# Combining Ridesharing & Social Networks

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# Overview of Pooll

## The problem

Modern day car traffic in the Western world is inefficient in terms of occupancy, which leads to relative high travel costs. These costs are already rising due to the continually increasing oil prices. Moreover, there is a potential reduction of pollution by increasing the number of occupants per vehicle; fewer vehicles fulfil the same travel demand.

Although in North America carpooling and ridesharing is gaining more and more popularity due to the construction of so-called High Occupancy Vehicle (HOV) lanes, Europe is still lacking any advances of getting more persons into a single vehicle.

It could be argued that traditionally, car travel is about freedom of movement and that carpooling reduces freedom both in terms of space and time. Also, in urban areas the quality of public transport can be considered very high. In that case using public transport is usually quicker, more flexible in terms of schedule and the privacy or at least the anonymity is higher.

However, research in primarily, the US, has shown that carpooling propensity increases if there are cost savings or low quality public transport as an alternative. Additionally, social aspects are mentioned as primary reasons for carpooling.

## The solution

Pooll provides a ridesharing service which ensures flexibility, trust, safety, reliability and fun. The solution is based on a system which enables travellers to announce their trips to other travellers. Whenever a part of a trip coincides with trips of other users, both travellers receive a notification and can invite each other for travelling together. Once both travellers have agreed by accepting the invitations the trip is confirmed and both travellers will receive a message with the details of their appointment. Future versions also include a mobile client for on-trip access and a payment system so that transfer of cash from the passenger to the driver is done automatically.

## The innovation

Pooll is innovative because it combines the strengths of social networks to solve the current problems of ridesharing.

A social network is a web-based service that provides its users with the ability to map their relations with other individuals and has gained a lot of popularity in the last few years. Most social network websites share the functionality of having a user profile with personal information of the user and ability to connect to other users by inviting them to one’s own social network. The largest social network in The Netherlands called Hyves has a user base of around 52% of the total Dutch population.

Lack of trust and safety seem to be the main problems for ridesharing. Pooll aims to solve this by integrating the social network of the user to his or her profile. Users can get information about other users by simply checking the profile on their social network. They can evaluate the profile and decide if the other traveller seems trustworthy and friendly. Furthermore, Pooll has an own rating system which keeps scores of persons, just like the rating systems commonly seen on auctioning sites. Amongst the criteria are factors like reliability, safety and friendliness.

Another innovative feature of the system is the mobile client. The mobile client consists of software that is run on a mobile device such as a smart phone or PDA. It requires a wireless internet connection and a built-in GPS sensor. This mobile client works as an enhancement to the non-mobile pre-trip system.

The mobile software can be used to replicates the functionality of the browser based version, but it adds localisation capability. It can be used to find trips that pass your current location and create a match on the fly.

It can also show the location and progress of other users you have a matched trip with. In case of unforeseen circumstances such as traffic jams, the user can then adapt to this changed pickup time or opt out of the trip completely.

## The customers

The users are all travellers that want to make trips together with other users. While the focus of the system is on car drivers because increased vehicle occupancy offers higher efficiency, there is also the possibility to plan trips using other modes. Travelling with friends, for example by train, also seems a nice experience to the user.

## Business model

The basic service is free to all individual users. This is to make sure that the initial required user base will be large enough to generate a probability of a match for a certain trip.

There is also a premium service which only companies can subscribe to. By paying a setup fee and a small monthly fee, they receive a portal to Pooll for use exclusively by employees of the company. This also adds another filter option, namely to filter trips by users of a certain company.

Finally, once a payment service is implemented, users can load cash to a balance attached to their user account. A passenger needs to have a prepaid balance which is high enough for the trip that he or she wants to be a passenger on. Pooll will act as an escrow service, generating revenue from the combined value of all the prepaid balances.

# Ridesharing

Over the years a lot of terms for travelling together by car have evolved. It seems that in the present literature no clear distinction is made between the different forms, instead a lot of terms are used interchangeably. It seems wise to try to define different forms travelling together by car.

## Definition of terms

The most well-known term is *carpooling*, which is the shared use of a car by the driver and one or more passengers usually for commuting purposes. Carpooling arrangements can vary in regularity and formality. *Ridesharing* is sometimes said to be a synonym for carpooling, but it is increasingly used to indicate a form of *ad-hoc* carpooling, thus with less regularity and formality. Where carpooling is usually performed by a distinct group (pool) of individuals alternating driving responsibilities, ride-sharing is less regular in the sense that it usually is a onetime arrangement between a driver and a passenger. This differs from *hitchhiking* in that ride-sharing is usually arranged pre-trip. *Slugging* is a form of hitchhiking used to gain access to HOV lanes where both driver and passenger have a mutual benefit. Finally, *car sharing* is model where multiple individuals rent or lease cars together in order to share costs which is attractive when it only used occasionally.

