. We took into account several factors that play a role in establishing trust. We established a 0 to 5 scores for each of these factors. Since one factor may be more important that the other, we assign

weights to each of the factors to control their level of influence while calculating the overall trust score for an individual. In our prototype we have set same weight (one) for all these factors but we determined these weights through our user study. Since, trust has varying meaning it was more appropriate to determine which factor plays major role from the users of the application.

4.2.1 Social Relationship

A social network is a graph of people, with each person acting as a node in the graph. The distance between two nodes in the graph is a direct measure of the strength of relationship between the people represented by the nodes. We therefore define and calculate social relationship as this distance in the social network graph. Higher distance means weak social ties and hence lesser trust in the person. On the other hand, a small social distance implies strong social ties and maps to higher levels of trust. For example, a direct friend will have a social distance of 1 and therefore a trust score of maximum 5. A friend of a friend will have a social distance of 2 and a stranger will have a distance greater than 5.

4.2.2 Affinity

A user may have several friends. However, he or she may have different levels of closeness with each one of them. For example, family members versus best friends versus acquaintances. The levels of trust between each of them is going to vary. Although affinity could be derived from social network graph as described in section 4.2.1, it is difficult to capture the granularity of affinity that we seek to differentiate trust levels amongst friends at the same level in the social network graph. Affinity can only be set for friends. It is a number that varies from 0-5. Values of 5 means a strong affinity for a friend, whereas 0 can imply just an acquaintance.

4.2.3 Ride reviews

Ride reviews and rating can be provided after a ride has been taken. This is an evaluation of the driver/passenger that can influence other people willing to share rides with the person being reviewed. This is a very common trust factor in many online systems such as eBay. Another factor is that if the person is not in your social relationship, then it doesn't mean you cannot trust him. The only way is the rider's history. So if there is no social realtionship, then this will help.

4.2.4 Number of rides together

The number of times a person has met another person for a ride share. This can be automatically be obtained from the system. A single ride will have the least importance but multiple rides will exponentially increase importance of this variable. The assumption here is that if you decide to take one ride from a person, the only reason why you would go with the same person is because you experienced a rideshare and developed a trust for the person. More rideshares together build more trust.

4.2.5 Other factors

We will discuss 2 other factors that may influence trust, but we did not include these into InstaRide. The first is driving experience. Driving experience evaluates the trust in a driver's skill at driving. No one would want to take a rideshare from a driver who is just beginning to learn driving. We assume more driving means you can trust the person more. A person with 2 months of driving experience may not be a suitable candidate to take a ride from. We also need to also take into account the fact that driving skills diminish with age, and

hence we must apply a weight to the driving experience factor accordingly.

The second factor that may influence trust, but not included in InstaRide is ride recommendations. A person can recommend a ride to another person. This will not only help users find ride, but also increase the trust factor of the ride, depending on the social relationship of the person recommending the ride. Therefore the weight on this variable will be the distance in the social relationship.

4.3 Implementation

4.3.1 Server

The server side implementation was done in Ruby on Rails with MySQL database for production application and SQLite during development. Ruby on Rails is an open source web application framework for the Ruby programming language. It provides agile development methodology and the results are available rapidly. It provides RESTFul interfaces and therefore any client application that is able to adhere to RESTFul conventions is able to interact with the server. This makes the overall implementation a lot simpler as compared to other web-services protocols such as SAOP [64].

Friendships

The server relies on a relational database to save and retrieve all information related to users and rides. The User and Ride models described in Section 4.1 are mapped to their corresponding tables *Users* and *Rides* in the database. The tricky part is developing tables for Friendship and Rideshare models, so we will discuss them here. At first glance, it may seem obvious that we need to create a table called friends for every user and put a list of

user id's that are a user's friend. But does this mean we will have to dynamically create tables for each friend? Also there is a lot of duplication since many users will have the same set of friends. It seems we are trying to model friends. However, we want to model friendship relation between users. This suggests that we should create a Friendship model and a corresponding *friendships* table. Each row in the friendship table will consists of a pair of users and their relationship status as shown in Figure 4.4

The relationship status can be one of *requested*, *pending* or *accepted*. So if user A (id = 1) sends a friend request to user B (id = 2), then we create a row with these user ids and set the status *pending* for user A, since A is pending for B's response. On the other hand B receives a friendship request and therefore the relationship status for B should be *requested*. Therefore, we must create another row for user B to save this relationship status. Thus, as seen in Figure 4.5 (a) by using two rows in the friendships table, we are able to store the complete relationship status. When B accepts A's friendship request, the relationship status for both A and B is set to *accepted* as shown in Figure 4.5 (b). If B denies the friendship request, the two rows are deleted from the database. After a friendship has been accepted and if either of the friends decide to break the friendship, we achieve this by simply deleting the 2 rows from the friendship table.

Ridesharing

Once friendship has been modeled, ridesharing can also be implemented using similar techniques. One addition we will make is to associate a ride between the 2 users involved in a rideshare. Thus we add the column *ride id* to the rideshare table. If user A (id = 1) posts a ride with ride id 15 and B (id = 2) requests a ride, then the rideshare table will have rows as shown in Figure 4.7 (a). When A accepts the rideshare, the status of the rows will be update to *accepted*. Now, if another user C (id = 3), requests the same ride, we will add 2

more rows to represent the request as shown in Figure 4.7 (c). When a rideshare request is denied or deleted after accepting, the behavior is similar to that of friendship denies and breakups as described in Section 4.3.1

4.3.2 Client

The client implementation was done using Objective-C and the Cocoa Touch Framework for the iPhone IO. The choice of the language and framework was based on the fact that we decided to develop our prototype for the iPhone. Additionally, Cocoa Touch is a very rich framework for user interface development and is specially tailored for a mobile device. The implementation was done exactly as the design described in Section 4.1.2. The REST interfaces was implemented from scratch using NSURLConnection. There were several 3rd party libraries available for doing this, but we chose to do it ourselves because of the level of control that behaved exactly as we wanted. The REST interfaces are capable of making both synchronous and asynchronous calls. Data is handled in XML format. We use KissXML , a popular DOM parser available for iPhone. DOM parsing is not supported by the iPhone SDK. Additionally we also do SAX parsing using NSXMLParser when needed. Other Cocoa Frameworks that we use are MapKit for displaying maps with ride locations, MessageUI for posting emails and AddressBook for handling the iPhone's native contacts.

4.4 Features

Listed below are the complete lists of features supported by InstaRide application. Figure 4.8, 4.9, 4.10 and 4.11 are snapshots of the user interface of InstaRide software.

1. Profile creation

2. View, add and delete friendships
3. Request, accept and deny friendships
4. Set affinity for a friend
5. Associate trust level with each user based on social distance, no. of. rides together, affinity level and ride rating
6. Display of connection between users to indicate how they know each other
7. View trust information for a friend or user
8. View, create and delete rides
9. Request, accept and deny rideshares
10. Rideshare feedback through voting/rating
11. Managing personal rides
12. Keeping track of favourite rides
13. Map to view source and destination of a ride
14. String search for rides
15. Location based (GPS assisted) search for rides

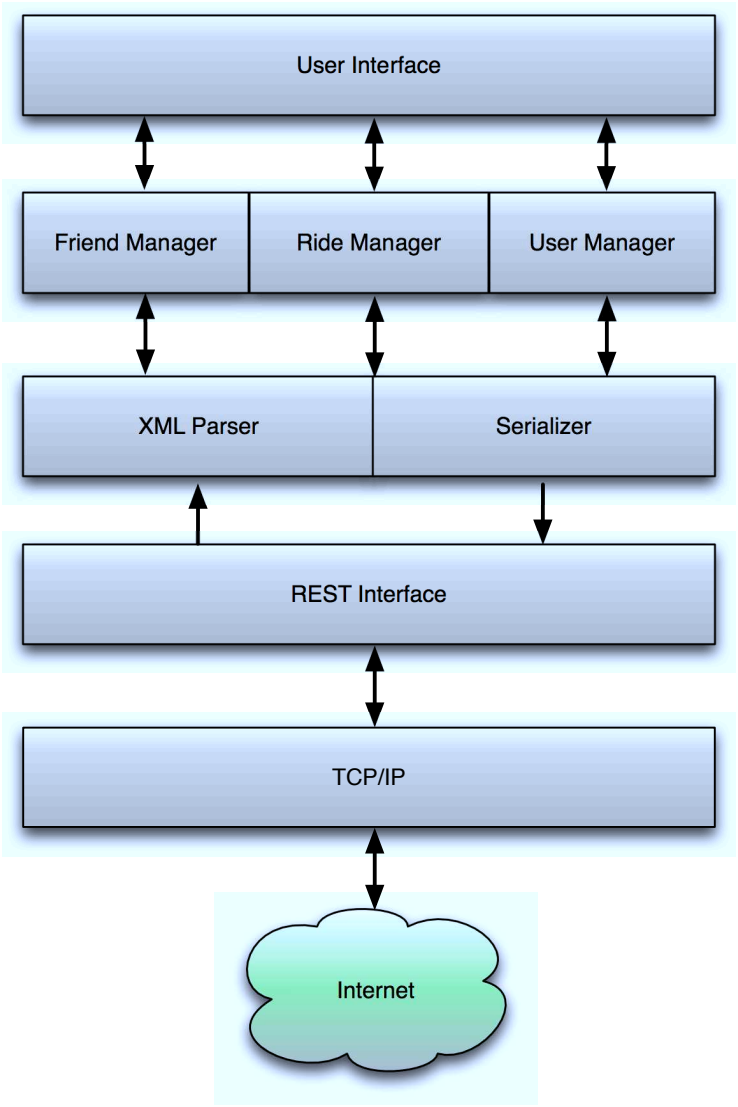

Figure 4.3: The Client architecture

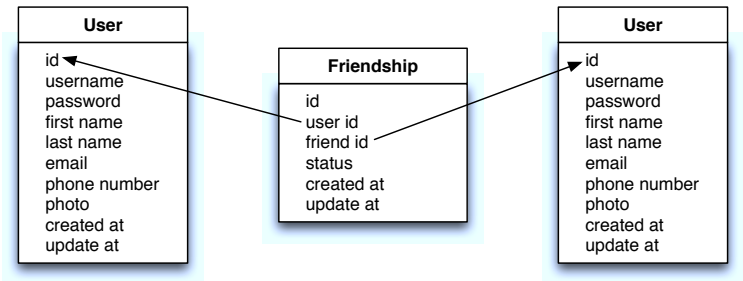

Figure 4.4: Relation between Friendship and User tables

user id	friend id	status
1	2	pending
2	1	requested

(a)

user id	friend id	status
1	2	accepted
2	1	accepted

(b)

Figure 4.5: Two rows of the friendship table showing friendship between A and B (a) when a request is sent and (b) when a request is accepted

