

THE KNOWLEDGE AND THE SYSTEM

A socio technical view for supporting London Black Cab Work

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Abstract: This paper reflects on the socio technical implications of two different technology-based Black Cab booking systems. Potentially there is a bi-directional impact on the drivers and passengers with respect to the level of awareness needed to use the systems and how situational acts vs. planned acts impact on the context changes experienced by all users.

Keywords: Situational Acts, Planned Acts, Mobile ICT, booking systems, cab

1. INTRODUCTION

The use of mobile technologies supporting work is currently the subject of significant research in many areas of work such as police work and health services (Sorensen and Pica, 2005; Wiredu, 2005). One of the key areas of concern is the relationship between emerging working practices and the specific properties of mobile ICT support. The mobile nature of the technology clearly strengthens the ties between the work situation, the possible decisions made by the worker, and the specific design of the technological support. Furthermore, it potentially reconfigures the ties between the individual worker and the organisational context in which work is conducted.

One interesting aspect of studying London Black Cabs in the light of mobile technologies supporting work is the possibility of comparing traditional working practices settled for many years. London Black Cabs are heavily regulated and their history goes back to 1620 when they were called Hackney cabs- such as street hailing (Bobbitt, 2002) against modern work

practices such as allocation of work by SMS or electronic booking systems. A second interesting aspect of the study of London Black Cabs is identifying the importance for drivers of relying on “The Knowledge” (a memory system for street routes that drivers are examined on by the Public Carriage Office in order to obtain their license) against relying on GPS systems or other “live” modes of data stream for location services. The use of location services or GPS is an ongoing process that it is producing dramatic changes, by means of, mobile ICT in the everyday working practices for drivers.

An important question is then: *What is the role of specific mobile ICT support features for the change to daily working practices of London Black Cab drivers?* This question relates to a more broad research concern: understanding the role of mobile ICT for the choice of work context for mobile workers. The decision process that arises from the choice between planned and/or situational acts.

The empirical data for this paper is provided by both qualitative interviews with 35 black cab drivers from whom deep contextual knowledge was gained, and through 14 hours of videotaped observation of driver-behavior (this part of the research is still being developed) in order to obtain deep situational insight. This paper in particular focuses on a comparison between two different technological means for connecting a potential customer to a black cab within the normal working conditions of the driver.

Although still in its early stages, there has been some research of the socio-technical aspects of mobile working (Orr, 1996; Kristoffersen and Ljungberg, 2000; Brown et al., 2001; Wiberg, 2001; Kakihara, 2003; Ling, 2004; Wiredu, 2005). In particular studies of police work in patrol cars (Manning, 2003; Sørensen and Pica, 2005) and of airplane pilots (Hutchins, 1995) may be relevant for the understanding of vehicle-based working.

The paper describes some of the specific properties for the two mobile ICTs studied in terms of the systems allocation of work to cab drivers, design factors in the system and the discourses related to the mobile ICT practices of emerging versus planned decision processes.

2. THE BLACK CAB, THE KNOWLEDGE AND THE SYSTEM

2.1 The London Black Cab Service

The history of the London Black Cab is rich and long (Georgano, 2000 and Bobbit, 2002). Three main reasons lead us to identify this type of work as an interesting case for study: it is still possible to compare live data between established ways of work and new technology driven ways to do work, the use of “The Knowledge” and changes due to technology modifying the way work was traditionally executed by cab drivers to use the mobile ICT. In the context of the London Metropolitan area, the use of electronic booking systems in cabs is a relatively new development. Unlike many other cities in the world where the use of GPS systems is generalised in cabs (Liao, 2003), most radio cab circuits still use inherited systems based on two-way radios and paper-clip bookings. This is the case for both licensed cabs and minicabs (restricted licensing).

In terms of operation modes there are two main types of cabs: licensed cabs and minicabs. The differences are based in the licensing method, the fares, and requirements for route planning. London Black Cab drivers, to become fully licensed, need to pass “The Knowledge”, an exam that requires them to know and recall from memory up to 400 routes or “runs” in Greater London. Black Cab drivers or “cabbies” (Townsend, 2003) are proud of this standard of knowledge that allows them so far to be faster than any GPS systems available (Skok, 1999).

