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User reaction to car-share and lift-share within a transport 'marketplace'

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User reaction to car-share and lift-share within a transport ‘marketplace’

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Abstract

User-centred design methods were used to understand the key motivators, potential constraints and design requirements associated with an innovative shared-vehicle scheme, offered as an integral component of a wider ‘transport marketplace’. A set of situated user trials were used to assess attitudinal and behavioural responses to a prototype service implemented in northern France. Potential motivators included the perceived benefits of reduced cost, environmental benefit, social contact and the provision of location-based information. The key barriers to adoption included: personal security during vehicle sharing, liability and flexibility in meeting individual transport needs. Contrary to initial indications by participants, ease of use was also a key acceptance criterion. The resulting design recommendations stress the need for maximising service flexibility, addressing perceived barriers and providing clarity regarding operational procedures and protocols.

Keywords

Car share; Lift share; User requirements; Location-aware computing

1 Introduction

1.1 Background

The motor vehicle provides undoubted benefits for users, including mobility, freedom and convenience. However Katzev [1] states that: ‘the private automobile, despite its numerous benefits, is largely responsible for many of the most serious environmental and social problems in the United States today’. These problems include:

- The impacts caused by ‘the haves’, particularly the economic and environmental impact of increased congestion and exhaust emissions.
- The social impact on the ‘have nots’.

The environmental impacts of increased car journeys have been well documented in the popular and scientific press. Car journeys can be an inefficient use of resources: in the UK, 60% of cars on the road have only one occupant; when business use and commuting is analysed, the proportion of single occupancy rises to 86% [2]. The motor car can also impact on the social cohesion within society. According to the UK Department for Transport, there are ‘clear connections between [lack of] transport and social exclusion’[3]. In the UK, typical of the developed countries, over half of the households in the lowest income quintile do not have access to a car [4]. In rural areas in particular, public transport may not be a viable alternative to owning or using a private vehicle.

1.2 Car-sharing and ride-sharing as alternatives to private vehicle use

Shared-use vehicle systems provide a potential solution to both (1) increasing access to transport where there are few alternatives to the private vehicle (e.g. rural environments with little public transport) and (2) increasing the level of vehicle occupancy by

promoting shared journeys [1, 5]. The popularity of shared-use vehicle systems has grown exponentially over the past decade from under 50,000 members in 1996 to nearly 350,000 in 2006 (more than 60% are in Europe), operating in 600 cities worldwide [6]. Shared-use vehicle systems consist of a fleet of vehicles that can be used by several different individuals throughout the day, i.e. differentiating between vehicle access and ownership [1]. They are variously termed ‘car’-share’, ‘car-pool’ or ‘car club’, with some specific ones based around transit hubs being termed ‘station cars’.

In comparison to private vehicle use, individual benefits of car-share are reduced transport costs; economic and environmental benefits are reduced vehicle kilometres, increased average speeds, and savings in fuel, accidents and emissions [7]. By requiring *conscious* decisions regarding transport, they may paradoxically also encourage greater use of public transport [1].

Car clubs can potentially benefit multiple groups, and in particular:

- Local residents who do not have access to a car
- Local car users who are trying to reduce their motoring costs
- Non-locals (eg tourists) travelling without their private vehicle who are looking for alternatives to public transport, car hire or taxis

Most car-share schemes are targeted at urban users and/or regular commuters. There are few reports on schemes (1) based in rural areas (where other transport options are more limited), and (2) used by tourists (who have specific needs which may or may not be satisfied by car-share).

A useful classification framework for shared-use vehicles was developed by Barth & Shaheen [8] and is shown in Figure 1. The car-share system investigated in this study fell into the category: distributed nodes without transit > inter-nodal travel allowed >

resort/park setting (although this last level of classification defines a more restrictive area of use than the one in this study which was the ‘Somme Bay area’). However, this classification does not differentiate between car-share for single users and car-share which also incorporates ride-share (also termed lift-share or journey-share), i.e. where multiple users can variously use the vehicles as drivers or passengers. The system in this study enabled use of a ‘car-share’ service combined with the additional ‘lift-share’ provision.

< insert figure 1 here >

Figure 1. Shared-use vehicle classification, based on Barth & Shaheen [8]

1.3 A role for new technology

New IT, including vehicle telematics can enable car-sharing to operate more effectively and efficiently. Most car-share systems are evolving from manual through partially automated (touch-tone/internet booking) to fully automated (touch-tone/internet booking plus integrated billing and advanced vehicle access technologies) [6]. Large European, North American and Australian systems have, in the majority, moved to full automation with the Asian market being fully automated from launch. This includes using telematics to communicate between vehicles and shared-vehicle management systems, GPS vehicle tracking, vehicle access through smart cards, mobile phone vehicle entry and reservations through SMS.

In addition, there are two additional roles that new technology can play. It can enable a focus on *transport solutions* rather than *vehicle use*, by offering a range of transport solutions, including integration between modes of transport and a brokering between those who need and those who can provide transport. It can also provide access to

personal, value-adding [9] services that either (1) are integrated within journeys, or (2) treat those journeys as a ‘means to an end’ within a mobile lifestyle.

1.4 Aims and objectives

Research on car-sharing has typically concentrated on provision of such services for residential neighbourhoods, organisations, commuters and college campuses. Studies on car-share for tourists, and particularly locations outside of urban areas, could not be uncovered, making this study somewhat unique. Although the tourist community (particularly those not using a private vehicle between home and destination) offers a potential market for such services, few are offered. One study in Germany [10] found that from a sample of 65 car share organisations only four named tourists as a potential group and none tailored their offerings to this group. Shaheen and Cohen’s international survey [6] also identified that ‘neighbourhood residential’ was the predominant car-sharing market in the majority of countries, followed by ‘business’. Exceptions were Austria, Japan and Sweden with business as their largest market.

The aim of this study was to develop a user-centred understanding of the requirements for a car-sharing and lift-sharing scheme as described above. In contrast to more established schemes, the study focused on use within a semi-rural area, by users, including tourists, who were not native language speakers.

