
Autonomous Vehicles: A User Perspective

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Abstract

This paper is an abstraction of the current PhD effort in this field. This research effort aims to promote public engagement, and evaluate user perception of autonomous vehicles (driverless cars) with an aim of uncovering key areas that potential users feel would affect the introduction of driverless cars.

This position paper outlines the justification that lies behind this massive change effort, taking into account the current failures that plague the road network. An introduction on the methodology used is given, the rationale behind it, its history and a practical application of it within this research effort.

At this point, data is still being collected and as it is still in a raw format, key pointers and factors have been included as representative of what the final solution may entail and a discussion outlines the possible application of this knowledge.

1. Introduction

Since its introduction, road transport has gripped society and has grown to become the number one method of domestic travel for the population. CBI (2010) reports that UK drivers covered a distance of 261 billion miles in 2010, with this figure set to spiral to 376 by 2035.

The immeasurable social and economic benefits of this method are prevalent, yet, currently reported and seemingly always rising are a number of issues that question the use of this method of transport:

- In the UK alone, 2013 saw 183,670 casualties in road accidents; this number only represents those reported to the police. (DfT, 2013)
- The RAC Foundation (2015) reports on behalf of the DfT (2013), that 69 percent of fatalities occurring on the road are related to driver/rider error as one of the contributing factors.
- 19.2 seconds were lost for every mile a driver covered in 2010 due to congestion; however, this amount is set to rapidly rise in the next decade. (CBI, 2015)

Seemingly, a contradiction appears, on the one hand, a system that has integrated itself into society, on the other, a system that is being questioned due to its mounting failures.

To tackle this issue, this position paper will highlight the efforts of this individual research effort and the efforts of the ARTS community to support a method and procedure that does not conform or line itself with current, failed methods. The overall idea is to form an inter-disciplinary coalition aimed at rapidly developing new ways of designing road transport systems, which implement the use of autonomies as a

driver/vehicle aid.
(ARTS, 2013)

The individual effort of this PhD program is to shift focus from the mounting technical challenge that lies in wait to the potential users of the system, investigating and analysing the countless variety of factors they are presented with in their acceptance and usage of computer assisted driving.

The expected outcome of this thesis is an extensive literature review covering the factors/variables facing each user in their acceptance/usage of this proposed technology and a model that outlines user perception, technology acceptance of the mentioned systems from a user perspective.

1.1 Rationale

Understanding the need for human factors research in this scenario is vital; to add weight to this research effort, the field of human factors when linked with automation in aviation demonstrates the importance and need for this kind of research.

Wiener and Curry (1960) mention that as expected, flight deck automation reduced accidents in aviation. However, surprisingly, a new trend of incidents occurred, linked directly to pilot error and a misunderstanding of the system.

The finding signifies the importance and the role any user plays in the introduction of a revolutionary system. Considering them is key to creating the required understanding needed between human and machine to assist with designing, developing and the hopeful usage of driverless car.

1.2 Aim

The overall aim of this research is to evaluate and model user perception of driverless vehicles with an emphasis of uncovering key acceptance issues.

1.3 Objectives

By employing a grounded theory approach a substantive theory can be developed which represents the topic of driverless cars from the viewpoint of user perceptions, through interviewing and analysing a variety of stakeholders. The objectives are therefore to:

- Critically analyse and evaluate data collected using a variety of manual coding procedures and qualitative analysis tool.
- Present the findings in a practical model, containing key features previously not known with a view to further understanding this complex element of the system.
- Enable a potential viewpoint of carrying human and machine elements in a practical manner.

2. Literature Review

A strong literature review supports the workings of any good quality research paper, however, it is noticeably missing from this one, the following discusses the reasons why.

Within the Grounded Theory field, the issue entailing the position of the literature review has been hotly contested. Ross (2014) states the debate has been on-going for the past twenty years and the author continues to define this confusion by stating it's role is unquestionable, rather the issue that arises is when to introduce it and how it should be used.

The initial Glaserian approach (1987) and the more recent constructivist Charmaz approach (2006) both champion the process of avoiding a pre study literature review. Charmaz (2006) raises an interesting point by mentioning how a literature review conducted prior to the study can stifle creativity coming out of the data or lead one down a linear, already well documented path which is not the case with the Grounded Theory. Glaser (1998) continues this theme by stating the whole premise of the Grounded Theory is the unpredictability it develops and how this unpredictability will lead the theorist down avenues not expected to new findings, the danger of a premature literature review is primarily the fact it may be misleading as well as wasteful.

2.1 When to introduce Literature

A literature review should be included within the study as an on-going learning and comparison process once the empirical study begins. In Figure 1, Lehmann (2001) diagrammatically represents the process of the Grounded Theory and in particular the role of the literature review. The literature review begins once data is collected and is described by Lehmann as informing and refining code at the open coding phase, helping to generate high quality memos and finally informing and helping to relate elements at the substantive theory phase. The key point to grasp from this diagram is that the literature is not activated until it is guided by the various stages of the methodology (coding, memo etc.)