Most cabbies own their vehicles and are proud of their high level of independence when choosing work. Minicab companies, however, have been able to compete with cabbies by hiring drivers who do not have “The Knowledge” but can complement their routes using GPS systems. Minicab drivers tend to drive vehicles owned by the minicab company and they are much less independent as the cabbies when choosing work.

The migration to electronic cab booking systems aims to take maximum advantage of the position of the cab at a certain time. Most radio circuits see this position awareness as a strategic advance when allocating work. When a booking is made, the job is allocated to a driver close to the passenger, reducing the arrival time (of the cab to the passenger) and waiting time (by the cab driver). Cabbies do compete with each other for hailing passengers, hence members of the same radio circuit tend to be overzealous when determining whether the allocation of the job has been fair and not subject to the call centre dispatcher preferences. The use of computerized booking

systems is a means both for optimization and for reducing possible conflicts between drivers.

Based on the empirical data and in a socio technical approach here is a list of some factors to consider in the design of the electronic booking systems:

- *Ubiquity*: identifying the location of drivers closer to the passenger wishing to be transported. This can be an accurate position (by GPS) or an estimated position (by zones).
- *Reachability*: communication between cab driver and call centre or cab driver and passenger shall be intelligible enough to provide basic information about ride.
- *Security*: passengers and cab drivers value the ability to travel and drive in safety. An added value for any system is the capacity for providing a backup communication media in the case of emergencies.
- *Ergonomics*: from the driver's perspective, a system that minimizes distractions from driving concentration is important; it is also important to note that the billing systems (credit card swap or account register) can also be incorporated into the system.
- *Easy learning*: from the driver's point of view it is important that the system should not be difficult to use, should be easy to understand and allows the rapid location of relevant information. The complexity of this objective is increased by the fact that drivers have different levels of general education and computer knowledge.

The role of these factors contributes to the mechanism of doing mobile work, when merging its role with the technology in use. Those mechanisms for doing mobile work are explained in the section 2.2

2.2 The Mechanism of Doing Mobile Work

The cab driver work can be presented from the interaction of the physical space, the mobile actor and the technology attached to work (Weilenmman, 2004, Elaluf-Calderwood and Sørensen, 2004). This way of looking at cab drivers' work is complemented by understanding the idea of what mobile work is and what it means in the context of spatially mobile workers.

From the interviews and observation completed it can be said that when a cab driver works around the city searching for work, the search and its success¹ depends on a number of factors:

¹ During interviews drivers have expressed different aims when measuring their workday success. For example: some drivers aim to make as much money as possible depending in their personal situations, others want to do easy rides (short journeys), other want to have a relax driving day with many breaks, etc.

- *Physical location*: where the driver and his vehicle are physically located at a certain time.
- *Awareness*: The driver needs to be aware of events on the road such as accidents, congestion, competition from other drivers, etc.
- *Time*: drivers go to work with a general timetable framework; drivers perceive time either as a compressed unit (E.g.: driving whilst talking to friends) or fragmented (E.g.: events or actions can occur at discrete intervals of time (E.g. one conversation followed up between two passenger hails using the mobile phone).
- *Strategic Planning*: cab drivers' decisions such as how many jobs they wish to take from the electronic booking system, when they will take those and where. E.g. some drivers plan to only take hails in the direction of the drivers home one hour before finishing their work shift, allowing them to get close to home whilst being paid for it.
- *Situational Acts*: when on the road which hailing situations are preferred by drivers based on the context of work, but also the opposite (not preferred and why)
- *Planned Acts*: different from strategic planning as the time intervals when these acts are planned are short and are a function of the randomness of available work.
- *Human Factors*: How the cab driver mediates with the mechanical, technological and human aspects of his work. If the driver is tired, lonely, stressed, or subject to other human emotions, it will affect the way jobs are taken.
- *Role of the technology*: cab drivers might use one preferred system for obtaining jobs or might choose to be more traditional and work the street hailing of passengers.
- *Emergent practices*: the evolution of the physical space in the city together with new technologies is creating new working practices that cab drivers are taking on board for their work.
- *Change to succeed*: this category expresses the randomness of the work, as success might occur "at the first turn of an imaginary fortune wheel" or might take many of the factors listed above in combination. Drivers express their measure of success in different ways currently under analysis.