The specific objectives of the study reported here were to identify key stakeholder issues and potential barriers/enablers to use, determine user requirements for booking and using such a service as part of a larger transport ‘marketplace’, test a prototype implementation of a service, and generate design recommendations.

2 Car and lift share within a ‘transport marketplace’

Underlying the operation of the shared vehicle scheme described in this article is the concept of a ‘transport marketplace’, enabled by an integration of web and wireless technology. This marketplace acts as a broker between those who *need* transport and those who can *provide* transport. Those *providing* transport can be commercial transport operators (e.g. public transport, taxi companies) or other individuals travelling by car who wish to share journeys. The marketplace, accessed via a single point of contact, makes available a range of transport solutions with varying modes of travel and cost and flexibility. Individuals or groups who need transport can specify their requirements and be matched to potential providers.

This study focuses on the use of a shared fleet of vehicles which are one of the offerings within the ‘marketplace’. They are made available to individuals at designated unmanned ‘stations’ and booked via the marketplace on a journey-by-journey basis. For legal and operational reasons, individuals must register as a member of a ‘Club’ and are provided with a personal transport pass (based on a type of smartcard) to enable use of the services without the need for interaction with an operator.

The car share scheme incorporates location tracking using GPS, and vehicle GPRS data links during car journeys, data transfer to and from the vehicle over WiFi networks at vehicle stations, keyless entry using the smart card transport pass, and a PIN to start the vehicle. At the booking stage, the customer can state preferences such as whether they prefer to be a driver or a passenger. As well as enabling the security features, the data links also enable personalised information to be sent to the vehicle, e.g. the personal greeting displayed within the vehicle (Figure 2). In addition, the vehicles enable additional passengers to be logged in/out as they join/leave the vehicle, see Figure 3.

This enables car sharing (for all or part of journeys) which minimises the costs per individual per mile. Costs were charged per person, per journey, and based on approximately 40p/mile.

< insert figure 2 here >

Figure 2. The system offered personalized greetings

< insert figure 3 here >

Figure 3. Passengers could be booked in and out

3 Method

3.1 Research perspective and overview

This research study was guided by four main theoretical user perspectives:

1. Innovations must demonstrate key user-centric characteristics, including compatibility with an individuals values, and relative advantage over alternatives [11].
2. That perceived usefulness and ease of use of technology leads to generation of attitudes and subsequent behavioural intentions [12].
3. That situated context [13] has a major influence on a user's behaviour, and that contextual enquiry [14] can help define systems.
4. User centred design, including prototype evaluation [15, 16] is necessary for effective design.

This research study comprised two main phases:

Phase (1) – User Requirements

This involved a series of interviews and discussions with service providers, plus interviews and card sorts with potential end-users. This led to the identification of basic user requirements for the service, including key perceived benefits and potential barriers for target users.

Phase (2) – User Trials

This comprised a set of situated user trials in France of a prototype shared fleet scheme in order to validate the user requirements and potential barriers identified in (1) above, and determine the usability of an operational system. These trials included registering for the service, making requests for journeys, receiving confirmation and booking of journeys and then using a vehicle within the shared fleet to make those journeys.

3.2 Participants

Phase (1) – User Requirements - involved analysis of stakeholders from service delivery (automotive, technical, legal, transport) and end-user (i.e. driver or passenger) perspectives. Eleven participants were selected from a larger sample according to two basic criteria: (1) those that would be *potential* users of a car sharing service (e.g. excluding those who stated they would *always* want to travel abroad with their own vehicle); and (2) selection of a heterogeneous group based on a range of factors that would influence the value that this service would potentially provide to that individual. These factors included the types of foreign travel people typically undertake, their preferred modes of transport, the degree of planning associated with travel, presence of travelling companions, foreign language abilities, and confidence when driving (abroad and in the UK).

Phase (2) – User Trials - was undertaken with 10 UK nationals. These were recruited from the UK based on identifying three distinct groups of the UK population who would be potential users of a car share service in the Somme Bay area of France. An attempt was made to stratify the user trial sample accordingly: six UK nationals travelling as tourists from the UK; two UK nationals on business in the Somme Bay area; two UK nationals permanently resident in France.

3.3 Test area

The test area for the service was the Somme Bay, within the Somme area of Northern France. The Somme region is semi-rural, with a population density of 90/km² over a land area of 6170km². The Somme Bay area (shown in Figure 4) is poorly served by public transport, and comprises approximately 80,000 inhabitants, of whom it is estimated that 10% have no means of personal transport. This proportion rises to 30% of those of retirement age. As well as a local need for additional transport, this region of France is also popular with UK tourists. Without a private vehicle, there are relatively few transport options within this region.

< insert figure 4 here >

Figure 4. The User Trial test area

3.4 Procedure

3.4.1 *Phase (1) – User Requirements*

Phase (1) was undertaken in the UK, as described in Section 3.1. This included a simple card sort exercise with participants to categorise and prioritise their main concerns with a car share scheme.

3.4.2 Phase (2) – User Trials

Following Phase (1), a series of user trials were undertaken. These trials were designed according to the process a potential user would undertake to become a member of the Club, make multiple transport requests, book vehicles for journeys, and then actually undertake those journeys using one of a fleet of telematics-equipped vehicles. These user trials comprised three main elements:

(1) Initial awareness and registration for the service

A phone-based registration process was undertaken with participants to collect the personal information necessary for them to become members of the Club. They were then supplied with a username and password to enable them to undertake vehicle bookings, and a personalised smartcard travel pass.

(2) Reservation of journeys

Journey reservations using the service website were completed by participants a few days after the registration process had been carried out. The participants travelling from the UK completed these reservations in the UK, at least 24 hours in advance of their intended journey using the transport marketplace website. The participants permanently resident in France and the business users already in France completed their journey bookings at the local French mobility centre, either immediately prior to, or within two hours of, their intended journey, using the same website. This mimics the anticipated modes of use of the service by the three categories of UK user as outlined above. All participants were provided with specific addresses to use during the reservation phase due to the need to start and finish journeys at WIFI-enabled locations, and made at least two journey reservations. The majority of these trips comprised return trips between the French towns of Abbeville and St-Valery shown in Figure 4. Each leg of these journeys

was approximately 20km long, comprised urban and semi-rural driving environments, and took about 25 minutes to drive.