Whenever in this paper ridesharing is mentioned, it is meant to indicate this ad-hoc type of arrangement.

## Traditional reasons for ridesharing

Most research on the topic of carpooling is has been conducted in North America. In the article by R.F. Teal "*Carpooling: who, how and why*", it is commented that carpooling can be considered as an old phenomenon. It originates as a social gesture from the time when car ownership was still very low. Car owners were usually happy to provide a ride to others if there was still space left in the car. Of course, first in line were the household members that had to be dropped off at a certain location.

As car ownership increased, ridesharing became less common. Generally, only if no car and no public transport are available, tendency to carpool will be present, except for some urban areas, where traffic became clogged and special treatment is now given to vehicles with a high occupancy.


LIFE

Three main characteristics are traditionally present amongst the drivers and trips where carpooling is being performed, these are:

- Low income
- High trip distance
- Low trip average speed

It seems that the cost savings that can be incurred due to carpooling are an important aspect of the decision to carpool. Furthermore, a high trip distance increases carpooling propensity because a comparatively small portion of the trip is spent on pickup and drop off, increasing efficiency. Finally, a low trip average speed is another aspect, because it has the side effect of the pickup and drop off influencing the total trip time only by small amount.

Other socio-demographic, spatial and temporal factors that are traditionally mentioned as being important in several studies of carpooling behaviour are listed in the table..

| Socio-demographic | Transportation | Spatial | Temporal |
|---|---|---|---|
| Age | Transit Availability/ Quality | Urban population | Schedule flexibility per trip (usually depends on motive) |
| Sex | Car availability | Residential location (metropolitan vs nonmetropolitan) | Regularity (every weekday, every Monday) |
| Income | Travel distance/time | Employment Location (suburb, city, CBD) | |
| Household size / household car ownership | Travel speed | | |
| | Trip Cost | | |

## Present reasons for ridesharing

More recent studies (such as Morency, 2006) confirm the above mentioned factors, but notice a shift from determining behavioural factors such as income to for example car availability and household composition. In this study in the Greater Montreal Area (Canada) it revealed that ridesharing increased during the study period (1987-2003) but that this does not automatically mean more desirable end results.

The study shows that the increasing number of trips made by car passengers does not necessarily result in a reduction in the total number of kilometers traveled. While ridesharing can yield an effective matching of trips, it can result in the multiplication of trips by drivers who act as taxi drivers. This occurs frequently in household-based ridesharing, where the mother drives a car to accompany their children to school, suffering a large detour on her way to work.

It seems that the psychological factors that have influence on ridesharing have not been taken into account in traditional literature. For example, recent literature tries to handle the complexities of interactions between individuals by research into the activity systems of households. Examples are agent-based micro simulations (Roorda, 2009) in which each agent represents a decision maker which can choose a destination, mode and also combining trips with other (household) individuals. Here personal attributes such as age, gender and vehicle ownership are modelled but some other underlying factors a left out.

It is likely that especially in non-household ridesharing, which would be the focus of Pooll, the psychological elements of trust, safety and reliability are likely to be other important factors which the determine if ridesharing with another individual is undertaken.

These can be improved by the addition of information from social networks. Just like auctioning sites feature rating systems to indicate the business credibility and reliability of a vendor, a personal profile provides some indication of the trustworthiness of an individual, enhancing trust and safety.

## Present reasons for ridesharing

Data that can be found about the reasons for ridesharing is quite outdated or regionally incompatible with the situation in The Netherlands. Therefore, at the start of this report a preliminary study was performed to access the likelihood that social aspects are an influencing factor of the success of a system like Pooll. Using a carpooling website described in the next paragraph called ‘meerijden.nu’, some information was gathered about the reasons for carpooling.

The text that accompanied the offered or requested trip was investigated for terms that matched one or more of the reasons for ridesharing below. The percentage of offers and requests that contained this reason is shown in the table. It seems that cost is still the governing factor behind the reason to carpool. 80% contained some reference to some sort of a payment agreement and 30% mentioned cost as a main reason.