3. Methodology

The selected methodology in use is Grounded Theory. The Grounded Theory method dates back to the 60's when it was introduced as the brainchild of Barney Glaser and Anselm Strauss (1967). The key aim of their offering was simple: to discover or generate a theory. The same authors described the method as a qualitative tool to aid in the discovering of a theory, at this point, they added, one must collect data that has been systematically gathered from social research. To effectively use the theory and take full advantage of all that it offers, Crooks (2001) recommends that it is used with phenomena where knowledge is scarce and the theory's use as the primary tool of exploration is established. In doing this, the method becomes the ideal choice that is at the forefront of exploring social relationships, perceptions and behaviour, three settings in which previous investigation in this field has been at a minimum.

What can be gathered from the quotes of the theorists above is that in situations where theory does not exist or one has a true lack of understanding of a topic, be it through ignorance or in this case, a new area, the grounded theory is the glove fit methodology to adopt.

In using this method, the Grounded Theory promotes investigating surroundings through a mixed methods approach or using schematic representations. This open ended-ness can be dangerous if misused but a justified application ensures a well-rounded theory that has delved to different depths to gather the required data needed when introducing something society has yet to see.

In this context, the study of driverless cars from the perspective of the user is unique in the sense that the literature, for such an important topic, is very limited, ranking our understanding of this key element very low.

It is the belief of the authors that this methodology will provide a strong foundation of understanding in this area and a baseline will be formed to give fellow researchers a number of key themes to pursue to reinforce an understanding of the subject and a hopeful expertise of this area.

3.1 Methodology Process

Grounded Theory can be described as an iterative development of sorts, with many phases, entwining as one to form a mid-level hypothesis or theory, Lehmann (2001) provides a

concise definition of the process by stating the Grounded Theory is like a spiral that begins a process of collecting data in a particular area of concern, this collected data is then codified and categorised in a process of triangulation until the point of saturation is reached. At this point, the researcher is aware that they are on the cusp of a substantive hypothesis or theory.

The process is contextualised in figure 1 and in figure 2 is a diagrammatical explanation of how this research effort has moulded the Grounded Theory to assist in studying this phenomenon.

An alternative method to the classic Glaserian and Straussian approach is the constructivist approach of Kathy Charmaz. As an alternative method, this approach takes a standing point between post modernism and positivism in an effort to transform qualitative research into a 21st century context and understanding (Charmaz, 2003).

Charmaz states that the 2 actors in the study (researcher and participant) should form their own data and analysis in a method of interaction. Doing this, the discovering of one issue is left behind, rather a picture is painted, one that covers the entire spectrum and one that represents the subject’s life (Charmaz, 2003).

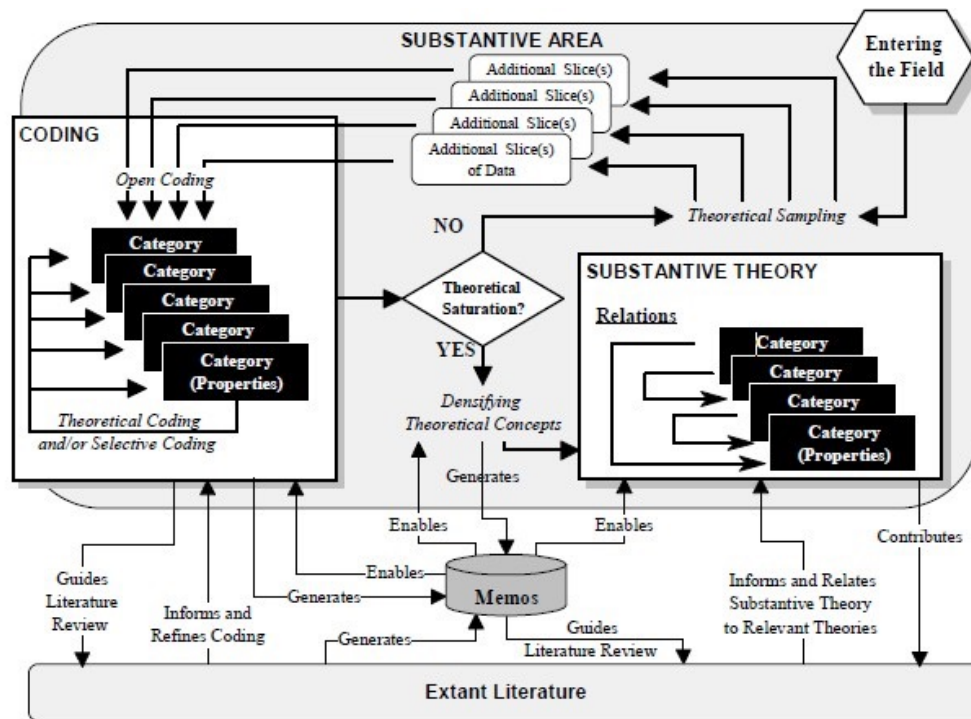
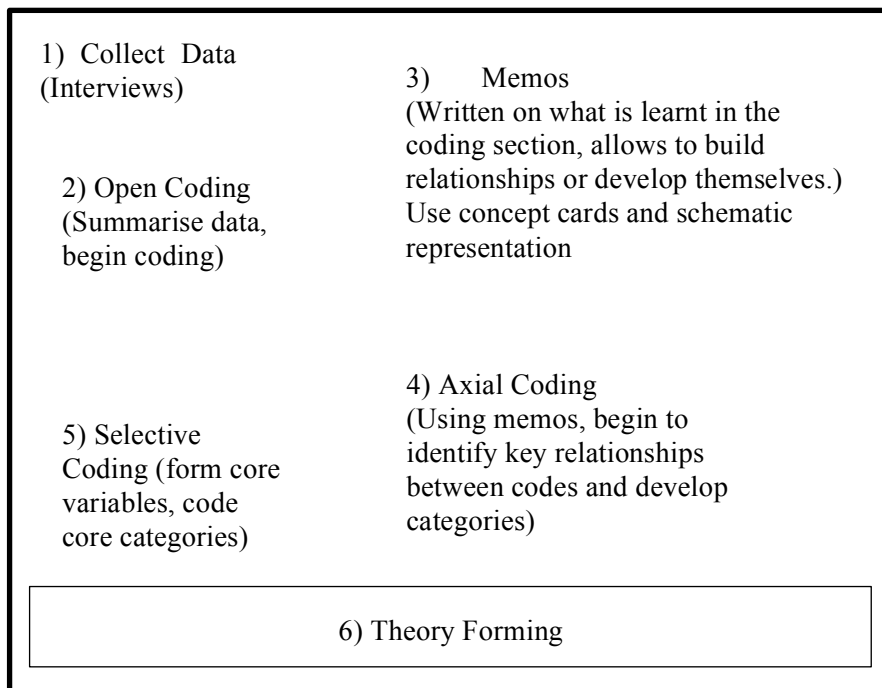