(3) Completing journeys

Having completed their reservations, participants undertook their journeys as booked. A total of 23 journeys were undertaken by participants; during each journey the participant was accompanied by an experimenter and completed the following tasks:

- Use the transport pass to gain contactless entry to a vehicle (entry was automatically enabled according to the journey reservation that had been completed).
- Complete a check-in procedure using an in-vehicle HMI (see Figure 5). This process was similar to the paper-based vehicle damage and status check normally carried out when hiring a car.
- Use the supplied PIN to start the vehicle, and then drive to the destination.
- During the journey, use the emergency call function which put them in contact with the mobility centre (for safety reasons, participants stopped the vehicle before using this feature).
- On arrival at their destination (a drop-off location), complete the vehicle checkout procedure, exit, and lock the car using the transport pass.

< insert figure 5 here >

Figure 5. In-vehicle HMI for recording damage

Participants were prompted by the experimenter where necessary; this was kept to a minimum to help identify key conceptual and usability barriers for first-time users.

3.5 Data capture methods during the User Trials

Questionnaires and experimenter observation were used throughout the trial.

Questionnaires captured overall attitudes at different stages of use (i.e. after initial explanation of the concept, after registration, after reservations had been made, and after journeys had been completed). These were adapted from technology acceptance literature, e.g [12], and comprised positively and negatively-phrased statements, based on 6-point agree-disagree scales relating to affective response, ease of use, relative advantage and behavioural intention constructs.

In addition, usability questionnaires were used after the reservations stage, and during and after each journey stage to determine the usability of the technology within the trial (i.e the web-based reservations system, the procedures for vehicle entry, check in, vehicle start, emergency call and vehicle check out). These also comprised positively and negatively-phrased statements, with 6-point agree-disagree scales based on [17] and the usability criteria described in [18]. A final questionnaire assessed overall reaction to the service (design and concept), perceived barriers and enablers, and expectations regarding quality of service. Experimenter observation was used throughout. The use of data capture methods throughout the user trials is summarised below.

Table 1. Data capture methods employed at stages in the study

Stage	Constructs being measured	Data capture
<i>Phase (1) – User Requirements</i>		
Independent of the User Trial	User requirements, barriers and enablers for stakeholders	Structured interviews and card sorts
<i>Phase (2) – User Trials</i>		
At trial onset	Initial user attitudes to the service concept	Attitude-based questionnaire
After completing the registration phase	User attitudes post registration	Attitude-based questionnaire
After completing the	Attitudes post journey	Attitude-based questionnaire

journey reservations	reservation Usability assessment of web-based reservation Conceptual understanding of reservations phase	Usability questionnaire Experimenter observation and/or enquiry
After each journey-related task	Ease of completion of vehicle entry, check in, starting car, emergency call, vehicle check out	Usability questionnaire
After completing each journey	Overall usability of the in-vehicle HMI	Usability questionnaire
After completing final journey	Final attitudes to the service (concept and design) Barriers and enablers Quality of service expectations	Attitude-based questionnaire Usability questionnaire

4 Results and discussion

4.1 Phase (1) – User Requirements

A set of outline requirements were established in Phase (1) based on the stakeholder discussions and initial interviews with participants, highlighting the need for a safe, flexible, convenient and relatively cost effective service. These are discussed in more detail (in the light of results from the trials) in Section 5. The end-users identified a number of perceived benefits of such a service: reduced cost - compared with public transport, taxi or car hire; environmental benefits of sharing; navigation assistance – either by using a local driver or an in-vehicle system; parking – having an allocated parking space; the potential integration of tourist information; social benefits of sharing with other like-minded individuals; freedom of responsibility from vehicle maintenance. Participants in Phase 1 raised a number of issues with the use of shared fleets within a wider transport marketplace. A frequency count differentiating between ‘minor concerns’, issues they ‘would need convincing about’, and ‘major concerns’ is shown in Figure 6.

< insert figure 6 here >

Figure 6. Impact of potential barriers to adoption

Figure 6 shows a wide range of potential concerns with using such a service. It is interesting that the potential *ease of use* of the service was the factor that was perceived as being of the least potential concern, reflecting the increasing *expectations* of consumers that systems are easy to use, e.g. Jordan [19]. There were some major concerns that approximately 50% or more of the participants felt would not be resolved satisfactorily by a service. These were mostly related to having potential strangers in the vehicle with them and particularly: feeling responsible for them; being safe, and ensuring personal privacy. Consistent with these findings are those of [20], who found that many existing carpooling websites did not tackle the issue of trust, which they identified as the most important issue for sharing rides.

In relation to the main factors that influence the adoption of innovations [11], *relative advantage* (i.e. the benefits of car-sharing) is acting as a potential enabler, ease of use (termed *complexity*) is perceived as relatively unimportant, and potential *risk* acts as a key barrier. In general, participants felt they would ‘need convincing’ that quality of service issues would be resolved, but had more fundamental concerns with risk factors. The concept of membership of an association (embodying promotion of shared values within a culture of use) can potentially address many of the security and trust issues that are potential barriers. Morse et al. [20] in testing a prototype carpool system, found two of the most appealing features of the system to be the ‘carpool pledge’ and the ‘carpool culture’. The ‘pledge’ is a series of statements with which each member must agree and

includes issues such as notification/cancellation rules, ‘clean car’ promises and how long a driver is expected to wait for a passenger. The ‘culture’ is where the member can describe desired carpool features such as type of music, quiet/talkative and off-limit topics.

4.2 Phase (2) – User Trials

4.2.1 Phone-based member registration

Table 2 presents the participant usability ratings after having completed the initial member registration stage. Responses are based on agreement or disagreement with statements, phrased both positively and negatively to minimise response bias. Values are based on scale responses where 1 represents ‘disagree strongly’ and 6 represents ‘agree strongly’.