Another reason that was frequently given was ‘cosiness’ or other social aspects in general. While these were not mentioned in previous literature of the subject of carpooling, it seems nowadays they have become a key part of carpooling behaviour.

| Reason | |
|---|---|
| Occasional carpool | 23% |
| Payment agreement | 80% |
| Costs mentioned as main reason | 30% |
| Social aspects mentioned as reason | 24% |

## State of the art of ridesharing systems

Some research has been conducted in order to find out the status quo of other carpool systems that are available both nationally in the Netherlands and internationally. The following have been researched:

The Netherlands:

- http://ride4cents.net
- http://www.meerijden.nu
- http://www.marktplaats.nl

International

- http://www.smartcommute.ca
- http://www.mitfahrgelegenheit.de

It seems that existing ridesharing systems in Europe are similar to notice boards. Users can pin messages to announce a trip or request a pickup point and a destination. The functionality more or less ends there. The first three solutions share that they are relatively low tech solutions. They do not really try to match trips in an efficient way; they are rather like message boards and do not match or filter to generate matches efficiently.

The fact that Marktplaats.nl, which is actually a generic marketplace system offering all kinds of products and services, is even used for ridesharing ads might indicate that there currently is no successful dedicated ridesharing system in the Netherlands.

On the contrary, the Canadian smartcommute.ca and the German mitfahrgelegenheid.de, reveal what a more powerful system can look like and how it performs. These try to match trips based on criteria such as origin, destination, date and time and radius. The in Germany popular mitfahrgelegenheid.de uses radius around origin and destination as one of the criterions for a match. Smartcommute.ca is superior in the sense that is filters based on radius (in this case buffer) around the *shortest route path* of the planned trip instead of only the origin and destination. This increases the probability of a match for a trip, especially for long trips.

Concluding, even the basic version of Pooll would be advantageous to the current Dutch situation, providing a dedicated platform for ridesharing instead of the message board workarounds.

# System description

## System overview

The Pooll system can be broadly classified as a traffic information system. It uses the well known client-server model as its architecture. The clients can be all sorts of devices, ranging from mobile clients like cell phones and PDA to a desktop computer at home. The server is a major component in the architecture. It is hosts the web server, email server and database, but also connects to other servers like the text message server and the web server of the social network. The diagram depicts the system graphically, the arrows being data flow and direction.

## Versioning schedule

The schedule at which functionality is added is an important factor to ensure that the system is a success. This success is mostly dependent on two factors, first the user base and secondly creating revenue in order to continually expand the service. A versioning schedule that could accomplish this is shown below.
In short, the user base is created by providing the basic service for free. Then revenue is created by adding components which are paid for by the customer (premium services) and by creating equity (payment service with a prepaid balance).

| Version | Added component |
|---|---|
| 1 | Web client Free |
| 2 | Web client Premium |
| 3 | Add SMS integration |
| 4 | Mobile client |
| 6 | Payment service |
| 7 | Mobility management and brokerage |

## Workflow

The workflow for creating a new trip should be as easy as possible. It is depicted below. The user starts with navigating to the website by entering the URL in web browser. The first page is the landing page, where there is a short presentation about Pooll for new users that are unfamiliar with the system. Users can then continue to the login screen or to the signup screen if they haven't yet registered. After the login screen the user is sent to the main screen.

From the main screen, the user can access all the other screens. The admin screen shows information about the history of his trips and matches. This is for tax purposes which could be major reason to use the system for lease car owners to use Pooll for every trip. This helps to create the large initial user base.

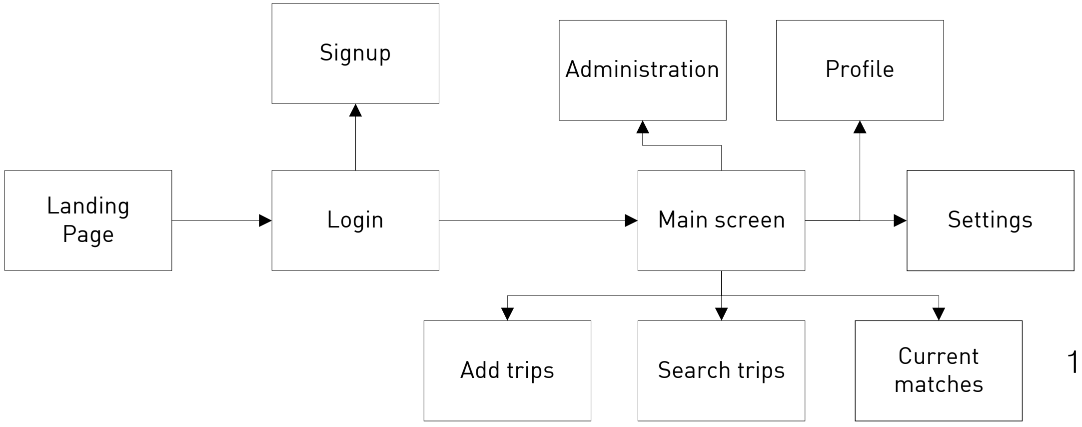
The Profile page is to update the user profile. The profile stores the basic user information that cannot be extracted from the social network. The Settings screen shows the system and user settings, like visibility and privacy options. The rest of the screens all relate directly with trips and the matching of trips. Trips can be added, edited, viewed or deleted. Also confirmed matched trips, be it one time or recurring, can be viewed, edited or deleted.