Based on this socio technological approach a brief introduction to the research approach is presented in the section below before passing to discuss the Systems observed based on the factors in the mechanism of doing mobile work.

3. RESEARCH APPROACH

The research approach is based on interpretivism and ethnographic methods. The interpretative approach tries to understand the world as it is, created by inter-subjective meanings in a social process. It tries to understand a social phenomenon from the perspective of participants in their natural setting. In an interpretative study, the researcher does not try to impose his/her own previous understanding onto the situation. The case study (London Black Cab) presented in this article places a significant interpretative value on the narrative as expressed by the object of study (the subject is being interviewed and what is said in the context of study). The understanding of the differences between the living situation of the mobile user and the researcher's hypothetical views is of paramount importance. Distinguishing between situated interaction in the world on one hand and interaction through technologies on the other is at the heart of virtual environments and mobility studies (Luff and Heath, 1998). The strategy defined for the collection of data was the use of one-one interviews with drivers from diverse social and cultural backgrounds. There has been research work (still ongoing) in recording everyday situations in which drivers use their computer systems and/or mobile devices. For analytical techniques the research is being worked using cognitive approaches, and microanalysis has been applied when required. There is very limited access to logs or records provided for the systems discussed, hence *this paper focuses on how the systems are used* (cab drivers, passengers) and *not on how the systems work* (interfaces, mobile antennas, software, hardware, etc).

4. TWO WAYS OF ALLOCATING JOBS

4.1 Driver-Passenger Interaction

We now aim to describe the interaction between driver and passenger in System A and System B.

System A

This is a cab radio call system that has fully migrated to an electronic booking system. Potential passengers book by phone or over the Internet (no SMS accepted). Payment methods are of three types: cash, credit card and account. The company gives preference to account customers over all other

transactions. Customers get an ID number for their booking or an email confirmation. An estimated cost of the journey is also provided on request and customers are required to state their final destination for this purpose. Customers do not interact with the cab driver until they are picked up at the start of the journey.

Drivers know the location of the customer and their approximate destination. Drivers book in the electronic system based on a virtual zone map. They manually input the zone they wish to be included in. The system automatically assigns them to a virtual queue – based on order of input of zone – of cabs. To avoid driver “choose and pick” of jobs from the system, drivers cannot see the destination (or the cost) until the job is accepted. Drivers can have three modes of “location” in the system (if on): p.o.b (passenger on board), free (no passenger), c.t.e (close to end of journey, which allows the driver to be re-assigned a place in the queue). There is also the option to be off the system if hailing passengers from the street.

Discrepancies do occur, as passengers are charged from the time the cab arrives to the point of collection, regardless of how long the passenger makes the cab wait, so for the last three years the new computer systems are being provided with a GPS system that can be checked by the call centre when there is dispute. In general the service is good, drivers tend to work a combination of radio jobs and street jobs.

Drivers have mobile phones in their cabs but it is not the primary mode of communication for work. Most work allocation is negotiated by the computerized system.

Drivers feel very comfortable with their radio circuit passengers as in most cases these will be account passengers, what they call “quality people” (business people), hence there is a level of relaxation associated with having knowledge of the journey destination.

Drivers express a level of respect for their passengers in their behavior: trying to make few or no calls on their mobile phones or keeping the radio volume low. Drivers are very receptive to passengers’ attitudes and desires (if the passenger wants to chat, the driver will listen and try to be more communicative). This is also true if dealing with cash jobs at late nights, as far as the booking is made through the radio circuit.