Table 2. Participant usability ratings at the member registration stage

<i>Positively-phrased statements</i>	<i>Mean (std. dev.)</i>	<i>Negatively-phrased statements</i>	<i>Mean (std. dev.)</i>
I was happy to provide all these details	5.2 (0.7)	I didn’t like some of the questions	1.9 (0.6)
The registration process was quick and easy	4.9 (0.6)	The registration process was too long and laborious	1.9 (0.3)

There were no major concerns at the registration phase: participants were happy to provide the personal and financial details needed, and found the phone-based process quick and easy to complete. In addition, the consistency between the positively and negatively-phrased questions provides some validation of the responses.

4.2.2 Web-based journey reservations

Table 3 presents the participant usability ratings after having completed the web-based reservation of journeys. Ratings are derived as described above.

Table 3. Participant usability ratings at the journey reservation stage

<i>Positively-phrased statements</i>	<i>Mean (std. dev.)</i>	<i>Negatively-phrased statements</i>	<i>Mean (std. dev.)</i>
Making a booking in this way is convenient for me	4.8 (1.0)	I found it inconvenient making a booking in this way	2.6 (1.3)
I am confident that a car will be available as I have requested	3.4 (1.0)	I am not sure that the car will actually be there when I go to collect it	4.2 (1.1)
I am confident that I have put in my booking requirements as I needed to	4.7 (0.8)	I think I may have put in the details incorrectly	2.5 (1.5)
It would be easy to use it if I had to do it again	4.7 (0.8)	I would find it hard to use the website by myself next time	3.2 (1.1)
I knew what to do next when I was using it	4.1 (0.7)	I often got stuck with moving onto the next page	2.7 (1.3)
It was quite fun using the website	3.5 (1.0)	It was a bit of a chore using the website	3.2 (1.3)
I understood the terms used on the website	3.2 (1.0)	The words and phrases used were difficult to understand	3.9 (1.2)
I knew what was happening at each stage	3.7 (1.1)	I sometimes did not know what the system was doing	4.3(0.9)
I was able to make my reservation as I needed	4.6 (0.8)	I could not book my journey as intended	2.6 (1.4)
The web site was easy to use	3.4 (1.1)	I found some parts of the web site quite difficult to use	3.0 (1.2)

The web-based reservations process was seen as a highly convenient method of booking solutions to journeys. However there was a lack of understanding of the concept of a ‘transport marketplace’ i.e. where a customer states a set of journey requirements, offers are made by transport providers to the consumer, which then have to be accepted by that consumer before they become firm bookings. Parts of this process could be synchronous, or asynchronous, which was initially difficult for participants to grasp. There were also a number of usability issues with the design of the service. These arose for two main reasons: the differing conventions employed by French and UK nationals (e.g. address formats) and the lack of local knowledge of most of the UK participants (and hence being uncertain of geographical locations).

4.2.3 Use of telematics features during the journey

Table 4 presents the ease of use ratings of the telematics features used during each journey. A minimal number of only positively-phrased statements was used in order to minimise interference with the journey process. Where functions were used more than once, the rating refers to first-time use, to reflect a novice user. Ratings are derived as described above.

Table 4. Participant usability ratings for telematics features

<i>Statements(all positively phrased)</i>	<i>Mean (std. dev.)</i>
It was easy to carry out the car check out procedure	3.6 (1.2)
It was easy to use the emergency call procedure	3.8 (1.5)
The radio presets [customisation] were easy to use	5.5 (0.7)
It was easy to use the PIN to start the car	5.6 (0.5)
It was easy to carry out the car check-in procedure	4.2 (0.8)
The smart card was easy to use	4.8 (1.3)

4.2.4 Overall usability assessments

Table 5 presents the participant usability ratings for the overall vehicle telematics system, having completed all journeys. Ratings are derived as described above.

Table 5. Overall usability assessments after completing journeys

<i>Positively-phrased statements</i>	<i>Mean (std. dev.)</i>	<i>Negatively-phrased statements</i>	<i>Mean (std. dev.)</i>
The in-car system was easy to use	4.1 (0.8)	I found some parts of the in-car system quite difficult to use	4.1 (1.1)
The in-car system helped me during my journey	2.7 (1.0)	The in-car system was not very useful	3.0 (1.2)
I knew what was happening at each stage	3.8 (1.1)	I sometimes did not know what the system was doing	3.4 (1.1)
I understood the terms used on the in-car system	2.7 (1.3)	The words and phrases used were difficult to understand	4.6 (1.4)
It was quite fun using the system	4.3 (1.1)	Using the system was a bit of a chore	3.0 (0.9)
I knew what to do next when I was using it	3.2 (1.0)	I often got stuck with moving onto the next stage	3.3 (1.0)
It would be easy to use the in-car system next time	4.9 (0.6)	I would find it hard to use the in-car system by myself next time	2.2 (1.0)
I am confident that I have done all the things necessary	4.4 (0.9)	I don't think I have used it properly	2.6 (0.7)

In order to actually complete journeys, participants had to undertake the stages outlined in Section 5.2. For first time use only, there were some procedural difficulties - relating to lack of procedural knowledge [21] - when undertaking the vehicle check-in phase, and starting the vehicle without use of an ignition key. Several additional issues became apparent, e.g. whether drivers would accurately report any damage caused (presuming they would be held financially liable for it), the high value associated with having an emergency call function, and concerns over not being able to re-enter vehicles once they had 'checked out' (e.g. if they had inadvertently left any luggage in the vehicle, or had parked it in the wrong place). Several procedures were novel, in particular the vehicle check-in and check-out processes used an in-vehicle touchscreen, where vehicle damage could be reported. Participants attempted to map these onto familiar processes. Most minor usability issues related to poor design and positioning of displays/controls, lack of feedback and lack of contextual help. The general ease of use is summed up by one participant who said 'it is easy when you know how'. Another typical comment was: '[it is] quite easy, but I'm not sure if I am doing the right thing at the right time' – again underlying the need to support procedures, especially for first time users.