### Trips pages

For each trip a user can indicate what his role will be. Roles can be driver, passenger or left open. A role left open can be inserted only when the user is a car owner (sets in the user profile) and means that the user is open to being either driver or passenger. If a (partial) trip match is found with another user having an open role, the users can decide who will be the driver for that trip.

The origin and destination are inserted together with date and time of the trip. The user can also select a gender for filtering purposes. The allowed values are 'all genders' or 'same gender'. This ensures that it is impossible for male profile to specifically search for female profiles possible increasing (perceived) safety.

For each of these values flexibility values can also be inserted. These constraints can be the total detour for the trip in kilometres or a time range for departure or arrival time. These constraints and ranges are prefilled into the user interface based on preset values in the user profile. This ensures minimal workload to the user.



### Profile page

The user profile is used to store the personal information of a user. The profile is created during signup to the Pooll system. Only if all the mandatory information is inserted will the user be able to add trips.

It contains the name, email address, phone number, home and (multiple) work addresses of a user. The integration with the social network is also arranged here. The user can specify (multiple) social networks and his or her username. By clicking on a link, a popup is opened which enables the user to grant Pooll access to his or her profile of the social network. This is possible to a common interface that is being developed by a consortium of large social networks called *Opensocial*, which is lead by Google.

The social network usually contains other necessary basic information of the user such as age and gender which is then stored into the Pooll user profile. The information about the friends of the user is not stored on the Pooll server as this violates the terms of use of most social networks. Instead, during the actual matching process the friend network information is used. While technically, this is very inefficient it is the only possible way at the time of writing. However, this workaround ensures that in the usually continually expanding friend network of a user, the most current version is used.

If the user has not completed the Pooll profile sufficiently by granting access to the social network, the user has to manually enter additional information. After validation of this data the profile can be stored.

### Settings page

Privacy and therefore visibility is of key importance. In the settings page people can select which information is visible to other users of the system. However, by default friends of the user can see all their information. For both friends of friends (second level, indirect friends) and non-friend (third level and up) personal information can be individually selected to be available for matching purposes. However, if an invitation is sent or accepted during a trip match, all information is shown.

# Choice modelling

As a part of this research, a choice experiment was conducted. The first goal was to test a certain hypothesis, the second goal being to act as a technology demonstrator or prototype for the first version of Pooll. Therefore, a dedicated web based questionnaire was created which uses the Hyves API to gather data from the social network. The data is used in the questionnaire to personalise the questions.