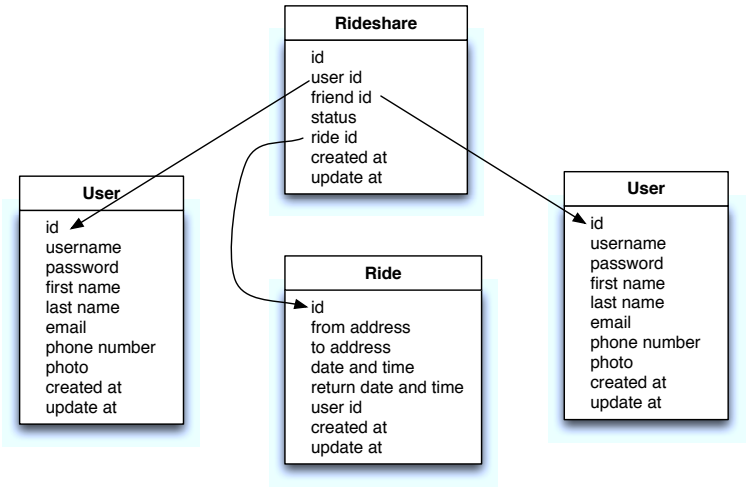

Figure 4.6: Relation between Rideshare and User tables

user id	friend id	ride id	status
1	2	15	requested
2	1	15	pending

(a)

user id	friend id	ride id	status
1	2	15	accepted
2	1	15	accepted

(b)

user id	friend id	ride id	status
1	2	15	accepted
2	1	15	accepted
1	3	15	requested
3	1	15	pending

(c)

Figure 4.7: Two rows of the rideshare table showing a rideshare between A and B (a) when a rideshare request is sent and (b) when a request is accepted

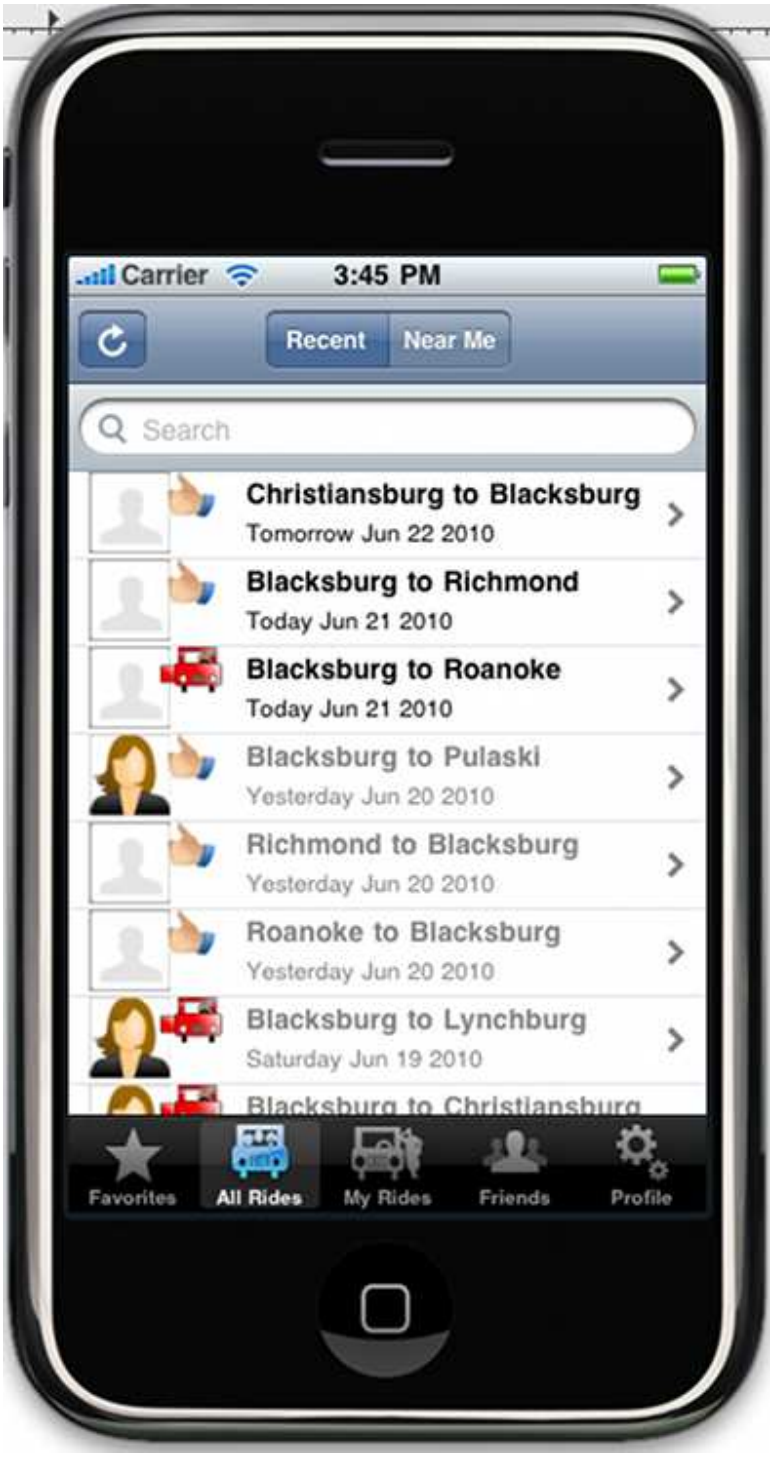

Figure 4.8: InstaRide User Interface

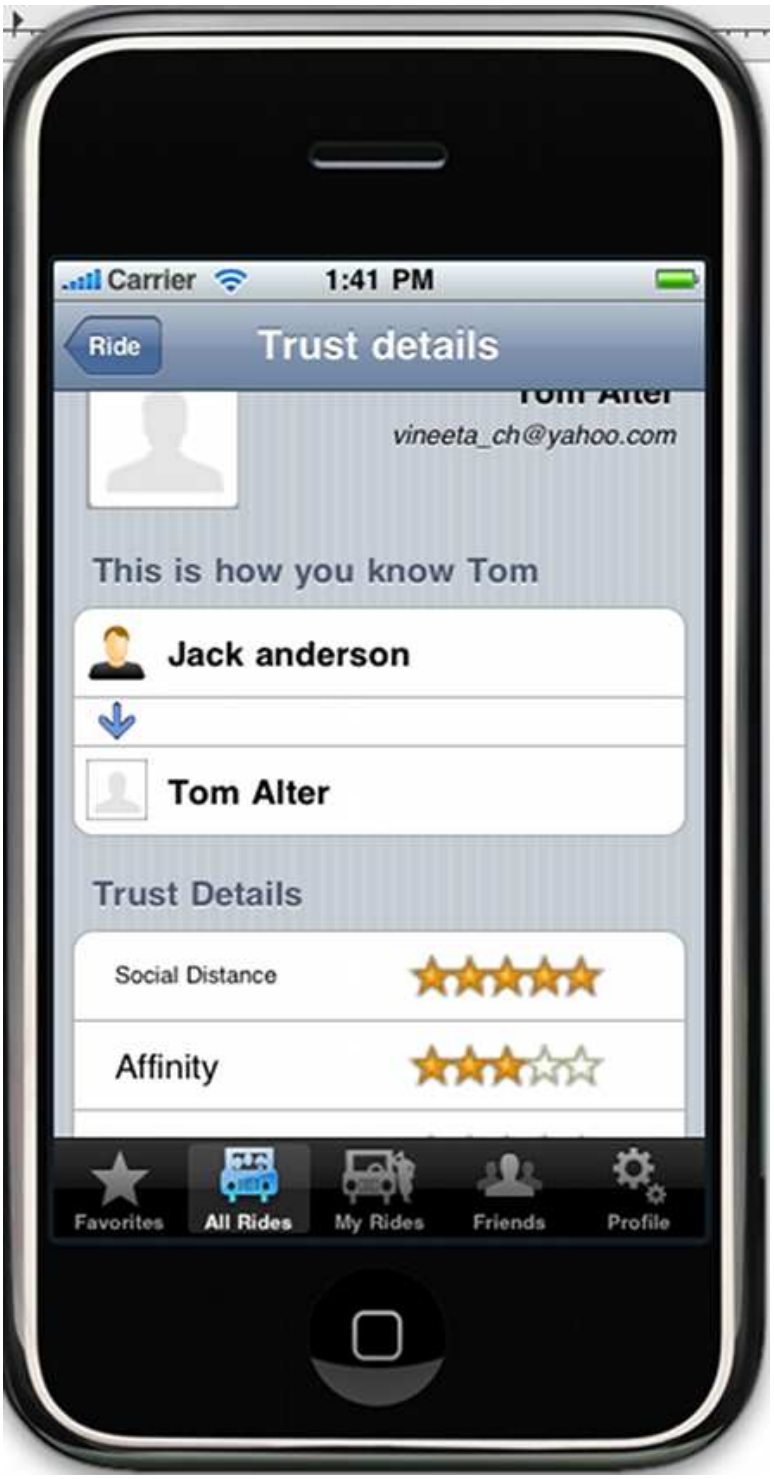

Figure 4.9: Trust Details User Interface

Figure 4.10: Create Ride User Interface

Figure 4.11: Friendship Invitation User Interface

Chapter 5

Results

In this chapter we are going to discuss the results of our preliminary survey and user study. We have divided survey results into different sections such as issues indentified in existing rideshare system, travel patterns, social networking, trust factor, benefits of ridesharing and use of ridesharing. The results are depicted through charts wherever necessary.

5.1 Survey Results

A total of 125 participants (71 females, 54 males) responded of which 88% were students and remaining 12% were faculty and staff. Most participants were 20-30 years of age and all were members of the Virginia Tech community. There was no incentive of any kind to participate in the survey. About 86% of the participants reported they are located off-campus where 60% live more than 5 miles from campus. The distance measure indicates that most people must be using some means of travel such as a car, bike or some form of public transportation. Thus, 49% of the participants use their car for daily commute to school or work, while 36% take the bus. The remaining either bike or walk to campus.

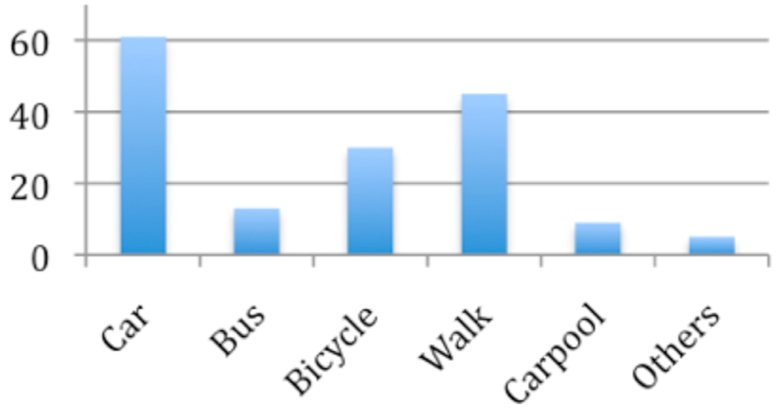

Figure 5.1: Mode of transportation for daily commuting (Number of people versus transportation mode)

Some of our results confirm that our target population was accurately chosen. Firstly, most of them have a daily travel requirement of 5 miles or more. Secondly, 81% of them own cars. This aligns with our goal to reduce the number of cars on the road. The huge number of cars also provides us with reasons to develop a public transit system by using these same cars as resources. Additionally, 18% who doesn't own a car solely rely on public transit or friends for their daily travel needs.

5.1.1 Existing rideshare systems

There were 9 questions dedicated to understanding the strengths and weaknesses of existing rideshare systems. We found out that ridesharing systems are not a popular option for a variety of reasons.