In a U.S study [22], the second phase of the pilot used the following technology: vehicle access using smart key, an internet-based reservation systems, vehicle status/tracking (location, distance travelled, fuel level, user ID, time), navigation. As in this study, the majority of users were satisfied with the technology provided. In the U.S study [22] some recommendations were made which could be of generic value, including: faster and more easily accessible smart key reader; incentives for refuelling; vehicle lockout for reserved vehicles (to guarantee availability); minimise the steps needed for reservation; a means to directly inform the reservation system on over-runs; fines for

not cancelling in advance; non-used, reserved vehicles converted to ‘available’ after a waiting period (10-15 minutes).

4.2.5 *Participant attitudes*

At three stages during the evaluation process (before registration, after journey reservation, after journey completion) participants completed a similar, short questionnaire to determine attitudes and intentions as they used the scheme.

< insert figure 7 here >

Figure 7. Changes in participants attitudes during use

This attitudinal data indicated that at each stage of usage, participants were generally positive towards the service, felt the service would be useful to them, and would be motivated to use it. A Friedman non-parametric test for related samples indicated no significant changes in attitudes due to increased service engagement. The findings in Figure 7 and those from Phase (1) shown in Figure 6 suggest the potential for wider adoption by the user group within the study. However there were also concerns about the service – also consistent with the findings from Phase (1).

In an empirical study of car-sharing in the Netherlands [23], it was found that adoption was influenced by the following factors: a clear perception of costs (absolute and relative to transport alternatives, especially ‘own car’); easy and cheap (or free) parking; lack of vehicle maintenance responsibilities; accessible and convenient vehicle locations 24/7; a perception of high quality; and integration with public transport modes. Results of an international survey of 33 car-sharing experts concurred with many of these

factors, identifying the most common motivations for car-sharing as cost savings, convenient locations and guaranteed parking [6].

A car-share study for commuters in the U.S. between 1998 and 2002 [22] identified key features for success including: streamlined technology (including smartcards), guaranteed parking and vehicle cleanliness. The study also proposed a common attitudinal profile of car-share users: dissatisfied with levels of congestion; environmentally motivated; comfortable with public transport (especially those with lower vehicle ownership, lower incomes and younger ages); open to experimentation. This user profile was not developed within the study reported here.

5 Design recommendations

The main output from this research was a set of design recommendations for the potential implementation of a car share system that is part of a transport ‘marketplace’. These are also applicable to more conventional car share schemes, and are summarised below.

5.1 Promotion and customer registration

Since the service is a novel one that tourists or non-residents may not have had previous experience with, it is essential that the benefits are promoted to potential users. In particular, the value-add needs to be highlighted – the ‘what does it do for me?’ factor, including:

- New mobility options where there were previously none.
- Access to car travel without private car use.
- The reduced costs compared with car hire or taxi.

- The lack of wear and tear associated with using their own vehicle, including typical overall costs per mile.
- The freedom from responsibility for vehicle maintenance and repair.
- The contribution to environmental responsibility.
- The potential for a social element, by linking up with other like-minded travellers or local inhabitants.
- Additional benefits (offered by location-awareness and wireless connectivity) such as navigation assistance, integrated points of interest information and not needing to find parking spaces or pay for parking.

The other main role that information plays at the initial stages of involvement is to overcome potential concerns that future users may have. Particular emphasis needs to be placed on safety and legal concerns, including the vetting of Club members, and the liability for vehicle damage and personal injury.

5.2 Booking transport solutions

One of the most novel aspects of the service is the concept of a transport marketplace, which brokers transport providers and transport customers. There are distinct phases in this transaction between a provider and a customer:

1. A customer states their journey requirements.
2. One or more transport operators offer a potential solution, or range of solutions to the customer, involving one or more transport modes, and possibly including shared vehicle use.
3. The customer accepts an offering made to them.
4. A firm booking results.

This transaction may be synchronous or asynchronous (indeed this is one of the areas where more research is needed to determine the extent to which this transaction process can take place over an extended period of time). One of the most important requirements to support at the user interface is the management of bookings, which may have varying status (e.g. requested, offered or confirmed) associated with them.

In addition, the reservations phase needs to support a variety of journey modes, which may be one or more of the ‘commutes’, ‘explores’ or ‘quests’ described by Allen [24]: travellers may be looking for travel options to specific destinations (at specific times), or may (e.g. as a tourist) have more general requirements such as ‘a trip to a coastal resort any time this week’. Alternatively, instead of a search strategy for solutions, travellers may wish to ‘browse’ those options that have already been supplied by the marketplace, and which they could also take up. Users must be able to specify any preferences (e.g. to be a driver) or constraints (e.g. luggage) that would influence the match between their transport needs and the transport solutions offered. The dynamic journey-specific constraints (stated on a journey-by-journey basis) can be linked to static user preferences that are determined when the user initially registers for the service. For example, a user may *always* prefer to be a driver (in which case this can be set within general preferences), or have no preference, or choose this on a journey-by-journey basis.

The web (including mobile access) should be the main means of enabling UK tourists to interact with the marketplace and book journeys, and these should be based on popular transport booking sites and good web design practice, e.g. Nielsen [25]. However, the user trials highlighted the important role that ‘Mobility Centres’ can play. These community offices can provide transport information, enable face-to-face travel

bookings, and help overcome potential adoption barriers for specific user groups (e.g. the retired population who may be less confident with new technology).

5.3 Undertaking journeys

Where a vehicle is being provided as a transport solution, a user must be able to access and use it without a key during the period of their booking. Since this may be a novel concept, support for first time use is needed, for example via a telephone helpline in the first instance, and then context-sensitive help (with multilingual options) presented via in-vehicle telematics. Users would expect to pick up and drop off vehicles at convenient locations (e.g. town or village centres and other transport hubs). Specific functional requirements emerged from the trials, in particular: checking in and out of vehicles, including vehicle damage notification; onboard navigation assistance; access to local information such as points of interest; and an emergency call function.