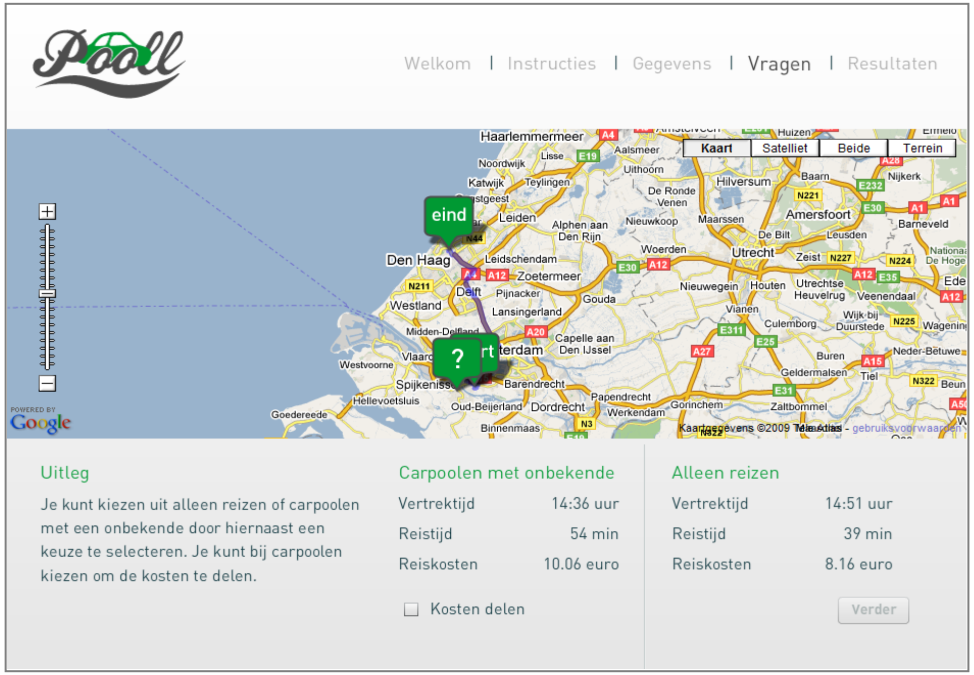
The questionnaire can be accessed at http://www.pooll.nl/poll/

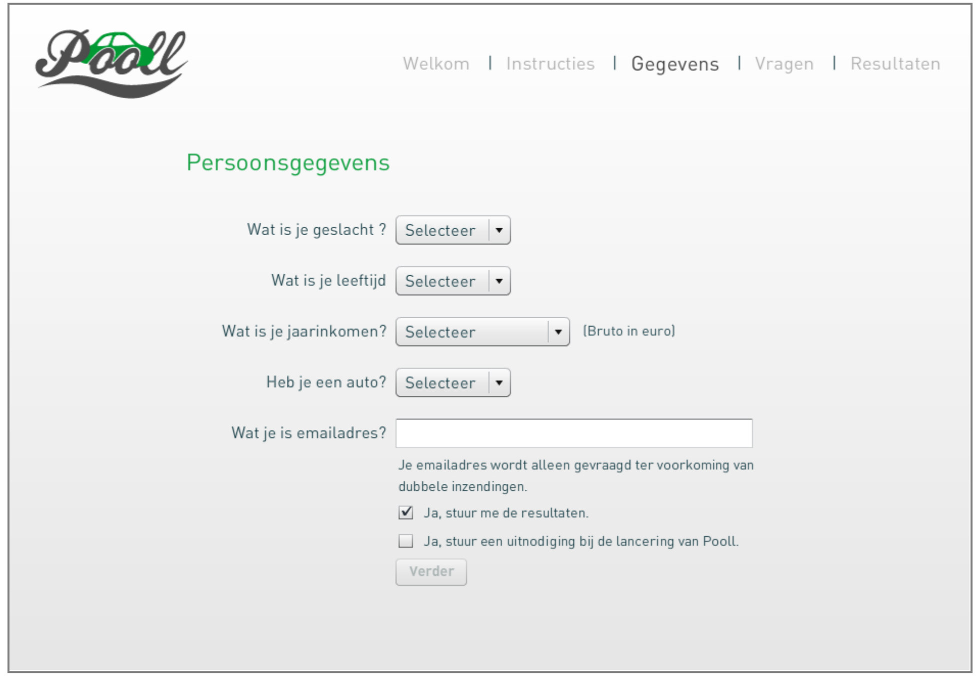
The questionnaire aims to find out the relationship between ridesharing pickup behaviour and the personal connection between the driver and the passenger that can be picked up. The hypothesis is that the pickup propensity is influenced by friend level, with a higher propensity for friends or known persons than for strangers. To find out what the relationship is, a choice experiment was conducted.

## Experiment design

The questionnaire consists of two parts. The first part is about the personal attributes of the decision maker, the second part consists of the actual choice situations. The personal attributes consist of