Awareness

There are at least 4 websites that allow members of this community to find and share rides online Craigslist [4], RIDEsolutions [17], Campus Ride Board [3] and Goloco [10]. However

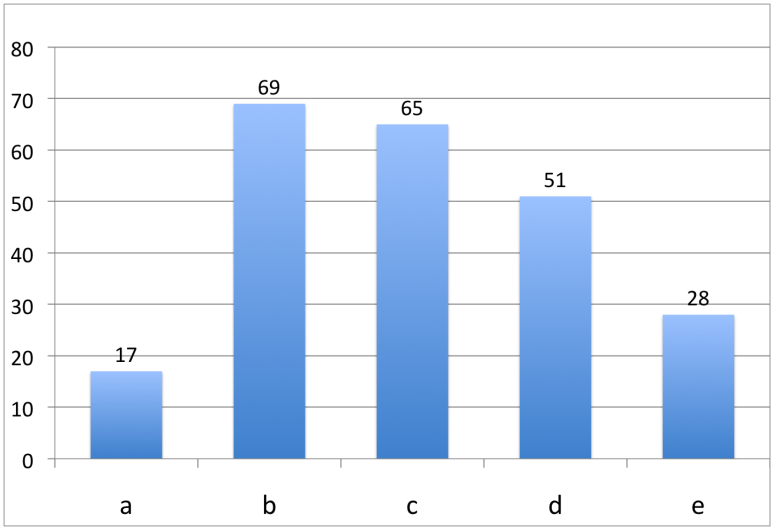

Figure 5.2: Problems with Existing Rideshare systems (a) Not user friendly (b) Complications in finding and setting up a ride (c) Does not handle end minute changes in travel plans (d) Can't trust co-passenger (e) Lack of awarenesss

69% of the participants are not aware of any such program. Out of those who have heard about a carpool option, only 13% had made use of a ridesharing website. From comments received from participants, it seemed that some have used social networking websites like Facebook [41] or community based mailing lists for obtaining rides. This clearly indicates that we need to increase awareness about various rideshare programs through posters, emails etc.

Inconvenience

Existing rideshare systems are not easy to use and do not provide some desired functionality. About 54% of the participants blame complications in finding and setting up rides as the major reason for not sharing rides. Apart from complexity and coordination, 86% of participants think that the bigger problem is lack of flexibility in travel, with the biggest factor being inability to handle last minute changes in travel plans. They usually have to travel at the time set by the car owner. Even if a ride is available, getting to a car owner or

carpool lot is inconvenient as very often the person requesting the ride is required to meet at the cars location. Users would prefer pickup and drop off closer to them. Such a service is possible only if the car owner and passengers are living close to each other or if the ride seeker lives along the route of the trip.

Another matter of inconvenience is that travelers - either car owner or co-passengers - may have to sacrifice their personal preferences, such as transporting their pets, stopping too often or not enough, smoking or even the amount of luggage that can be carried.

Trust

Second only to inconvenience, 41% of our survey respondents think that it would be difficult to trust the person offering or requesting a ride. This is evident from the questions regarding the kind of people they would want to give and accept a ride from. Trust is not only tied to ones ability to know the other person, but also to factors such as driving skills and smoking in the car. We discuss the trust factor for ridesharing in more depth in Section 5.4.

Availability

A ridesharing is almost always carefully planned and requires immense co-ordination online or offline. On a question why people would not prefer to share rides, some indicated that rides are usually not available for short distances (< 50 miles), since it is a hassle to arrange for one. Since most of the arrangement is done online, it is difficult to arrange for a ride when a person is away from his computer, say for example in a shopping complex. In other words, it is very difficult to find rides on the go.

5.1.2 Travel Patterns

Most people travel shorter distances most of the time. Naturally, short trips, like travel to work or home, are more frequent than long trips. The participants are mainly living in a small college town in Virginia with a reputed public bus transit system. Despite this, only 36% participants take the bus to work on a daily basis. Most, 49%, still prefer to drive everyday. Only a small number, 7%, share rides in some form for travel to work or nearby short distances.

Of all the public transportation options available, people mostly use city bus service for their daily needs such as traveling to campus, shopping or going to the airport. The reasons for using buses vary. Many use the bus service because they do not own a car. A number of students do not drive to campus because it is difficult to find parking. Some people also prefer using the bus during inclement weather, usually to avoid adverse driving conditions or to prevent damage to their personal vehicle. A majority of the participants prefer to use bus when they go out for parties, so that they can avoid driving after consuming alcohol.

Our results show that 72% of the participants do not use or are less likely to use ridesharing for local events or shopping. Their behavior is the same for daily commuting, such as travel to work or school, with 67% participants expressing their unwillingness to share rides. These results are attributed to the fact that carpooling is an inconvenient option and requires planning and coordination. In another question where we asked the reasons for not using carpool as a means for transportation, the same participants mentioned less flexibility and lack of trust as the reasons for not using carpool.

In contrast, when it comes to ridesharing for longer distances, 56% participants would like to go the extra mile to find one. Naturally, long distance travels are not very frequent and ridesharing could significantly reduce costs for the journey.

These numbers indicate that ridesharing is used mostly in long distance travel that is mostly done during holidays and vacation i.e. infrequently. Dealing with ride planning complexities on a daily basis like commuting to work which involves depending on others to meet their schedule timelines is not something users are willing to face.

5.1.3 Social Networking

Understanding a user's social relationship and network is critical for ridesharing systems. The important questions are - would anyone trust people beyond their social network? How does trust vary with depth in a social network hierarchy?

Most of the participants of the survey were relatively new to the city they live in (average 1.5 years in town) and most of them were students. Having been in a place for a relatively short duration means that their local social network may not be very large. Here we see a potential for a ride sharing system acting as a platform for developing new social ties.

Local communities and organizations play an important role developing social relationships. 65 precent of the participants are member of at least one community group. Out of the remaining 34% - 13% who have been living in and around campus for more than 4 years (even 20 years and above) are not a member of any group or organization. Either they don't like socializing or don't have a means to participate.

People belong to church and student associations, among other groups. They usually gather face-to-face for community group meetings and events. Based on the participants comments, we learned that such events are usually organized at places that are not so well connected. Any gathering at an inconvenient location will provide a good opportunity for ridesharing, thereby not only achieving the goal of using fewer vehicles, but also increasing direct communication between members of that group.

With Internet penetration currently at 74.4% in the US [26], some of the most popular platforms for developing social ties in this digital age are online social networks. Given the young age of the participants, almost 53% use some sort of social networking websites on a daily basis, and an additional 35% use such services at-least once a month. Having said that, such online tools can be leveraged to connect people for activities such as ridesharing.

Social networking tools are useful at connecting people that are more likely to trust one another and might really help encourage carpooling. They could provide a great opportunity for people to make more friends and engage in more social activities than they otherwise would. For example, a user wanting to go to Wal-Mart might look at their trip as an opportunity to hang out with a new friend; the purpose of the trip has completely shifted from one of just getting to Wal-Mart to one of making a social connection.

Social networking is taking a new turn with the increasing availability of Internet on mobile devices. This means you carry your social connections everywhere you go and have ability to socialize while on the move. 53 % of our participants had mobile phones with Internet connectivity. According to the national survey that was conducted in April 2009 [53] where 56% of American adults connect to the internet wirelessly either through laptops or through hand held device. Out of this 56%, 32% have used cell phone or smart phone to access the internet. These numbers reflect growing trend in mobile phone usage.

5.1.4 Trust Factor

Many people treat carpooling as a blind date, where they strongly hope the person they are sharing the ride with to behave as they expect. People seek trust in the form of personal security i.e. no mistreatment of any kind. Further, people want to trust the competency of the driver i.e. good driving skills and valid drivers license. Trust plays different roles in both

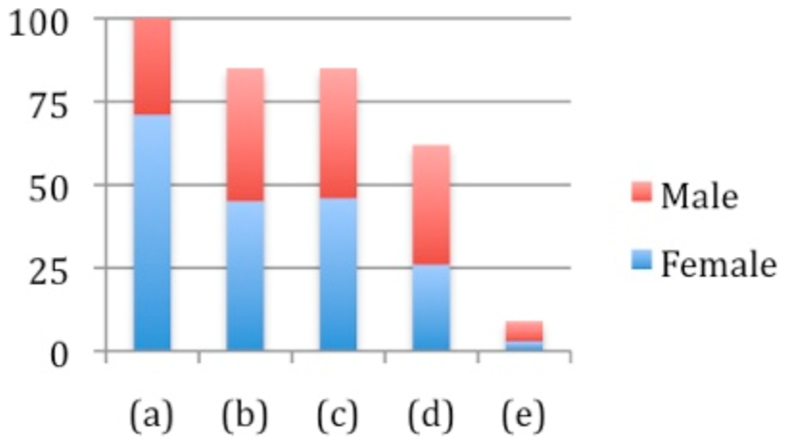

Figure 5.3: Accepting rides from different individuals (a) Friends (b) Friends of friends (c) Community (d) VT Community (e) Stranger

scenarios of accepting rides and giving rides.

Accepting Rides

We asked participants to specify the type of individuals they would accept rides from. We found out that 98% of them were happy to accept rides from their friends. While this was not surprising, we also found that 69% would also accept rides from the friend of a friend. When it comes to communities, 69% would accept rides from people of their community, and 50% would accept rides from people belonging to the university community. Only 7% would accept rides from strangers. The percentages are strongly related to the strength of the social relationship between them.

Giving Rides

When we asked participants their preferences in giving rides to people, 99% said they were most comfortable offering rides to their friends, while 82% would give a ride to the friend of a friend. Again the trend is similar to accepting rides, except that there are a slightly higher

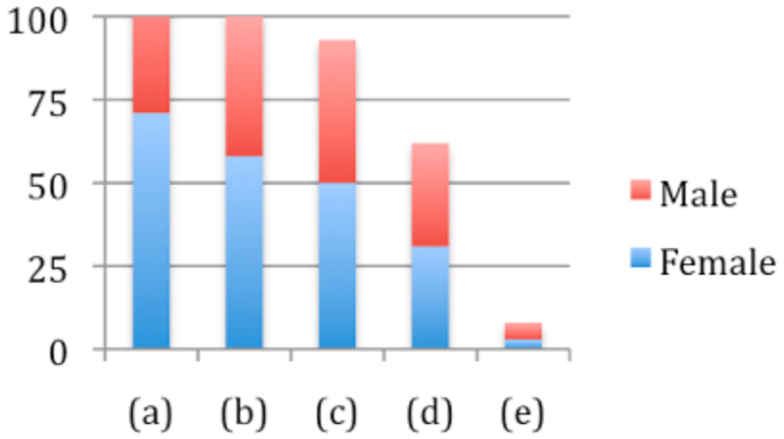

Figure 5.4: Giving rides to different individuals (a) Friends (b) Friends of friends (c) Community (d) VT Community (e) Stranger

percentage of people who would give rides rather than accept rides. Interestingly, people are even slightly more comfortable in giving rides to strangers, than taking one from them.

A prior knowledge of a social relationship is crucial in establishing trust. However, if you meet a stranger and then if you have a friend introduce you to the stranger, the trust factor is redefined. When we asked our participants, if there was some trusted system that could tell them that someone who is offering a ride is a friend of a friend or member of a shared community, 67% responded they would request a ride, up from 7% if they were strangers. Similarly, if such a system could identify their social relationship with someone who is seeking a ride, 66% are more likely to offer one, up from 10% if they thought they were strangers. These numbers indicate the importance of a feature that would display how one user is related to another and thus reduce trust concerns.