The usability and safety requirements for in-vehicle systems should take account of international design standards for dialogue management, visual and auditory information presentation [26-28], and a procedural standard for assessment of in-vehicle systems for suitability for use whilst driving [29]. In addition to formal standards, specific codes of practice exist in Europe [30], Japan [31] and the USA [32].

5.4 Lift sharing

A key feature of the transport marketplace is to offer vehicle access to users who may not be willing or able to drive themselves, and to reduce journey costs by sharing vehicle occupancy between registered members (for all or part of the journey). There are five key requirements to support vehicle sharing:

- Individual passengers must be able to check in and out of the vehicle (e.g. using their smart cards).
- The location of passenger pickups and drop-offs must be supported by an onboard navigation system.
- The service must establish the protocols for car sharing (e.g. responsibilities, rules governing lateness, the flexibility of drop-offs and changes in journey itineraries).
- The cost implications must be immediate and transparent to all undertaking the journey (and the financial benefits of greater car occupancy highlighted)
- The perceived security and trust of members needs to be maximised (e.g. photo ID and on-screen identification of potential passengers)

The recent development of a prototype ridesharing system [33] incorporated system intelligence which enabled potential passengers to state loosely-defined ride requirements such as ‘any time today’ sometime this week’. In addition, they used this intelligence as an opportunity for the system developers to learn how the users defined ride requirements as an input to future versions of the system. Maximising the flexibility of lift-sharing will be essential for widespread adoption, and this would be an avenue for future research.

6 Adding value with location-relevant information

One of the key perceived benefits of a localised transport marketplace and car sharing service was the ability for users (and particularly tourists) to tap into ‘local knowledge’, either through meeting local people when sharing transport, or by access to information on local amenities and attractions. A frequently-stated requirement was for navigation

assistance. However at both the reservations phase, and during journeys, participants also described how such a service could add value by providing them with information relevant to their journey or destination. In particular, the tourists had requirements for information that was easily accessible (e.g. not constrained by opening hours or language barriers), of high quality and relevance [34], and that satisfied ‘windows of opportunity’ [35], for example unanticipated needs or interests during a journey. The provision of local information to users, especially to tourist groups, is a key opportunity for adding value with a car sharing service over and above the increased mobility offered. Information provision to the tourist can capitalise on two types of journeys they may undertake: information on the (1) areas or Points of Interest they are either travelling *past*, or (2) making specific journeys *to*, roughly mapping onto the ‘explore’ and ‘quest’ journey types described by Allen [24]. There are two main opportunities for satisfying information requirements: (1) at the reservations phase when journeys will be planned in relation to knowledge of the local environment, and (2) immediately preceding or during journeys when in-vehicle telematics can be used to provide real-time, location-relevant information. In addition, information can be highly tailored to the individual, since user profiles will be held by the service, and could also be provided to members’ personal portable devices for more seamless information delivery. The combination of mobile usage contexts and information scarce environments present a specific opportunity for provision of location-based services [36].

7 Conclusions

The main conclusion from this study is that car and lift share supported by web and wireless technologies can be successful for a wider market than is currently using it. The type of service described can successfully integrate vehicle use within a wider set of transport solutions: it can enable mobility for those groups who do not (for financial or other reasons) have access to a car, and reduce the impact of car use on the environment by increasing vehicular occupancy. The findings provide some support for the assertion of Jussiant [37] that ‘the time has now come for car-sharing’ with a view ‘to achieving sustainable mobility’.

However there are some key barriers which must be overcome if such a service is to be adopted by user groups, particularly those relating to security, liability, and the flexibility offered in meeting individual needs. In addition, ease of use (in the widest sense of the word) *did* prove to be a key barrier to actually using a prototype service, even though it was not identified by participants as such before the trials.

The real opportunities for this type of concept may lie with the integration of travel solutions with other mobile services. Tourists are typically ‘information hungry’, and may have specific constraints such as language barriers. Relevant, personalised and timely information can be provided to end-users according to their motivations for requiring transport solutions. In this way, such a service can both be viewed as a functional transport solution, and as a means of adding additional value to a mobile end-user within a wider context of use.

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References

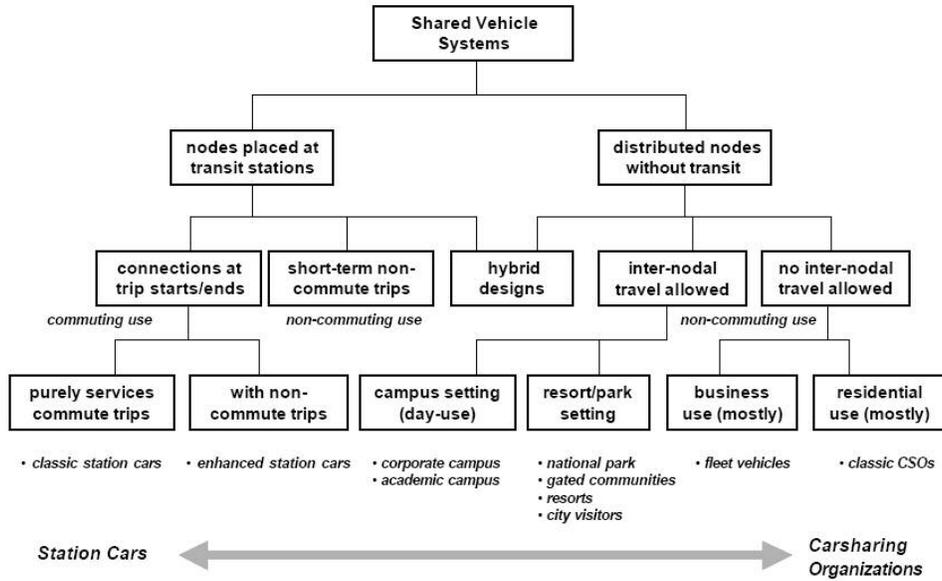
- [1] Katzev R. Car Sharing: A New Approach to Urban Transportation Problems. *Analyses of Social Issues and Public Policy*. 2003;3(1):65-86.
- [2] DfT. Transport Statistics, Section 1: Roads, vehicles and congestion. 2004 [cited 2006 28 January]; Available from: http://www.dft.gov.uk/stellent/groups/dft_transstats/documents/page/dft_transstats_026282.hcsp
- [3] DfT. Social exclusion and the provision of public transport - Main report. 2004 [cited 2006 28 January]; Available from: http://www.dft.gov.uk/stellent/groups/dft_mobility/documents/page/dft_mobility_506795-03.hcsp#P52_4338
- [4] DfT. Transport Trends Section 4: Variation in personal travel and access to services. 2004 [cited 2006 28 January]; Available from: http://www.dft.gov.uk/stellent/groups/dft_transstats/documents/page/dft_transstats_026297.hcsp
- [5] Motorist's-Forum. The Potential Role of Car Sharing and Car Clubs within Socially Disadvantaged Groups (Supplementary Report 3). 2002 17 June 2002 [cited 2006 28 January 2006]; Available from: <http://www.cfit.gov.uk/mf/reports/carclubs/supp3/index.htm#3>
- [6] Shaheen SA, Cohen AP. Growth in Worldwide Carsharing: An International Comparison. *Transportation Research Record*<<http://trbmetapresscom/content/120399/>>. 2007;1992/2007:81-9.
- [7] Fellows NT, Pitfield DE. An economic and operational evaluation of urban car-sharing. *Transportation Research Part D: Transport and Environment*. 2000;5(1):1-10.
- [8] Barth M, Shaheen SA. Shared-Use Vehicle Systems: Framework for Classifying Carsharing, Station Cars, and Combined Approaches. *Transportation Research Record*<<http://trbmetapresscom/content/120399/>>. 2002;1791 105-12.