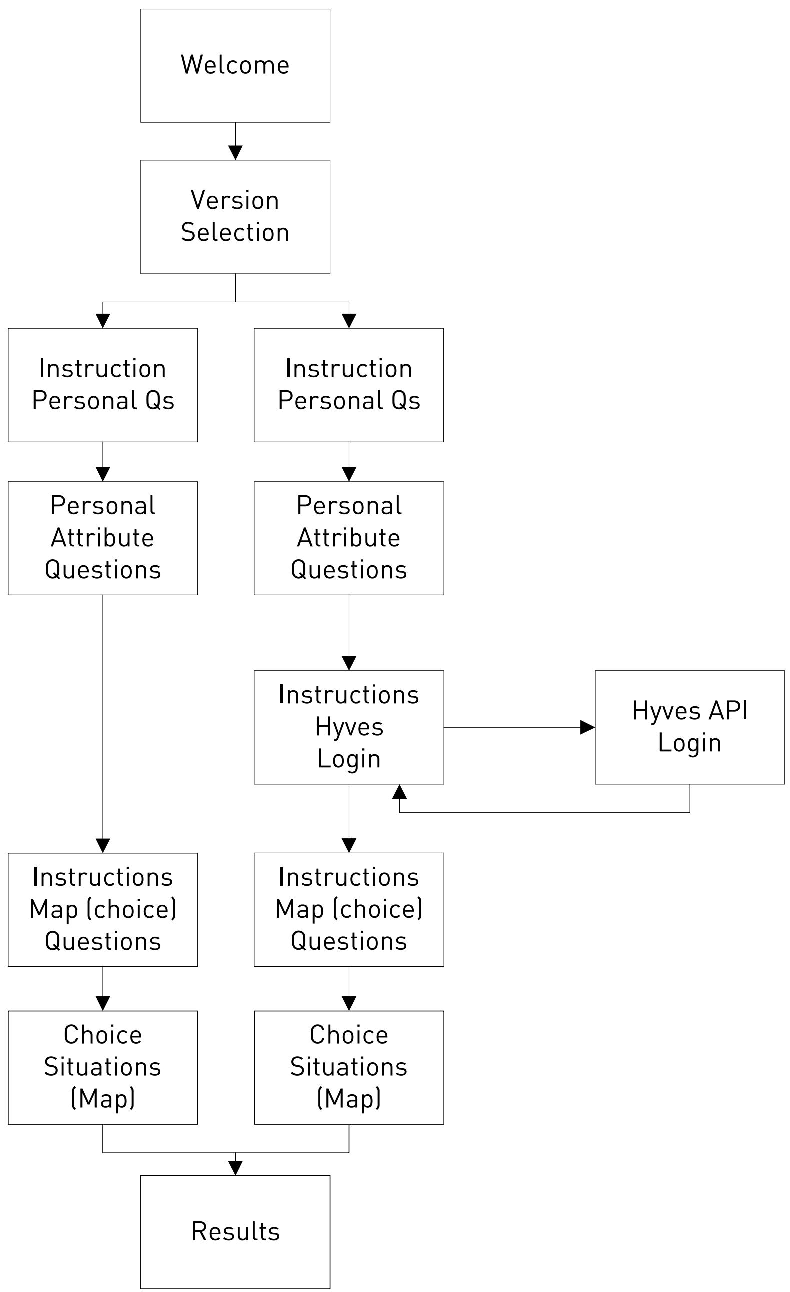

gender, income and age. In the second part the choice situations are a choice between driving alone (no ridesharing) or driving with someone else (ridesharing). These are paired questions, one question of a pair consists of picking up a friend, the other of picking up one unknown passenger. The destination for both the driver and passenger are assumed to be exactly the same.




The routes for driving alone or ridesharing are displayed on a map together with trip attributes consisting of travel time, departure time based on a preset arrival time minus travel time that is necessary for the chosen alternative and travel cost based on distance in kilometres multiplied by 20 eurocents. Because picking up a passenger will always increase travel distance and thus travel cost, a trade-off situation was created by allowing the option to split cost (50%-50%) in case of ridesharing. This option is however not mandatory as picking up a friend might lead to the decision of not splitting the travel costs.

The respondents were asked to answer 20 choice situations. These 20 questions consisted of 10 pairs of questions, each pair with identical route. The order of these routes was randomised so that respondents were unlikely to recognise the routes as being a particular pair.




## Experiment testing

After building a prototype of the questionnaire a usability test was conducted to test the interface and workflow. The results lead to changes in the instructions pages and the interface accompanying the choice situations. Furthermore, the graphical design was adjusted to create a more pleasing user experience, increasing the likelihood of joining the experiment and subsequent completion.

To act as a technology demonstrator it seemed wise to actually connect the questionnaire to the social network. In this case the Dutch social network Hyves was chosen because it has a large national user base (52% Dutch of population). However, to account for non-users of the social network a second version of the questionnaire was developed in parallel. Both versions can be filled in using the same interface. Respondents can select which version of the questionnaire they would like to participate in at the start of the questionnaire. The final questionnaire workflow is shown in the diagram.