System B

The cab is provided with a GPS system that sends the location of the driver in real time to an application server. Passengers call a number using their mobile phone and based on the location services of the network the closest cab to the passenger is called directly through the mobile phone in the cab. The passenger is, the closest cab to him/her is called directly

(language) and cab driver and passenger negotiate by voice call where the passenger will be picked up, the estimated time of arrival at the destination (for the cab) and in some cases where the passenger wants to go and method of payment.

Street pick ups or street hails can also be booked by SMS, in which case the driver calls the passenger to confirm call – there is no Internet or call centre available (at this moment in time) – using the text header in the SMS message.

The main issue for drivers is that customers do not wait for the cab they booked if there is another available arriving earlier on. This makes the drivers wary of customers disappearing. It is perceived as a disadvantage that the customer cannot be charged a deposit in advance for the assignment. There are also fluctuations in the precision of the GPS systems and how jobs are allocated – there is no queuing – hence the driver has the added tasks of getting information from the passenger, defining the driving route, driving with the passenger and obtaining his/her payment.

Drivers use their mobile phones as the primary source of communication for job allocation. Job rejection does not affect the chances of getting a new job allocated immediately. However if the driver answers the call he is obliged to comply and do the run (travel to the passenger).

This issue depends upon the time of the day. At nights drivers are at especially high risk of not finding passengers or not being paid. Hence drivers have a more reserved attitude to jobs and tend to make rounds around the city more frequently than the drivers in System A.

There is no call centre associated with the system, hence if a driver gets in trouble the only assistance he/she can reach is using his/her mobile phone. The GPS system is used to locate drivers but does not help them to find the optimum route to their destination. This is primarily planned as in System A using the knowledge - the very difficult examination taken by London cab drivers in order to get their license with the Public Carriage Office. In figures 1 and 2 below we present physical pictures of the systems described.



Figure 1. System A



Figure 2. System B

4.2 Systems Comparison

We now describe the major characteristics of the systems and give examples of how operations are completed.

Table 1. Socio technical description of the systems

	System A	System B
Ubiquity	Driver has the system integrated in the vehicle. Driver determines when the cab is made available. Driver is company shareholder with participation in the working practice decisions. Min 30 rides a month are required.	Driver has the system integrated in the vehicle. The driver determines when the cab is made available. The driver pays a flat fee (monthly) for access to the system. No min number of rides.
Reachability	Multiple repeaters around London. Good reception. The system has a manual backup and alternative backbone network.	Access is supported by commercial satellites and GPS network. Good receptions but sometimes there are some reachability issues.
Security (from competition)	Good. Access to transactions and locations for driver and passenger are managed by call center. Once a booking is completed the chances that the job will be taken away from allocated driver is low, Drivers only can see non-allocated jobs. In most cases passengers need to provide a credit card for payment.	Reasonable. Communications between driver and passengers are completed using digital mobile networks. There is no assurance that once driver and passenger have agreed to the service, the passenger will wait for cab. Sometimes passengers do take the first cab that arrives to their position and not the one booked.

	System A	System B
Convenience	<p>D Driver is given in advance all information for ride by computer system: passenger location, destination, cost and payment.</p> <p>U Passenger can book cab by phone call or internet. Methods of payment are diverse.</p> <p>R Passenger is also provided with estimated time of arrival for booked cab.</p>	<p>Driver has to negotiate with passenger collection time, location, are and method of payment. This negotiation can distract the driver from driving well when on the road.</p> <p>Passengers can only book by mobile phone calls. External conditions such as noise of the road can affect the quality of the call - can take long to get passenger details - and in some cases another cab will arrive to passenger location and passenger will cut call canceling the booking.</p>
Localisation	<p>Driver inputs his location in the Zone system. GPS is not used to verify the position of the driver unless there is a complaint or dispute. The driver can change the zone system manually at any time.</p>	<p>Driver's location is determined by an advanced GPS system build into the vehicle. This system is a real time feature that cannot be changed manually but only turned off.</p>
Instant Connectivity	<p>D Driver is able to correlate a position in a cab queue when waiting for a new job assignment.</p> <p>U A reply is obtained from a call centre or internet page and email confirming booking.</p>	<p>There is no queuing system. The nearest cab to the passenger gets the job from the system</p> <p>Direct communication with driver and confirmation that its on its way.</p>

* From the driver point of view unless otherwise stated.