5.1.5 Benefits of ridesharing

Ridesharing is not popular and is often seen as an inconvenient means of travel. However, it can be made fun provided the users see an incentive in using it. The biggest factor that

attracts people to ridesharing is cost. 82% of the respondents say they would like to save costs by ridesharing. The other convenient factor is that ridesharing could also allow drop off and pick up. This is particularly useful in places where parking is a real problem - 62% would actually rideshare to reduce parking problems at their destination.

Next to costs, people are aware of the effect transportation has on the environment. 69% said they would rideshare because they would like to be environmentally friendly.

Traffic congestion is not isolated to larger cities. Considering the fact that all participants were from a small college town, 37% of the participants face traffic congestion sometimes and another 9% always. Congestion in large cities is expected to be a much bigger problem. Therefore, 38% of the participants would also like to rideshare to avoid traffic congestion. Reducing congestion is not only good for the environment, but will also help people reach their destination on time.

Ridesharing can be thought of as a social event. Some people may not like driving long distances alone and they often try to find out if they could find a travel companion.

5.1.6 Use of ridesharing

Ridesharing has similar transportation usages as public forms of transportation, such as buses, trains, taxis or sometimes even airplanes. We asked the participants 3 questions about the purpose of the travel for which they would use ridesharing. The results are summarized below.

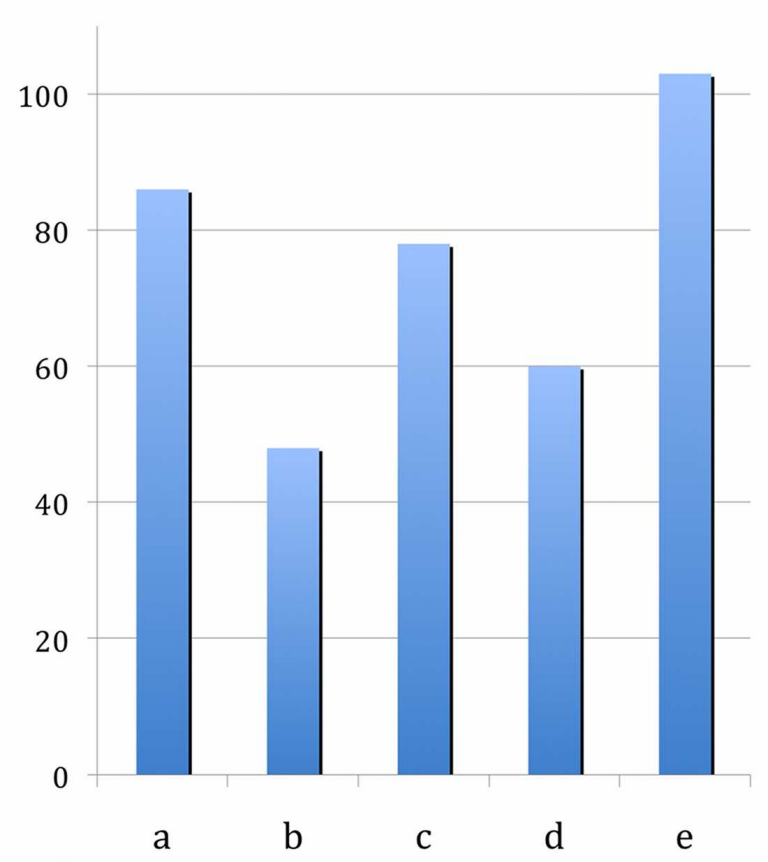

Figure 5.5: Motivating factors for ridesharing (a) Environment (b) Congestion (c) Parking (d) Convenience (e) Cost

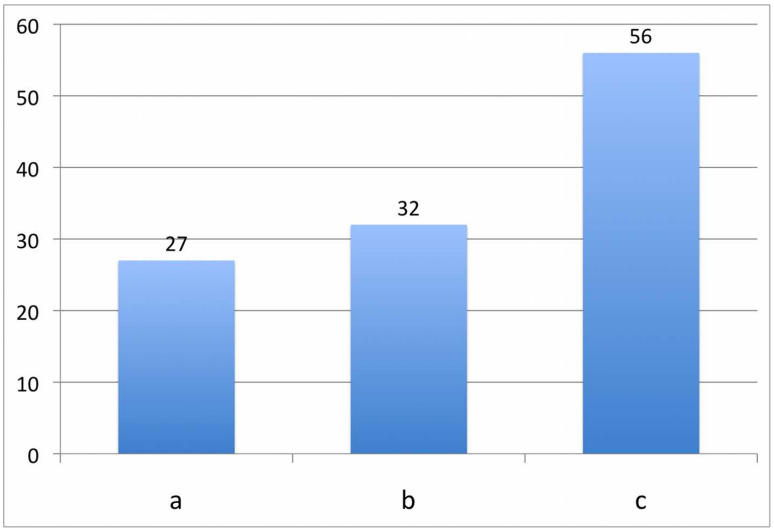

Figure 5.6: Use of ridesharing (a) Likely to use carpool for local events and shopping (b) Likely to use carpool for commuting to work or school (c) Likely to use carpool for vacation and long distance trips

Local events and shopping

72% of the participants are unlikely to use ridesharing for shopping or local events, suggesting that shopping is really a personal thing to do at one's own convenience. Only 21% would use ridesharing for local events. This figure is similar to the percentage of people without a car. These numbers indicate that for activities like local shopping and events ridesharing may not be a preferred mode of transportation either because of flexible schedule or inconvenience.

Commuting to work or school

The results are similar to local events and shopping. About 67% are unlikely to use ridesharing for their daily commutes. Perhaps, the inconveniences of arranging rides and differences in schedules have a role to play in this particular case. If we can reduce this number then that would have a great impact in reducing traffic congestion and pollution. A ridesharing application that can handle scheduling difficulties can aid in this scenario.

Vacation and long distance trips

Of all, long distance trips are the most popular rideshare purpose. 56% of the participants would use ridesharing for such activities. Long distance trips are infrequent and so the inconvenience of scheduling a ride is offset by the savings in cost. Longer trips also require more than one driver to avoid exhaustion. Additionally, long drives can be more fun, since the rideshare may turn into a social activity.

5.2 User Study Results

In this section we discuss the results of the prototype evaluation. First we discuss the results of usability evaluation that focusses on user interface layout, navigation and terminologies used. Second we discuss feature evaluation that focusses on how successful these features were in meeting users' expectation from a ridesharing application. In this section we also present the results for trust related questions that helped us design a trust model.

5.2.1 Usability of the Application

There were 11 people who participated in the study, 8 males and 3 females. We asked our participants to fill out the usability evaluation questionnaire after they finished executing benchmark tasks. Table 5.1 lists the results of our usability questionnaire. Number in the cells indicate the number of participants and each number has been differentiated by a color. Other than the questionnaire, we also noted down the usability issues observed during the course of benchmark tasks.

Questionnaire results indicate that we need to make improvements related with terminologies and layout. In the, "Invite Friends" view participants found the terminology confusing for

the pending friendship request and pending invitation. They were not able to understand what each meant unless it was explained.

Some of the problems that we observed during the study were related with the delay in the refresh of an action. For example, it took a while for the application to add a friend to a participant's friendship circle when a friendship request was accepted by them. Initially, the, "My Ride" view that lists the rides posted and rides shared by the logged in user was not noticed by the participants but they learned about it during the course of the study. Participants were not sure about setting the affinity level, the usual behavior is tapping on the star to highlight it but in our software we had a slider to set the rating which was confusing.

Overall participants found the InstaRide software usable. They found the organization of information clear and the content on this application as expected(A1, A3). Navigation was also considered to be effortless(A4, A6). Answers A11, A12 indicate that the application had a high learnability curve and encouraged exploration of features. All of them agreed to recommend this application to others (A7).

Table 5.1: Usability Evaluation Questionnaire with Results

Answer	**Question**	**Strongly Disagree**	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**
A1	Organization of information is clear			1	5	5
A2	Font type and size make it easy to read content throughout the application			1	3	7
A3	Content on this application is what I expected				6	5

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Table 5.1 – Continued

Answer	Question	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
A4	Navigation to find information is easy and effortless			2	6	3
A5	Layout is confusing	3	4	2	2	
A6	Navigation buttons use meaningful label				6	5
A7	I will recommend this application to others				4	7
A8	Each view has the right amount of information			3	5	3
A9	As I navigate, I know exactly where I am		1	2	6	2
A10	Terminology throughout the application is useful and appropriate		1	3	7	
A11	The application encourages exploration of features		1		5	5
A12	I believe most people would quickly learn to use this application			1	4	6

5.2.2 Feature Evaluation

Table 5.2 lists the results for the rideshare, social networks and instantaneous rideshare feature. Participants found these features easy to use (A13, A14, A15, A17). However,

two participants expressed concerns related with posting rides mainly while entering address details. Another problem was related with the "To Date" input section that did not make much sense in the one way ride scenario. Basically, we should hide the display of "To Date" when it is a one way ride.

Eight participants agreed to use InstaRide software to increase their social circle and all of them agreed that this application would help them meet new people (A18, A19). These answers indicate that InstaRide can serve as a potential platform to increase a user's online and offline social network. The instantaneous rideshare feature that uses GPS to find rides near a user's current location was also found useful by all the participants (A20).

Table 5.2: Feature Evaluation Questionnaire with Results

Answer	**Feature**	**Question**	**Yes**	**No**
A13	**Signup**	Was the signup process easy to understand and use?	11	
A14	**Posting and Viewing Rides**	Was it easy to post rides?	9	2
A15		Was it easy to request rides?	11	
A16		Search functionality displayed the results as expected?	10	1
A17	**Social Networks**	Was it easy to add friends?	11	
A18		Would you use this application as a means to increase your social circle?	8	2
A19		Do you think this application can help you meet new people?	11	
A20	**Other Concerns**	Do you think the instantaneous ridesharing feature can help avoid ride scheduling difficulties	11	

Table 5.3 lists the results for the trust feature and the trust perception evaluation. Here we

were trying to understand if the trust feature was able to cater to our users trust concerns.

All those participants who had used one or the other ridesharing application had trust related concerns(A21, A22). They unanimously agreed to share rides with friends and friends-of-a-friend (A23). The decision for sharing rides with strangers varied with traveling distance, time, driving skill and gender. We will discuss these results in detail later.

Table 5.3: Trust Questionnaire with Results

Answer	**Question**	**Yes**	**No**
A21	Have you ever used any other ridesharing applications?	2	9
A22	If yes, did you have trust-related concerns while using those?	2	
A23	Would you use this application to share rides with friends of a friend?	10	
A24	Was the affinity level feature useful in making a decision to offer or accept rides?	11	
A25	Does the application provide you enough information about an individual in terms of trust level that helped you make an informed decision in sharing rides with him/her?	9	2
A26	Would you use this application for accepting rides?	9	1
A27	Would you use this application for offering rides?	9	1
A28	Is gender important to you in deciding about accepting a ride?	6	5
A29	Is gender important to you in deciding about giving a ride?	9	2
A30	A person has offered or requested a ride. Would you add him/her as your friend before you meet them for the ride?	1	10
A31	Would you add him/her as your friend after the ride?	9	

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Table 5.3 – Continued

Answer	Question	Yes	No
A32	If a friend of yours who has given 100 rides vs. another friend who has given 5 rides would you trust one more than the other for ridesharing?	11	
A33	Are you comfortable in sharing driving cost(e.g., gas, tolls) with your friend?	11	

Social Relationship and Trust

In our benchmark task we had provided a pre-existing social network for the participants. This network consisted of friends, friends-of-a-friend (f-o-f), friends-of-a-friend-of-a-friend (f-o-f-o-f) and strangers. To set the affinity level, we asked the participants to assume some of these members in their social network as best friends, good friends and acquaintances. The next thing was to observe how participants expressed their affinity through the 5 star rating feature on the user interface with 5 being closest. We observed that this kind of feature helped users distinguish one friend from another in terms of their trust preferences.