## Questionnaire distribution

Because the questionnaire can only be completed electronically it was chosen to invite respondents by email. The personal network as well as the Hyves community was asked to fill in the questionnaire. The Hyves API account manager also provided an advertising budget of 400 Euros in order to advertise people to fill in the questionnaire. The adverts were initially targeted to persons between 10 and 70+. However it seemed that users aged 10-20 years were predominant in the page views, but did not at all join the test. At the same time persons of the personal network of the author did complete the experiment easily, only by inviting via email. Therefore the target for the ads was adjusted to 20-55 years of age. Also different ads were tried in parallel to different target groups. This resulted in a higher click-through rate but not in any significant increase in experiment completion.

## Experiment results

In total 58 respondents successfully completed the questionnaire. Of these respondents it seems that only a small fraction (10%) has filled out the questionnaire due to advertising on Hyves.
In order to test the hypothesis of the pickup propensity increasing when a friend rather than a stranger has to be picked for share ride, the detour factor was picked as a suitable measure. The detour factor is defined as

$$\mathrm{df} = \frac{tt_{\ chosen\ \ route}}{tt_{\ shortest\ \ \ route}}$$

*With df* being a ratio called the detour factor, the numerator being the travel time for the chosen route between origin and destination (possibly via the pickup location of passenger) and finally the denominator being the shortest route path between origin and destination.
In the questionnaire the distances were automatically calculated by the Google Maps API based on the provided waypoints.

The lower bound of *df* is 1 meaning that the chosen route is the shortest route possible in term of travel time, which of course occurs when the respondent drives alone or when the pickup location is *exactly* on the route (starting and stopping is not taken into account). The highest value of *df* in the questionnaire was 3.6, the lowest value 1.26. The two question pairs were observed individually, the first group being the ridesharing with friends and the second one ridesharing with strangers.

For all respondents, the detour factors based on their selection were averaged. The percentile increase is the time multiplier which an average respondent states he or she is willing to have in order to pickup either a friend or a stranger. As seems likely, drivers want to ‘go the extra mile’ for picking up a friend. The difference between a friend and a stranger in terms of time is about 17%.

| | Friend | Stranger | Difference |
|---|---|---|---|
| Average detour factor (time) | 23% | 6% | 17% |

Some data was also gathered about the respondents’ gender and subsequent pickup behaviour. Analysis confirms another assumption, namely that males are more likely to engage in ridesharing with unknown passengers.

| | Friend | Stranger |
|---|---|---|
| Male | 21% | 8% |
| Female | 23% | 2% |

Another observation could be that females are more likely to engage in ridesharing with friends than males, the difference is however not significant given the low total number of respondents and gender split (n=58 of which 34 male and 24 female).

Concluding, an average detour of 25% in terms of time for picking up a friend seems acceptable. This information can be used in the filter algorithm of Pooll, which will broaden the constraints of a trip match, provided the matched users are friends of each other.

The detour is purposely expressed as time, because passenger pickup in clogged urban traffic may require a detour in distance in terms of a few percent, but an increase in time of a multitude. Therefore, travel time is selected for this measure to account for this variability.

In order to create utility functions of both alternatives based on the gathered data, the software package BIOGEME (Bierlaire, 2007) was used. However, the first runs of the BIOGEME package revealed some problems with the used utility function which included all personal attributes. The optimization algorithm did not converge and could therefore not generate usable attribute coefficients for the utility function.

Consulting the BIOGEME internet users group revealed some ways to counter this problem. The most frequent reason for the problem was that the utility function is just too complicated and the package cannot generate the coefficients. The solution is to simplify the utility function, i.e. decrease the number of choice attributes.

In the next BIOGEME runs, the attributes were removed one by one. This way the algorithm used by BIOGEME was able to converge to a result and to provide the attribute coefficients of the alternatives. The utility function and parameters are shown in the appendix

The devised utility function shows that on average (friends and strangers combined) ridesharing is likely to occur more with increasing age and that income is of relative little importance. However, a further analysis by plotting both age group and income versus detour factors reveals the following when plotted as linear trend line of a scatter plot.

# CONVERGE assessment

The assessment and validation is a key step in the development and implementation process. The means focus of this step is deciding whether and how the Pooll service should be technically implemented and the verifying that the application performs as expected based on the results.