5. HOW DOES ICT SUPPORTS BLACK CAB WORK

5.1 Emerging versus Planned Decisions

When using System A, the passenger exchanges instant connectivity for convenience (if the cab booked does not arrive on time, the radio circuit is able to provide the next closest one in a matter of minutes). When using System B the passenger has a level of ubiquity attached to his position, and security is exchanged for instant connectivity (the passenger and the driver talk to each other in real time to discuss when and where to be collected).

This way of negotiating position is not unique to the cab business; the police also use diverse methods of communication to create awareness of position and location, and there are similar trade-offs between these methods and instant connectivity (Sørensen and Pica, 2005). In order to understand this without undermining the factors that attract passengers to choose one method over another, we also need to look into the driver's convenience and the ideas provided by mobility studies (Perry et al, 2001).

As the cab driver moves around the city searching for possible passengers, whilst being shown as available for the radio circuit, many events might occur. Radio circuit, the generic name used for computerized cab circuits, is seen as a reliable – but not the main or only - source of income for cab drivers. This is in part due to the careful control of the cost of each journey, competing against street hails, which are less carefully recorded and where discrepancies can occur.

With system A, in which the driver relies on the information provided by the computerised system to obtain work, each time he is “live” in the system he is allocated a queuing number. This queuing number allows the driver some level of planning (the question: which job I will take?) based on his vehicle physical approximate location within the parameters of the system (zones). In some cases for example, a cab driver might have a queuing number such as “4”, and whilst waiting to ascend to the top of the queue, the driver might decide to take a short run around a physical area or stop at a cab rank for a break.

The cabbie is more relaxed as the pressures of constantly searching for new passengers is reduced by the greater trust placed in the computer system.

Cab drivers in system A know in advance their destination or proximity even before they have collected the passenger, allowing them to check routes, verify that there are no road closures, etc. There is a level of safety associated with the idea of traveling when the destination is known.

With System B, in which the driver relies on his mobile phone to obtain work – besides street hails – the ubiquity is wider. Drivers get accustomed to longer runs on specific routes to maximise the number of passengers transported. However passengers sometimes take the first cab that is closer to them and the driver loses his ride.

During the interviews drivers in System A, those were quoted saying: this uncertainty is the main reason they felt discouraged from trying the system B.

With System B drivers argued that using the system was advantageous when working at night: the cab density (number of cabs available) is reduced, passengers are more eager to confirm that the cab is a licensed one (especially female passengers) and are prepared to wait longer times – if

necessary -until in arrives. There is hefty competition from minicabs but black cabs feel backed by their good reputation.

There is a relationship between the spatial distribution of cabs and the passengers that affects the social interaction, the expectations (from drives and passengers) before the journey, during the journey and at the end of the journey.

With System B drivers find more difficult to control their petrol costs: they tend to aim to find the information required for collection of the passenger, but only on collection find out the final destination. Sometimes the journey to the passenger can take as much time as the hail itself due to traffic congestion. Uncertainty becomes part of the space of interaction between the driver and passenger. At some point the private space of the cab driver is claimed as public by the passenger (during the journey); at the same time there is an interaction that links the situational acts (collecting a passenger) with the planned ones (where to go, cab driver choosing to be available or not), etc.

5.2 Systems and their Riddles

Cab drivers concerns are driven by a sense of risk attached to the idea of multiple tasking when driving their vehicles, being wary of multitasking when working. Hence the need of a simple electronic booking system.

In system A, drivers claimed that the computer screen was a distraction to their driving, and liked the fact that the system turns off to black screen after two minutes idle. They perceived system A as fair, with little competition between drivers in the radio circuit.

Nevertheless problems do occur, such as when drivers are on the boundary of one zone and the job allocated is too far within the zone or there are physical obstacles that make the journey not worthwhile (sudden closure of roads or a one way system), and there is also the probability that another driver is closer to the passenger to be collected. Then communication to the call centre is required to clear doubts. Misunderstanding can also arise when the description for the collection point or the passenger to be collected is not clear.