- [9] Sheth JN, Newman BI, Gross BL. Why we buy what we buy: A theory of consumption values. *Journal of Business Research*. 1991;22(2):159-70.
- [10] Loose W, Mohr M, Nobis C. Assessment of the Future Development of Car Sharing in Germany and Related Opportunities'. *Transport Reviews*. 2006;26(3):365 - 82.
- [11] Rogers EM. *Diffusion of innovations*. 5th ed. New York: Free Press; 2003.
- [12] Davis FD. Perceived usefulness, perceived ease of use, and user acceptance of information technology. *MIS Quarterly*. 1989;13(3):319-40.
- [13] Dourish P. *Where the Action Is: The Foundations of Embodied Interaction*. Cambridge, Massachusetts: MIT Press; 2001.
- [14] Beyer H, Holtzblatt K. *Contextual Design: Defining Customer Centred Systems*. San Francisco: Morgan Kaufmann Publishers; 1998.
- [15] ISO. *ISO 13407: Human-centred design processes for interactive systems*. Geneva: International Standards Organisation; 1999.
- [16] Preece J, Rogers Y, Sharp H. *Interaction Design: Beyond Human Computer Interaction*: John Wiley & Sons Ltd; 2002.
- [17] Nielsen J. Heuristic evaluation. In: Nielsen J, Mack RL, editors. *Usability Inspection Methods*. New York: John Wiley; 1994. p. 30.
- [18] ISO-9241. *ISO 9241-11 Guidance on Usability*. 1998.
- [19] Jordan PW. Pleasure with products: Human factors for body, mind and soul. In: Green WS, Jordan PW, editors. *Human factors in product design Current practice and future trends*. London: Taylor and Francis; 1999.
- [20] Morse J, Palay J, Luon Y, Nainwal S. CarLoop: leveraging common ground to develop long-term carpools. *CHI '07 Extended Abstracts on Human Factors in Computing Systems Factors in Computing Systems*; 2007 April 28 - May 03, 2007; San Jose, CA, USA: ACM, New York, NY; 2007. p. 2073-8.
- [21] deJong T, Ferguson-Hessler MGM. Types and qualities of knowledge. *Educational Psychologist*. 1996;31(2):105-13.
- [22] Shaheen S, Wiprywski K, Rodier C, Novick L, Meyn MA, Wright J. *Carlink II: A Commuter Carsharing Pilot Program, Final Report: California PATH Research Report, UCB-ITS-PRR-2004-23*
2004 August 2004.

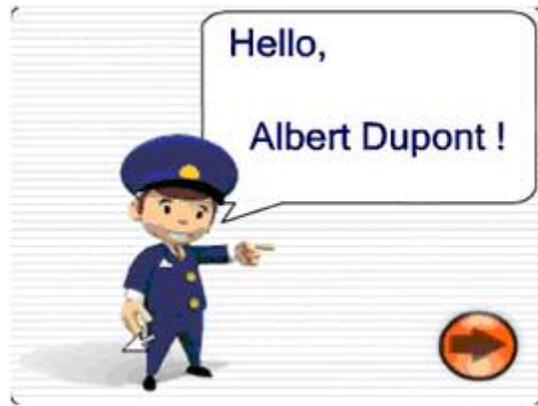
- [23] Meijkam R. Changing Consumer Behaviour Through Eco-Efficient Services; An Empirical Study on Car Sharing in The Netherlands: Delft University of Technology; 2000
- [24] Allen GL. Cognitive abilities in the service of wayfinding: A functional approach. *Professional Geographer*. 1999;51(4):554-61.
- [25] Nielsen J. *Designing Web Usability: The Practice of Simplicity*: New Riders; 2000.
- [26] ISO. ISO 15005: Road vehicles – Ergonomic aspects of transport information and control systems – Dialogue management principles and compliance procedures. 2002.
- [27] ISO. ISO 15008: Road vehicles – Ergonomic aspects of transport information and control systems – Specifications and compliance procedures for in-vehicle visual presentation. 2003.
- [28] ISO. ISO 15006: Road vehicles – Ergonomic aspects of transport information and control systems – Specifications and compliance procedures for in-vehicle auditory presentation. 2004.
- [29] ISO. ISO 17287: Road vehicles – Ergonomic aspects of transport information and control systems – Procedure for assessing suitability for use whilst driving. 2003.
- [30] EC. *European Statement of Principles on the Design of Human Machine Interaction*. eSafety Task Force, European Commission; 2005.
- [31] JAMA. *Guidelines for In-Vehicle Display Systems*. Japan Automobile Manufacturers Association; 2004.
- [32] AAM. *Statement of Principles, Criteria and Verification Procedures on Driver Interactions with Advanced In-Vehicle Information and Communication Systems*. Driver Focus-Telematics Working Group, Alliance of Automobile Manufacturers, U.S.A; 2003.
- [33] Wash R, Hemphill L, Resnick P. Design decisions in the RideNow project. *Proceedings of the 2005 international ACM SIGGROUP Conference on Supporting Group Work 2005 November 06 - 09, 2005*; Sanibel Island, Florida, USA: ACM, New York, NY; 2005. p. 132-5.
- [34] Barry CL, Schamber L. Users' Criteria for Relevance Evaluation: A Cross-Situational Comparison. *Information Processing & Management*. 1998;34(2-3):219-36.
- [35] May P. *Mobile Commerce: opportunities, applications, and technologies of wireless businesses*. New York: Cambridge University Press; 2001.