In our application the affinity level was visible only for direct friends i.e. if A is a friend of B and B is a friend of C. A will not be able to see the affinity level set by B for C. We purposely refrained from revealing this information to A since that might not have been acceptable by B. But we realized during the study that revealing this information would have aided more in making a ridesharing decision thereby extending the principle that trust is conditionally transitive i.e. if Alice trusts Bob and Bob trusts Cathy, depending on how much Bob trusts Cathy might make Alice trust Cathy. The current design is based on the fact that if Alice trust Bob then she might trust Bob's friends as well as discussed in Chapter 2.

Almost all participants gave 5 stars to best friends, 4 to good friends, 3 or sometimes 2 to friend-of-a-friend if they were friends of good friends, otherwise they were given either 1 or 2 stars. Strangers were given no star.

All participants agreed that the affinity level feature helped them in making a decision about an individual during ridesharing. (A24). Participants found the display of relationship between users i.e. how one user knows the other as a motivating factor to add a user as their friend. They found the trust level feature useful particularly when they do not know the user directly, as in the case of friend-of-a-friend and stranger (A25).

Social Relationship and Ridesharing

Through our benchmark tasks (mention number), we tried to evaluate the scenario for rides offered by good friends, f-o-f-o-f and strangers. We observed whether participants would accept rides from these individuals or not. All participants expressed 100% percent confidence in sharing rides with their good friends and best friends as they mentioned that their company would be fun. Ten participants were confident in sharing rides with friends-of-friends. However, this varied how the friend-of-friend was connected. Our benchmark task results indicate that if the path was coming from a best or good friend, 10 participants would agree in both giving and accepting rides. If the path was coming through an acquaintance 4 would agree to accept rides and 6 agreed to offer rides. A trusted source is valued more than a less trusted one. Here the trusted source is the path that originates from the best friend and the good friend. A less trusted source is the path that originates from an acquaintance. Six participants would not take rides from distant friends such as friend-of-a-friend-of-a-friend, 7 would offer rides and 4 would neither accept nor offer rides to distant friends. Participants mentioned that a social distance of 2 as in the case of a friend-of-a-friend is trusted but as social distance increases more information in terms recommendation and rating would be

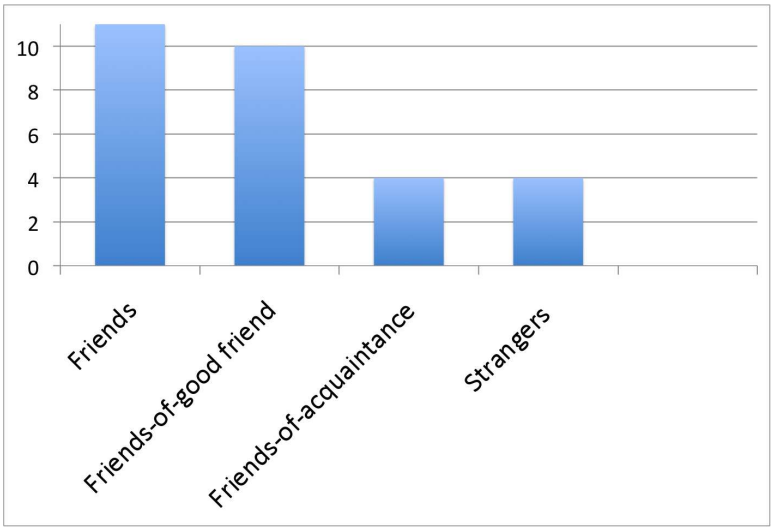

Figure 5.7: Number of people versus relationship preferences for accepting ride

needed to decide about sharing rides with them. This indicates that the social distance is an important factor in building trust. In the case of sharing rides with strangers, 2 participants, females would take rides from strangers of same sex and 2 male participants would take rides from strangers irrespective of the sex. The results are shown in figure 5.7. Similarly we tried to find out whether participants would offer ride to these individuals or not. The results are shown in figure 5.8.

We had a benchmark task where the participant was offering a ride and three users with varying social relationship requested for the ride. Assuming there were 3 seats available in the car we wanted to observe whom the participant would be willing to offer the ride. The different individuals were good friends, friend-of-a-friend-of-friend and stranger. Three participants would offer ride to everyone with the intention of saving cost. 3 female participants agreed to offer the ride to everyone only if the good friend was coming along. Three participants would offer the ride only to good friend and f-o-f-o-f and 2 participants would offer the ride only to the good friend. Participants agreed to offer rides to strangers with conditions of saving cost and if close friends were along with them. In the scenario where participants

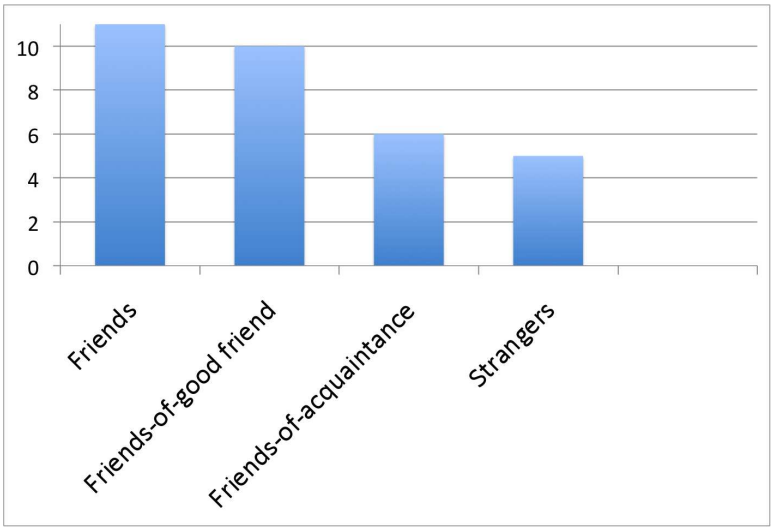

Figure 5.8: Number of people versus relationship preferences for offering ride

were asked to offer a ride only to a stranger, 4 participants would not offer the ride, 2 participants would offer the ride to save cost and also if more information was provided about the stranger and 5 participants would offer the ride only to female strangers. Participants are willing to share rides with strangers provided more information is given about them and they get some cost benefit. Female participants would offer rides only if the stranger was a female otherwise they would not.

Gender, Travel Distance and Trust

Overall both male and female participants considered female passengers a safer company. They believed females are generally non-violent when compared to males. Also, single males took this as an opportunity to start a new relationship.

In figure 5.7 and reffig:OfferingRidesStudy.eps those who are willing to share rides with strangers would do so only if the driving distance is small, more information is given about the stranger in the form of recommendation or information about the strangers' affiliation to a group or community. One participant mentioned about meeting with the stranger in

person prior to taking a ride to learn more about him/her. Another participant (male) sought ridesharing with a stranger of opposite sex as an opportunity to date and develop new relationship.

It was interesting to see how perceptions varied with travel distance. When asked whether participants would give/accept ride from a stranger or distant friends, 5 of them would share the ride only if the distance was small. One participant mentioned about the concerns related with the liability of sharing rides. In case of any mishap the stranger might sue the driver (as in the participant) which would be a rare case with a friend. For a short distance the likelihood of a mishap is low.

The larger the distance the more discomfort is associated with it. This indicates that apart from safety, liability concern is also one of the reasons why people may not consider sharing rides with strangers or distant friends. Sharing longer rides with a known person such as a friend can be fun because they can talk and they will have similar interests which may not be the case with strangers or distant friends.

Because of the subtle difference between offering rides and accepting rides we were not really sure if participants would think about it during benchmark tasks but we found that participants did see both as a different scenario. They expressed more confidence in offering rides since they found themselves more in control as opposed to accepting one. Almost all of them agreed to use this application both for offering and accepting rides (A26, A27). We attribute this to the fact that users found the features handling their trust concerns well because of the fact that it is closely associated with a user's social circle.

Time/Urgency and Trust

We presented a scenario where a participant had to catch a flight and they needed a ride. If only 1 ride was available and it was offered by a stranger, would they take this ride? Seven participants would not take the ride from a stranger even when the situation is urgent, they would rather book a taxi. Three of them would consider taking the ride because of the urgent situation but would prefer to have more information about the stranger in terms of recommendation and rating. Female participants would consider strangers only if the stranger was a female. One male participant would consider taking the ride provided the stranger was a female again treating this as an opportunity to develop a new relationship . When given a choice between a stranger and a friend of a acquaintance 9 participants would rather consider the latter. This shows that a connection of some form or the other is important. Even a distant relationship is considered more trustworthy compared to no relationship.

Driving Skill and Trust

To understand the importance of driving skill and trust we presented a scenario where a best friend was rated with a single star for driving skill meaning bad driver and a stranger was rated with 5 stars meaning excellent driving skill, would the participant request for a ride from the best friend? The trust perception changed here. One participant mentioned about knowing the reason why someone would rate a good or a best friend with a single star. With no prior driving experience with the friend, participants were not really sure of sharing rides with them. Three participants would not take the ride from either, 3 of them would take the ride from the friend, treating this as an opportunity to teach him/her driving and also because they don't mind taking the risk with the best friend and 5 participants would take

the ride from the stranger .

Ridesharing and Familiarity

When we asked the participants whether they would add a stranger as a friend prior to taking a ride (A30), 10 participants answered they would not add a stranger as a friend prior to taking the ride. However, after taking the ride when they become familiar with the stranger 9 of them would add them as their friend. Familiarity is another factor that indicates the level of trust. The more familiar one person becomes with another person the more comfortable they are in sharing rides.

Determining Trust Factor Weights

We asked the participants to rate the factors shown in table 5.4 based on their preferences on a scale of 1 to 5. The intention was to determine which metric should be given more weight while designing the trust model. Clearly, social relationship weighs most, followed by driving skill, followed by recommendation and rating by other passengers with same weights. Gender was considered least important however our female participants mentioned gender most important after driving skill during discussion.

Table 5.4: Trust and Ranking. 1 lowest 5 highest

Metric	**1**	**2**	**3**	**4**	**5**
Social Relationship with the individual					11
Gender	8	2		1	
Driving Capability			3	8	
Recommendation by a friend	1	6	3	1	
Rating given by other passengers	3	2	5	1	

Chapter 6

Discussions

This chapter has been divided into two sections - first we discuss the outcome of our preliminary survey. Second, we discuss the outcome of our usability study.

6.1 Survey Discussion

The results of the survey show that although people seem to be interested in ridesharing, it remains an unpopular mode of transportation. A general unawareness of ridesharing websites is a clear signal about the lack of interest in such systems. The most important reasons for its unpopularity are the inconvenience, lack of trust and motivation.