In system B drivers are concerned with the accuracy of the GPS systems used. Central London has a high density of mobile masts; hence the accuracy of their most probable position is high. However, there is also greater competition: since the system does not provide a queuing system, two drivers in the same street might both be ideally located for a job or run appearing in the street, yet the allocation of the job is random and there is always a chance that the passenger will take the first taxi that passes close to him regardless of the agreement they might have with another driver.

There are also issues concerning billing and payment. Taxi drivers in system A know in advance the method of payment (cash, account, credit card) and since their destination is also known they have an advantage when estimating the best route and cost.

Failures occur in the computer systems when no jobs can be allocated. If the system is down notification is provided to drivers. For drivers in system A, a broadcast in the two-way radio system announces the problem. For drivers in system B, a broadcast SMS is the way of announcement.

This type of system failure does not affect the passenger's potential to get a cab when needed, but it might affect the payment method (if paying by credit card). It will also affect the interactivity between driver and passengers as uncertainty is added to the journey in terms of ubiquity and reachability. In these situations some drivers switch to street mode until they are sure that the systems do work properly again. Having said this, outages are infrequent.

Computers in vehicles may fail and in that case both systems have workshops where cabs can be repaired. This activity implies a down time off the street, which drivers find difficult accept as it is unplanned time of the road that has a cost in their day profits.

5.3 Is Mobile ICT Challenging Mobile Work ?

The first and main concern for drivers is the competition between drivers using the Knowledge and drivers using GPS systems, or in other words licensed cabs vs. unlicensed cabs (for now). GPS systems in London are not yet able to provide "real time" information of what is happening at the very congested London roads (Example: routes closed by the police due to an emergency are only updated in GPS systems after a gap in real time). Cabbies are aware that this will not be in the case in future when technology will be able to provide location services with "real time". The need for the Knowledge is then questioned not only because of the technology but also by other factors such as congestion, more routes defined as one-way systems, many alleys and shortcuts being closed due to safety measures.

Drivers express this change as a way of making their "skilled" job an unskilled one; anyone with a GPS could do their job. No specific training will be required to do a cab job. This is the case with minicab companies, which are gradually obtaining a bigger share of the cab market. Their costs are reduced because those companies can hire drivers at low rates, who are not required to own their cabs for work.

Cabbies see the use of mobile technology as an enhancement of their private and social life, which can continue even when at work. They also appreciate the fact that their passengers seem to be at ease in using the back

of their cabs as an extension of their offices, homes, bars, etc by using mobile technology to be in touch with whom they want. Cabbies do highlight that as their work is isolated, human interaction is achieved through their mobile phone.

6. CONCLUSIONS

This paper has not aimed to do a theoretical review of the design parameters used in the design of cab systems, neither to describe state of the art systems but to analyze how everyday cab drivers adapt their working practices depending upon the technology.

In this paper only part of the empirical work completed has been presented. There still a considerable amount of data to be analyzed under the socio technical lenses explained in the introduction to this document. Considering the complex spectrum of issues related to time and space faced by cab drivers and their passengers, there remains considerable research into how new technologies improve the services provided by the cab drivers to passengers. A first questions regarding the evolution of human-to-human resource knowledge (such as the Knowledge) against computer-to-human resources (GPS systems) used by cab drivers arises: Will “The Knowledge” be replaced by more advanced GPS systems? Will call centres become redundant if smart systems could automatically handle passenger bookings? How will this affect the passenger and driver expectations of the service provided and used?

There is from the social pint of view a richness and variety on the cab driver’s job as per changed through the use of mobile ICT. Drivers expressed feelings of isolation when doing their everyday work: Mobile ICT use is allowing drivers to overcome their isolation.

In terms of understanding the factors that are relevant for mechanisms for executing work with mobile workers, this ongoing research expects to contribute to further research work with the development of a model that maps the factors listed in Section 2 with the occupational frameworks of time and space, currently being blurred through the use of technology such as mobile phones and doing so mobile workers try to make sense of the socio technical issues arisen by the use of mobile ICT.

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