[36] Schiller J, Voisard A, editors. Location-Based Services. San Francisco, CA, USA: Morgan Kaufmann; 2004.

[37] Jussiant L. Combined mobility and car-sharing. . Public Transport International. 2002;51(6):12-5.



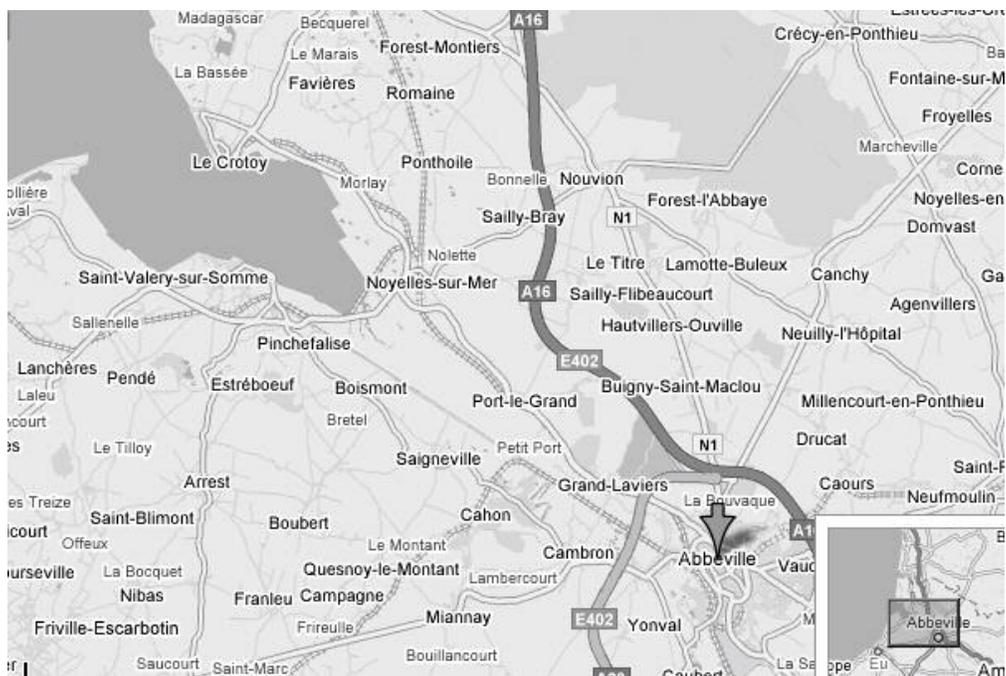
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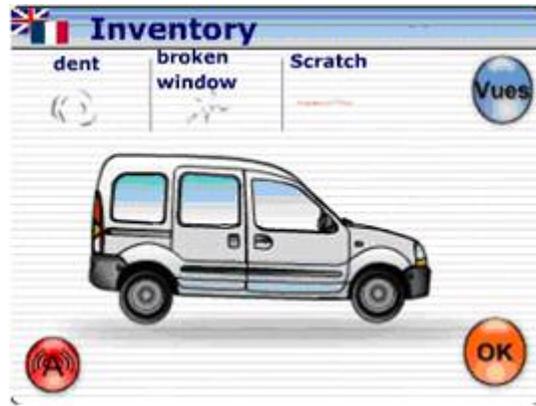
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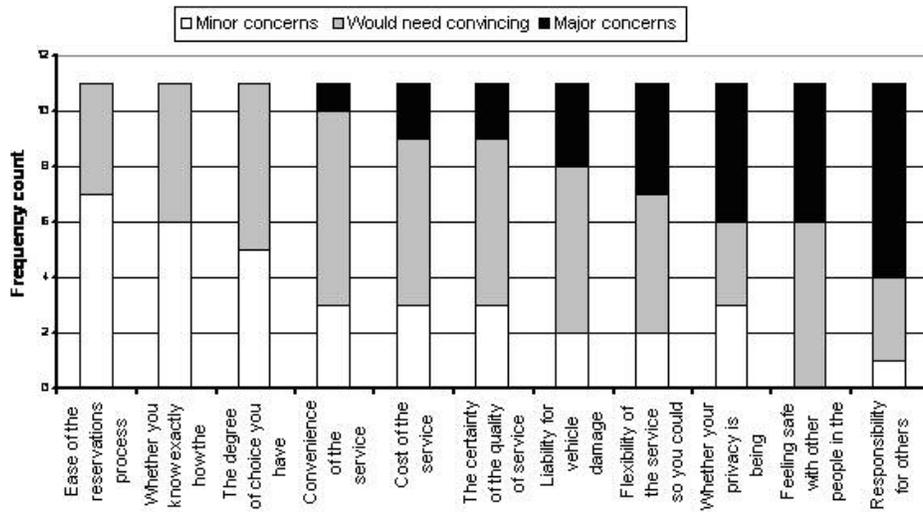
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