Complications in finding and setting up a ride, the amount of co-ordination required and lack of flexibility mainly cause the inconveniences. One solution to this problem would be to improve the usability of the tool that enables ridesharing. Another solution would be to increase the number of members willing to participate in ridesharing. Having a large user-base would increase the availability of rides, which in turn would enable greater flexibility

in choosing a schedule.

We identified trust to be a major factor that people consider while offering or accepting a ride. Most people are more willing to offer or take a ride from another person with whom there exists a social relationship, even an indirect one. Therefore, we look forward to promoting ridesharing amongst friends, friends of friends and communities based on common social networks. Immediate friends are without doubt the best travel mates, but friends of friends are the ones that can increase the number of participants in the ride sharing program. For example, consider the case where John has 100 friends and each of them have another 100 friends whom John has never met or known directly. However, if John decides to take rides from friends of his friends, he will have 10,000 people from whom he can take rides with a high level of confidence and trust. Social networks provide this kind of extended relationships and are the best means to reach a larger population, without compromising greatly on the trust factor.

Our survey respondents reported they are willing to participate in ridesharing provided they are able to trust all occupants in the car. However, very few agreed to share rides for local events, shopping or their daily commute to work. Long rides are more popular for ridesharing, primarily due to the cost factor. This gives us insight that there should be a clear motivation for people to participate, be it financial or otherwise. Apart from low costs, there are several people who can be motivated based on environmental concerns such as air pollution and global warming.

6.2 User Study Discussion

We had divided are usability study into two parts, user interface evaluation and feature evaluation. Our user interface evaluation results indicate that most participants agreed

that the content was meaningful, properly organized and presented and navigation was effortless. We can infer that participants liked the functionality from the fact that they all agreed to recommend this application to others. However, we observed some problems and inconsistencies that we discussed in Section 5.2. The results from the study has been used to improve our application design.

Our features mainly categorized as signup, social networks, ride posting and viewing and trust was found easy to use. The outcomes imply that we have been successful to a large extent in justifying our usability goals of efficiency, ease-of-use and high learnability.

The purpose of our study was not only to evaluate features and user interface but to look for answers to questions that assessed a user's perception of trust on relationship, driving skill and various other factors that come to play when ridesharing and trust is involved. Time, urgency, driving skill and travel distance has a role to play in ridesharing and it was evident in the results how each of these contributed to changes in trust preferences.

Through our benchmark tasks we were able to find the areas that needed improvements in usability experience. We got some very useful suggestions from the participants and some of these were pre-typed sample addresses, sorting rides based on street address, including a recommendation feature, showing the number of people rating a particular user. The most interesting and intriguing part of our study was the discussion that we had with our participants regarding their trust preferences. We asked some standard questions from the them as follows:

1. Why did you take this action?
2. What if this person was of same sex?
3. What role does driving skill play in making a decision?

4. What role does urgency play in sharing rides with a stranger?

Social Relationship

We mentioned earlier in Chapter 1 and Chapter 2 that integrating social networks with ridesharing systems will embed trust in it. A social network consists of connections or relationships that are direct or indirect. It is made up of friends, friends of friends, members of community and sometimes strangers too. A person may not trust all these different types of individuals for collaboration. For example, Bob and Tom are friends of Alice in her social network but Alice trusts Bob more than Tom. Another example, Alice and Cathy belong to Virginia Tech community on a social networking site but they do not know each other in other words they are strangers to one another. Would Alice trust Cathy? We wanted to identify these trust preferences involving the relationship one individual shares with another individual. Through literature reviews we found that trust can be transitive depending on how much one person trusts another person. Through our survey results we already had an idea that people trust friend-of-friend but we wanted to find out if they would trust all friend-of-friend, would they trust friend of acquaintance? The results were as expected, participants expressed more comfort in sharing rides with friends of good/best friends instead of friends of acquaintances.

The next question was how to distinguish a good or a more trusted friend from an acquaintance visually. We provided the affinity level star rating system that allowed users to rate their friends based on their closeness with them. The principle where Alice trusts Bob doesn't imply Bob trusts Alice i.e. trust is not bi-directional is applied through the affinity level feature. The affinity value represents the weight in a weighted social network graph. We also provided a visual representation of the social network graph i.e. "How you know this user" on our interface. Our participants found this a very useful feature. They mentioned

that a display of connection helped them consider an individual for ridesharing which in general scenario they would have ignored. Articulation of relationship helped in reforming user's trust preferences.

All these facts indicate that a simple integration of social networks with a collaborative system assuming that a user will trust everyone in his/her network is inaccurate. There should be tools to display the relationship and affinity differences.

From our survey results we had found that one of the motivating factors for ridesharing would be cost saving on gas, tolls etc.. However, we thought that people may not be comfortable in sharing driving costs with friends. We found that all the participants were comfortable in sharing driving expenses which is a good thing because one of the most important incentives for ridesharing which is saving money would be met.

Trust Model

We wanted to understand the role of factors such as driving skill, gender and time. Our benchmark tasks were designed to capture trust preferences for each of these. Most of the participants did not consider age and gender an issue except for females who consistently mentioned about sharing rides with strangers only if the stranger was a female. Some of the things that we realized during the study was importance of driving distance and recommendation. Participants were not ruling out sharing rides with strangers provided the travel distance was small. Other important factor was a recommendation feature. Participants mentioned that a recommendation by a friend would help them gain trust for strangers or distant friends.

We tried to combine these metrics with social relationship to see how trust preferences varied. The combinations were social relationship and driving skill, social relationship and

urgency, social relationship and gender, social relationship, urgency and gender. This kind of combination helped us find out that social relationship is important but not the only important thing when designing a collaborative system. In ridesharing systems driving skill and rating would sometimes outweigh social relationship. Eliminating strangers from a person's rideshare network may not be a wise decision since some of them are willing to share rides with strangers to save cost, provided more information is available about the stranger in terms of rating and recommendation. Familiarity established during ridesharing also helps in increasing trust.

These findings infer that a trust model should consider social relationship(broken down as social distance and affinity level), driving skill, rides together (familiarity) and recommendation. We do feel that each one of these have a role to play in making a ridesharing a successful system.

Based on the results of our usability study we are proposing a trust model as given below:
Social Distance (S), weight (w_s)
Affinity level (A), weight (w_a)
Familiarity with rider (F), weight (w_f)
Reviews/Riderating (Ra), weight (w_{rating})
Recommendation (Re), weight ($w_{recommendation}$)

$$Trust = (w_sS+w_aA+w_fF+w_{rating}Ra+w_{recommendation}Re)/(w_s+w_a+w_{rating}+w_{recommendation}+w_f) \tag{6.1}$$

The weights for each of these factors were determined for InstaRide protoype where, $w_s = w_a$ and w_s, $w_a > w_{rating}$, $w_{rating} > w_{recommendation}$, $w_{recommendation} > w_f$
On a five point scale, $w_a = w_s = 5$, $w_{rating} = 3$, $w_{recommendation} = 2$, $w_f = 1$

With this trust modal we are making a case that in a ridesharing system, different factors that are considered to build trust would have different weights. For any other collaborative application a similar trust modal should be designed by carefully identifying various trust factors and their weights for those applications empirically.

Instanteneous Ridesharing

Lack of flexibility is one of the reason why people would not use a ridesharing application, we found this during our survey and literature review. To address this we developed a mobile phone based ridesharing software to provide connectivity on the go and use location awareness services to schedule rides instantaneously. The "Rides Near Me", feature would sort the rides based the location closest to a users current location. Our participants found this feature useful.

Chapter 7

Conclusions and Future Work

In this chapter we conclude the thesis and discuss the future work in the areas related with this thesis.

7.1 Conclusion

The three contributions we have made in this thesis is discussed below:
Firstly, we have taken a step towards an in depth understanding of users perceptions of trust in a collaborative system such as a ridesharing. Despite the advantages a ridesharing application has to offer in terms of travel convenience, cost savings, reduction in pollution and traffic congestion it is not a preferred mode of transportation. We wanted to understand the problems that keep users away from ridesharing. Our approach was to begin with a survey to identify the problems. We identified three issues as follows:

1. Lack of trust which causes social discomfort

2. Inconvenience in scheduling rides

3. Lack of motivation

Our survey results indicated that users are willing to share rides with friends, friend-of-friends and member of their community i.e. any individual with whom they have some or the other form of social connection.

We conducted an exhaustive usability study by designing benchmark tasks that presented various scenarios that are important in ridesharing and that can affect users trust preferences. The analysis of our usability study results indicates that social distance and affinity of one user with another plays the most important role in establishing trust between passengers.

Secondly, to solve the issue of inconvenience, we have designed and implemented a mobile phone based rideshare software so that users would be able to use these systems on the go. Location aware services in these systems will further enhance usability experience by allowing users to find rides near them thereby aiding in the problem of lack of flexibility and inconvenience. *InstaRide* is based on a user's social network, it provides tools of trust in the form of a trust level feature and the display of social relationship.

Finally, we have designed a modal of trust for ride sharing applications. This modal is made of up factors such as ride rating, affinity level, social distance, familiarity and recommendation. We determined the weights of each of these factors for our prototype through the usability study. This modal can be employed in other applications however, some of the trust factors and weights would vary depending on the type of application and users trust preferences for those systems.

Our goal is to leverage social networks to embed trust in rideshare programs. Trust can only be embedded when we are able to understand its multifaceted meaning. Through this research we learned that any collaborative application that requires trust would need an understanding of various scenarios of trust perceptions. Other factors that are specific to a

collaboration can be used to tailor a trust model that would enhance user experience and make these systems successful.

A ridesharing application can also help a user meet new people. The result of our survey and usability study indicates that users are willing to shares rides with strangers and friends-of-friends either to start a new relationship or make new friends thus InstaRide can also serve as a platform to expand a user's social circle.

7.2 Future Work

There are some key areas where we see future enhancements in terms of new features, analysis and adding a notification system.

7.2.1 New Features

From our study results we found that users would like to have a recommendation scheme where a friend could recommend another user for ridesharing. We discussed in Chapter2 how various applications such as Facebook and Orkut employ recommendation to expand a user's social network. If a similar tool is added to InstaRide then it will help a user to know more about the distant friends or strangers and remove any apprehensions whatsoever associated with their behavior, driving skill etc.

Another useful enhancement would be displaying the total number of people who voted for a particular ride similar to what Amazon does and displaying the total number of rides offered or taken by a user. All these informations will help determine a user's driving skill and how active they have been in offering or accepting rides.

7.2.2 Integration with Other Applications

In the InstaRide application users build their rideshare network by inviting their friends and friends-of-friends. To make this functionality generic it would be nice to provide ways to import and integrate friends from some of the existing social networking applications such as Facebook, MySpace etc.

A rideshare application that is location aware can help people track their friends location and use this information to setup rides instantaneously. Four-square is a location-based social networking application that can help users track their friends' location. It would be useful to integrate InstaRide with it as that would allows users to contact their friends who are closest to their physical location and share rides. This would aid to the problem of trust as rideshare will be setup between users who are related to one another. It would also provide flexibility in setting up rides.

7.2.3 Analytics Tool

In order to continuously get feedback about how the InstaRide application is being used, it would be very useful to integrate an analytics tool to the application that generates statistics about users of the application. The information gathered could tell about how many users or new users launch the application in a given time interval. It would tell which are the most frequently used features and capture events and actions of users. To protect user's privacy, no private data such as user name will be logged or analyzed. One such tool is Google Analytics [11]. It provides easy to use APIs for iOS applications and browser based web applications. It is difficult to simulate real-life scenario in a controlled study environment with a set of benchmark task. We can use these tools to conduct a formative evaluation for extended period of time away from an experimental setup.