## Application description

| Application | Technologies | Function/service | Verification |
|---|---|---|---|
| Web based client | Software module | Interface for controlling user account, add, editing, deleting matches and general communication between users. | Functional testing, unit testing and compatibility testing (cross browser) Regression testing per iteration |
| Mobile software client | Software module<br>Wireless connection<br>Localisation (GPS) | Identical, plus added wireless connection and localisation by GPS. Plotting map GIS data of users and trips | Functional testing, unit testing and compatibility testing (cross platform, Windows Mobile, Symbian and Apple Iphone) Regression testing per iteration |
| Trip matching module | Software module<br>Optimisation algorithms | On the fly trip matching, filtering, scheduling, optimising carpools | Load testing (performance + stress) Integration testing |
| Database module | Database manager (DBMS)<br>Database servers | Storing, retrieving data used for the trip matching modules and the user profile system | Load testing (performance + stress) Integration testing |
| User communication module | Email servers<br>SMS servers | Communication between different users, system to cellphone | Conformance testing(SMS) Integration testing |
| Social network API module | Software web service module | Connection to the API of the social network. | Conformance testing(API connection) Integration testing |
| Payment | E-payment service provider<br>Financial management | Transactions of trips, keeping user balances, transactions to bank accounts | Conformance testing(E-payment) Integration testing |

# Assessment objectives, assessment category and user groups

| Assessment category | Assessment Objective | User groups involved in validation |
|---|---|---|
| Technical Assessment | • Very high uptime<br>• High availability<br>• Low latency<br>• High redundancy<br>• Fast trip matching algorithm | System operator, Software developers |
| Impact assessment | • Increased vehicle occupancy<br>• Decreased traffic intensities<br>• Increased demand for pickup/dropoff stations<br>• Decreased user travel flexibility<br>• Increased driver distraction | System operator, Users |
| User acceptance assessment | • Providing high ease of use<br>• Providing efficient and reliable communication systems for invitation and matching | System operator, Users, Software developers |
| Financial assessment | • Providing highly secure payment system<br>• Providing real-time transactions<br>• Providing highly redundant setup | System operator, E-payment provider |

## Decision makers, user groups involved and assessment objectives (two descision makers)

| Application | Decision Maker | Assessment Objectives |
|---|---|---|
| Web based client | End user | • Increasing vehicle occupancy<br>• Decrease cost per travelled unit of distance<br>• Improving safety of ridesharing<br>• Improving reliability of ridesharing<br>• Increasing flexibility of ridesharing<br>• Increase mobility options |
| Trip matching module | System operator (Pooll) | • High performance of the matching algorithms<br>• Achieve  high quality of information to Pooll users<br>• Providing a high probability of trip match |

## Expected impacts

| Impacts expected | Target groups | System | Impact* |
|---|---|---|---|
| Increased vehicle occupancy | Driver, vehicle manufacturer | Mobile client software | ++ |
| Increased demand for pickup/dropoff stations | Road operator | • Trip matching software module<br>• Optimisation | +/- |
| Increased driver workload | Driver | • Mobile client software | - |

(* ++ very positive; + positive; 0 neutral/uncertain; - negative; -- very negative)

## Assessment method

| Impact | Increased vehicle occupancy |
|---|---|
| Assessment method | Equip and monitor a test group of users |
| Indicator(s) | Matched trips, vehicle occupancy |
| Reference case | Before and after |
| Data collection | Through application |
| Conditions of measurement | Homogeneous group |
| Statistical considerations | Large sample size (1000+) in order to have some probability of matched trips |
| Measurement plan | Usage data is sent to server then analysed |

# Conclusion

This investigation into combining social networks into a ridesharing system seems quite promising. This paper provides a description, high-level design and high-level implementation schedule for the development of such a social network-attached ridesharing system.
Choice modelling evolved into a questionnaire which has the basic client-side technical properties of the proposed client (version 1) of the software.

The choice modelling revealed that drivers are willing to encounter about 17% extra travel time as a detour to pick up a friend rather than to pick up an unknown person. The addition of a social network might therefore be a key part of a new ridesharing system. Furthermore, this addition will increase (at least perceived), safety, thrust and reliability.

Research into user needs for users of a ridesharing system needs to be conducted. Moreover, extra research should be conducted to gain insight into the psychological factors that increase trust and perceived safety.

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# Appendix

## Utility function and parameters

Driving alone

0 -0.00565*ageGroup -0.001*incomeGroup -0.0289*aloneTravelTime -0.183*aloneTravelCost

Ridesharing

1.05 + 0.00565*ageGroup -0.001*incomeGroup -0.0819*carpoolTravelTime + 0.00878*carpoolTravelCost