7.2.4 Push Notifications

In order to save battery life, backgrounding is not allowed by iOS. This means that when a user requests a ride and if the ride is needed immediately, the other user must have the application running. An alternative is to place a phone call or send a text messaging, but these are not free services and do not integrate well with the applications. Apple designed the Push Notification Service [2] to solve this problem. This service will allow the user to send requests in form of text or sound. The receiver will read the information and may tap a button to launch the InstaRide application to take further actions, such as offering a ride. Thus InstaRide combined with push notification will greatly improve the response time of users.

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Appendix A

Informed Consent Forms

VIRGINIA POLYTECHNIC INSTITUTE AND STATE UNIVERSITY

Informed Consent for Participants in Research Projects Involving Human Subjects

Title of Project:

InstaRide – An Instant Rideshare System

Investigator(s):
Dr. Andrea Kavanaugh, Dr. Manuel Perez, and Vineeta Chaube

I. Purpose of this Research/Project

InstaRide is an iPhone based rideshare system that would leverage social networks to embed trust. This study involves understanding the interpretation and perceptions of trust in a collaboration based social software like a rideshare application.

II. Procedures

You will be asked to perform a set of tasks using the InstaRide program. The tasks are associated with the functionality of our system. These include: creating a profile, adding friends to build up a virtual social network, and posting, viewing, offering and requesting rides on the iPhone. Please note the tasks mentioned above are only for experimental purposes and will run in a simulated environment. Your role in these tests is that of evaluator of the InstaRide software. We are not evaluating you or your performance in any way; you are helping us to evaluate our system. All information that you provide us will remain confidential and anonymous. Your actions will be noted and you will be asked to describe verbally your learning process. You may be asked questions during and after the evaluation, in order to clarify our understanding of your evaluation. You will also fill out a questionnaire relating to your usage of the system.

The session will last 60 to 90 minutes. There are no risks to you. The tasks are not very tiring, but you are welcome to take rest breaks as needed. If you prefer, the session may be divided into two shorter sessions. You may also terminate your participation at any time, for any reason.

III. Risks

There are no known risks to the subjects of this study.

IV. Benefits

Your participation in this project will provide information that may be used to improve the usability of InstaRide and will give us insight into the future design.

No guarantee of benefits has been made to encourage you to participate. You may receive a synopsis summarizing this research when completed. Please leave a self-addressed envelope with the experimenter and a copy of the results will be sent to you.

You are requested to refrain from discussing the evaluation with other people who might be in the candidate pool from which other participants might be drawn.

V. Extent of Anonymity and Confidentiality

The results of this study will be kept strictly confidential. No one outside the project team will be able to connect any data with your name. The information you provide will have your name removed and only a subject number will identify you during analyses

and any written reports of the research. Neither a video nor an audio recording will be made of the experimental session.

VI. Compensation
Your participation is voluntary and unpaid.

VII. Freedom to Withdraw
You are free to withdraw from this study at any time for any reason.

VIII. Approval of Research
This research has been approved, as required, by the Institutional Review Board for projects involving human subjects at Virginia Polytechnic Institute and State University.

IX. Subject's Responsibilities
I voluntarily agree to participate in this study, and am not a minor (am not under 18).

X. Subject's Permission
I have read the Consent Form and conditions of this project. I have had all my questions answered. I hereby acknowledge the above and give my voluntary consent for participation in this project. If I participate, I may withdraw at any time without penalty.

_____ Date_____
Subject signature

_____ Date _____
Name (Please Print)

Should I have any pertinent questions about this research or its conduct, I may contact:

Vineeta Chaube Investigator	Email: vineetac@vt.edu Phone: 5409989317
Dr. Andrea L. Kavanaugh Faculty Advisor	Emai: kavan@vt.edu Phone: 5402311806
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David M. Moore Chair, IRB	Email: moored@vt.edu Phone: 5402314991

Appendix B

Survey Questionnaire

Survey Questions

1. Demographic Information:

   a) VT Affiliation - Student, Faculty, Staff

   b) Age

   c) Gender

   d) Do you live off-campus or on-campus?

   e) How far is your house from work place/university if you live off-campus?

      - Within 1.5 miles
      - Within 5 miles
      - more than 10 miles

   f) Do you own a car

      - Yes
      - No

   g) How do you usually commute?

      - By car
      - Bicycle
      - Walk
      - Bus
      - Carpool

   h) Do you have a mobile handset (phone etc.) through which you can access Internet?

      - Yes
      - No

2. How often do you come across traffic congestion while driving by car?

   a) Daily b) Sometimes c) Don't drive

3. Is car-parking space a problem at work-place/university?

   a) Yes b) No c) Sometimes

4. Do you prefer public transportation? If yes which one

a) Blacksburg Transit b) Carpool c) Smart way

5. Have you heard about the available carpool systems in university, if yes which one?

a) Yes b) No

6. Have you used any carpool system/website before, if yes which one?

7. Would you like to use a carpool system?

a) Yes b) No c) Not sure

8. If no then what are the possible reasons you would NOT opt for a carpool? Check all that apply.

a) Safety b) Finding carpool is time taking c) Loss of freedom d) other (please explain)

9. If yes then what are the possible reasons for you to OPT for carpool? Check all that apply

a) Environment friendly b) Helps avoid traffic congestion c) Energy conservation d) e) Solves parking issues f) Serves cheaper g) other (please explain)

10. Would you prefer carpool for going to local shopping, events etc.

a) Yes b) No

11. Would you prefer carpool for daily activities or routine like going to work, university, church etc.

a) Yes b) No

12. Would you prefer carpool for going on vacation, conferences over long distances

a) Yes b) No

13. What do you think is the most common reason for people not using carpool/rideshare websites?

a) Not user friendly b) Complications in finding and setting up a ride c) Does not handle end minute changes in travel plans d) other (please explain)

14. Would you be willing to accept a ride from a stranger/strangers or only from a known friend, (this is related to matching trips in rideshare systems)? Check all that apply:

a) Friends b) Virginia Tech Community (students, staff, faculty) c) Strangers d) other (please explain)

15. Would you be willing to give a ride to (check all that apply):

a) Friends b) Virginia Tech Community (students, staff, faculty) c) Strangers d) other (please explain)

16. Do you like using social networking websites like Facebook, Orkut , Myspace etc:

a) Yes b) No

17. Please share your thoughts about ride-sharing systems like carpool, vanpool.

Some things that you think are good or bad about the websites/current systems that offer these functionalities. Are they good enough to satisfy your needs? What change are you looking for? These and more views that we would like to know about.

18. Consider the following Scenario:

You are interested in finding rides to home, school, work or the shopping mall. So you register yourself on a website for getting rides. The website connects you to several people that you may know or be comfortable with to take rides. This way you form a social network of people from whom you may take a ride or even offer a ride when you are driving. You can also register and add friends using your mobile handset.

One fine day, after attending classes you wished you could straight away go to Wal-Mart for grocery. You say to yourself, "I wish I could get a ride to Walmart". You take out your mobile handset; send message to the rideshare system "Need a ride from Drillfield to WalMart". This message is sent to all the commuters who belong to your social network and who are around campus. Joe-the-Classmate gets the message while he was getting into his car and was heading towards Walmart. He looks at his handset and realizes that you are less than a mile away from his location and so he decides to give you a ride. You update your status saying that you got the ride. This informs your other friends who might be thinking to pick you up too.

There could be many similar scenarios where we might need a ride spontaneously. The instant rideshare system is capable of handling last minute changes in travel plans.

Question – would you prefer an instant ride matching system that would get you rides immediately and at the same time avoid the hassle of registration for a planned trip on a carpool website?

Appendix C

Benchmark Tasks

Benchmark Tasks

For all these tasks assume Tony, Leena and Tom are your friends.

Leena (female) – is your best friend

Tom (male) – is your good friend

Tony (male) – you met him at a party and meet him occasionally

Lisa (female) – is a friend of Leena

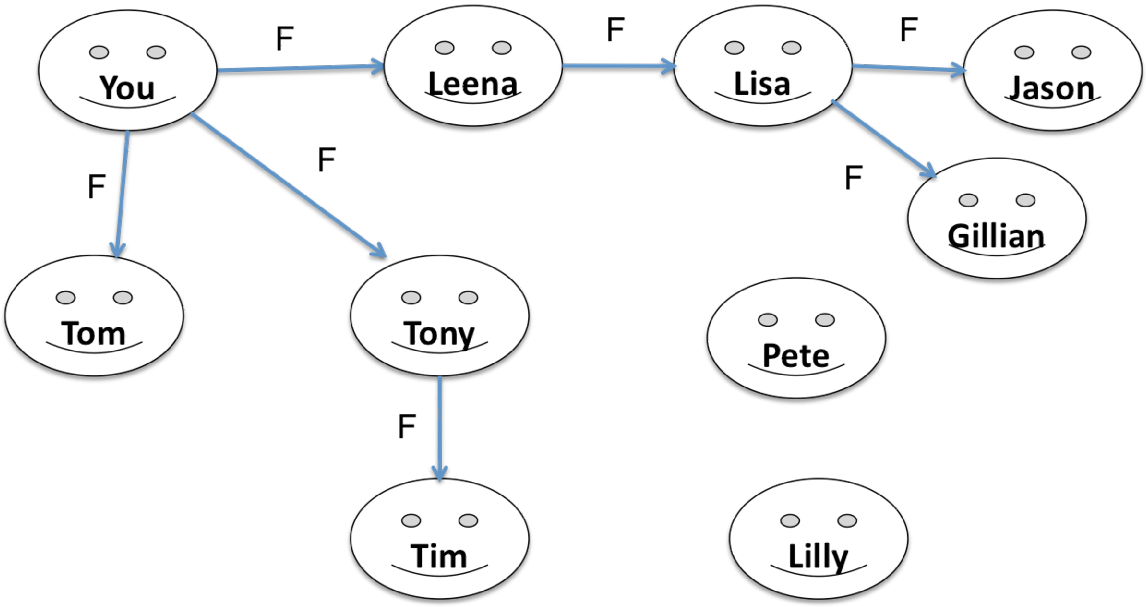
Jason (male) – is a friend of Lisa

Gillian (female) – is a friend of Lisa

Tim (male) – is a friend of Tony

Pete (male) – is a stranger

Lilly (female) – is a stranger



Profile

The application has been uploaded on the iPhone. A profile has already been created for you. The details are given below.

Male Participants -
First Name: Jack
Last name: Anderson
Username: jack
Password: abcd
Email: instaridejack@gmail.com
Phone number: 5409982344

Female Participants -
First Name: Jill
Last name: Anderson
Username: jill
Password: abcd
Email: instaridejill@gmail.com
Phone number: 5409982344

1. Participant views his/her own profile

You want to check your profile details.

Starting Point: Profile screen
End Point: Logged in users Profile Setting screen

User Expands Social Rideshare Network

2. Participant views other users profile

Your friends are Tony, Leena and Tom. You want to find out if they are using this application (You do this by tapping the add button). You also view their profile (You tap on the row that contains users name to see their profile). You see their friends.

Starting Point: Your Friends screen
End Point: Users Profile screen

3. Participant sends friendship request

You are finding friends on InstaRide and see that Tony, Leena and Tom who are your friends are in that list. You send friendship request to all of them.

Starting Point: Find Friend screen

End Point: "Request Sent" message

4. Participant checks pending friendship invitation

You sent friendship request to Leena, Tony and Tom a while ago and want to check if they responded to it. You go to the profile setting and see the pending invitations.

Starting Point: Profile screen
End Point: Pending Invitations screen

5. Participant checks pending friendship request

Lisa sent friendship request to you. Before accepting friendship, you want to verify if you know Leena either as a friend or as a friend-of-a-friend. You see her profile and accept friendship request because you know her through Tom.

Starting Point: Profile Setting screen
Ending Point: "You accepted the friendship" message

6. Participant sets affinity level for friends

You want to set the affinity level for your friends to distinguish whom you trust more. Leena is your best friend. Tom is a good friend. You met Tony at a party and meet him occasionally. You know Lisa through Tom. Set the affinity level based on your social relationship and trust preferences.

Starting Point: Your friend's screen
End Point: Affinity level set

View and Respond to Posted Rides

7. Participant views and requests rides - Friend/Tom posts this ride

You need a ride from **Blacksburg to Roanoke** on **25th July** and wondered if someone could give you a ride. Other users have posted ride offers that you can take. However, before sending ride request you want to verify if you can trust the posters. You verify that and send ride request based on your trust preferences.

Starting Point: Rides List Screen
Ending Point: "You have requested this ride message" - if you requested this ride

8. Participant views and requests ride

You need a ride from **Blacksburg to Salem** on **25th July** and wondered if someone could give you a ride. Other users have posted ride offers that you can take. However, before

sending ride request you want to verify if you can trust the posters. You verify that and send ride request based on your trust preferences.

Starting Point: Rides List Screen
Ending Point: "You have requested this ride message" - if you requested this ride

9. Participant views and requests ride

You need a ride from **Salem to Blacksburg** on **25th July** and wondered if someone could give you a ride. Tim has posted a ride offer. You send ride request based on your trust preferences.

Starting Point: Rides List Screen
Ending Point: "You have requested this ride message" - if you requested this ride

10. Participant views and requests ride

You need a ride from **Blacksburg to Christiansburg** on **25th July** and wondered if someone could give you a ride. Other users have posted ride offers that you can take. However, before sending ride request you want to verify if you can trust the posters. You verify that and send ride request based on your trust preferences.

Starting Point: Rides List Screen
Ending Point: "You have requested this ride" message- if you requested this ride

11. Participant offers rides to a posted ride request

You will be driving back from **Christiansburg to Blacksburg** on **25th July**. You were checking the rides posting and came across a ride request to **Blacksburg** on **25th July**. You decide to offer the ride. However, before offering you would like to verify whether the request is by a stranger, friend or friend-of-a-friend so that you can trust this poster. You verify that and send ride offer based on your trust preferences.

Starting Point: Rides List Screen
Ending Point: "You have offered this ride" message- if you offered the ride

12. Participant offers rides to a posted ride request

You are going to drive back from **Roanoke to Blacksburg** tomorrow. You were checking the rides posting and came across a ride request for **Blacksburg** tomorrow at 5 pm. You will be driving in that direction at that time and decide to offer the ride. However, before offering you would like to verify whether the request is by a stranger, friend or friend-of-a-friend so that you can trust this poster. You verify that and send ride offer based on your trust preferences.

Starting Point: Rides List Screen
Ending Point: "You have offered this ride" message- if you offered the ride

13. User offers rides to a posted ride request

You are going to drive back from **Richmond to Blacksburg** tomorrow.
You were checking the rides posting and came across a ride request to **Blacksburg** tomorrow at 5 pm. You will be driving in that direction at that time and decide to offer the ride. However, before offering you would like to verify whether the request is by a stranger, friend or friend-of-a-friend so that you can trust this poster. You verify that and send ride offer based on your trust preferences.

Starting Point: Rides List Screen
End Point: "You have offered this ride" message- if you offered the ride

Create a new ride

14. Participant creates a new ride offer

You are driving to **Maryland** from Blacksburg this weekend and wished you had a driving companion in the long drive. You use InstaRide and post ride offer. We will give you ride details.

From Address:
Street Address - Sunridge Drive
City - Blacksburg
State - VA
Zipcode – 24060

To Address:
Street Address - St. Johns College
City - Annapolis
State - MD
Zipcode – 21401

From Date – 27th July, 1 pm
To Date – 27th July, 7 pm

Starting Point: Edit New Ride Screen
End Point: "Ride Created Successfully" message

15. Participant responds to ride request for the post he or she made

You had posted a ride offer to **Maryland**. Other InstaRide users responded to the offer by requesting for this ride. However, before you accept their request you would want to

verify how much you trust this user. You accept request/s based on your trust preferences.

Starting Point: Ride details screen
End Point: "You accepted this request" message

16. Participant responds to ride request for the post he or she made.

You had posted a ride offer from **Blacksburg to Christiansburg** on **29th July**. An InstaRide user responded to the offer by requesting for this ride. However, before you accept the request you would want to verify how much you trust this user. You either accept or deny the ride request based on your trust preferences. A post has already been created for you.

Starting Point: Ride details screen
End Point: "You accepted this request" message – if you accept the request otherwise "You denied this request" message – if you denied the request

17. Participant responds to ride request for the post he or she made

You had posted a ride offer **Blacksburg to Lynchburg**. Other InstaRide users responded to the offer by requesting for this ride. However, before you accept their request you would want to verify how much you trust these users. You either accept or deny the ride request based on your trust preferences. A post has already been created for you.

Starting Point: Ride Details Screen
End Point: "You accepted this request" message – if you accept the request otherwise "You denied this request" message – if you denied the request

18. Participant creates a new ride, this time requesting for a ride

You need a ride to **Radford**. You post a ride request. We will give you ride details.

From Address:
Street Address - Sunridge Drive
City - Blacksburg
State - VA
Zipcode – 24060

To Address:
Street Address - East Main Street
City – Radford
State – VA
Zipcode - 24142

From Date –22nd July, 1 pm
To Date – 22nd July, 7 pm

Starting Point: Ride list Screen
End Point: "Ride Created Successfully" message

19. Participant responds to the ride offers for the post he or she made

You had posted a ride request to **Radford**. Other InstaRide users responded to the request by offering this ride. However, before you accept their offer you would want to verify how much you trust these users. You accept a ride offer based on your trust preferences.

Starting Point: Ride Details Screen
End Point: "You accepted this ride" message – if you accept the offer otherwise
"You denied this ride" message – if you denied the offer

20. Participant responds to the ride offers for the post he or she made

You had posted a ride request from **Blacksburg to Pulaski** on **30th July**. Other InstaRide users responded to the request by offering this ride. However, before you accept their offer you would want to verify how much you trust these users. You accept a ride offer based on your trust preferences. A post has already been created for you.

Starting Point: Ride Details Screen
End Point: "You accepted this ride" message – if you accept the offer otherwise
"You denied this ride" message – if you denied the offer

21. Participant responds to the ride offers for the post he or she made

You had posted a ride request from **Pulaski to Blacksburg** on **30th July**. Other InstaRide users responded to the request by offering this ride. However, before you accept their offer you would want to verify how much you trust these users. You accept a ride offer based on your trust preferences. A post has already been created for you.

Starting Point: Ride Details Screen
End Point: "You accepted this ride" message – if you accept the offer otherwise
"You denied this ride" message – if you denied the offer

Task for time and trust and gender

22. Participant requests for ride

You need a ride from **Blacksburg to Richmond** airport on **30th July** at 5 pm to catch a flight and wondered if someone could give you a ride. Two rides are available. You send ride request to one of them. However, before sending ride request to one of them you

want to verify if you can trust the poster. You verify that and send ride request based on your trust preferences.

Starting Point: Rides List Screen
Ending Point: "You have requested this ride message" - if you requested this ride

23. Participant requests for ride

You need a ride from **Blacksburg to Roanoke** airport on **21st July** at **5 pm** to catch a flight and wondered if someone could give you a ride. Only one ride is available. However, before sending ride request you want to verify if you can trust the poster. You verify that and send ride request based on your trust preferences.

Starting Point: Rides List Screen
Ending Point: "You have requested this ride message" **-** if you requested this ride

User Searches for Ride

24. User searches for a ride
You need a ride to Richmond. You search for the ride.

Starting Point: Search Rides Screen
End Point: Result of the search

25. Participant searches for ride near himself or herself

On a bright **Saturday, 26th July** you decided to go shopping to **Christiansburg**. You go to your car but realize that it's broken down. You took out your iPhone and checked if there was any current ride available near you for Christiansburg. You send ride request.

Starting Point: Rides Near Me screen
End Point: "You have requested this ride" message

Rating and trust Question

26. Leena who is your best friend and Lilly is a (Stranger). Other users have given Lilly 5 stars for driving. Leena has only 1 star for her driving skill. Whom would you prefer sharing rides with? Why?

Familiarity and trust Question

27. Pete is a stranger to you but you took 2 rides with him, would you add him as your friend why or why not?

Appendix D

Post Evaluation Questionnaire

Usability Evaluation Questionnaire							
		Strongly Disagree	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**	**Other Comments**
Organization of information is clear.							
Font type and size make it easy to read content throughout the application.							
Content on this application is what I expected.							
Navigation to find information is easy and effortless.							
Layout is confusing.							
Navigation buttons use meaningful label.							
I will recommend this application to others.							
Each view has the right amount of information.							
As I navigate, I know exactly where I am.							
Terminology throughout the application is useful and appropriate.							
The application encourages exploration of features.							
I believe most people would quickly learn to use this application.							
Feature Evaluation Questionnaire							
		Yes	**No**	**Other Comments**			
Signup							
Was the signup process easy to understand and use?							
Posting and Viewing Rides							
Was it easy to post rides?							
Was it easy to request rides?							
Search functionality displayed the results as expected?							
Social Networks							
Was it easy to add friends?							
Would you use this application as a means to increase your social circle?							
Do you think this application can help you meet new people?							
Trust (Trust is associated with the level of social comfort when planning and sharing rides with another individual.)							
Have you ever used any other ridesharing applications?							
If yes, did you have trust-related concerns while using those							
Rank each one of these based on their importance in providing trust in ridesharing.(5 highest, 1 lowest. Each should have a unique rank).							
Social relationship with the individual							
Gender							
Driving capability							
Recommendation by a friend							
Rating given by other passengers							
Would you use this application to share rides with friends of a friend?							
Was the affinity level feature useful in making a decision to offer or accept rides?							
Does the application provide you enough information about an individual in terms of trust level that helped you make an informed decision in sharing rides with him/her?							
Would you use this application for accepting rides?							
Would you use this application for offering rides?							
Is gender important to you in deciding about accepting a ride?							
Is gender important to you in deciding about giving a ride?							
A person has offered or requested a ride.							
Would you add him/her as your friend before you meet them for the ride?							
Would you add him/her as your friend after the ride?							
If a friend of yours who has given 100 rides vs. another friend who has given 5 rides would you trust one more than the other for ridesharing?							
Are you comfortable in sharing driving cost(e.g., gas, tolls) with your friend?							
Other Concerns							
Do you think the instantaneous ridesharing feature can help avoid ride scheduling difficulties?							