Figure 1- Lehmann (2001) Grounded Theory Model

Figure 2- Practical Grounded Theory Application



4. Sample

Although proposing a specific number of samples in a Grounded Theory study is incorrect, many theorists give an indication of a roundabout figure they require for saturation (the point at which no more participants are required).

Thompson (2011) suggests that a grounded theorist starts out with three or four general participants, upon completion of these general, random samples, a theorist can gauge a narrow scope with the intention of creating a far more focused interview process. By doing this, the eventual number of samples required is lowered as the study finds its focus earlier than usual.

The same paper conducted a study of over 100 Grounded Theory studies in a bid to find the average number of participants a typical Grounded Theory study would employ, upon completion of the study it was identified that the average number was 25, with the majority of the studies employing between 20-30 participants for their research efforts (Thompson, 2011).

The use of a smaller sample is also echoed by Charmaz (2006) who advises that a smaller study with modest aims will achieve saturation quicker, no mention of the sample size is made but one can calculate that a small study with modest aims is translated and carried by a smaller sample group.

4.1 Target Sample

For this study the sample group comprises of participants who have some relation to the road such as policemen, truck drivers, cyclists and environmentalists. The benefit of this group is that they already possess a stake in the road environment and employing them will ensure the thesis has a true account of what different users with different connections to the road think and how they perceive the technology to be in relation to assisting them

with their driving task. Whatever similarities and differences can be uncovered will serve as fruitful data.

5. Findings

The findings are currently at the memo phase, with relationships being formed. Selective coding and comparison with existing literature are the next two phases in the processing of the data. Below is an example of some of the findings currently being picked out from the data.

5.1 The Cosmopolitan Road

This code is interesting; it highlights a fundamental issue that requires solving before the system can be placed on the roads, considered as a pre-requisite. The thinking behind this code is that our road users adopt a multitude of travel variations, some use car, some use a bike, some use a truck and so on. Upon interviewing and speaking with the various groups it becomes clearly evident that there are some key underlying issues that exist which are major contributors to incidents between the various parties. The purpose of this code, once finalised, is to sit between pre-requisites and acceptance factors as a key issue to solve before the discussion of any technology.

5.3 Role of the Driver in a driverless world

A consistent code appearing is the mention of the role of the driver in this upcoming driverless world. Many of the participants accept that surrendering control is an activity they will have to do at some point and are not disheartened by this. Stages seem to be linked to this area in the sense that the automation will most definitely have various stages ranging from full driver control to full machine control, what scares participants is the issue of a handover between the two and how a scenario of this sort would look and work, especially given driver distraction in a vehicle that is fully driverless.

5.4 Zones vs. Usage

The road can be divided into different zones based on the risk each one entails. Considering two at this time, the high risk being urban and the low risk being motorway and rural, the perceived usefulness will be discussed of these two.

Participants feel that on a motorway or rural road with the limited number of variables occurring at any given time, automation would prove a helpful aid, achieving the driving task and allowing the now operator to busy themselves with a task of their choice.

In a high-risk zone, such as a town or busy high street, participants strongly united in feeling a driverless vehicle wouldn't cope with the number of scenarios that usually play out in this environment. They felt situations such as a dog running free, a delivery man blocking the road with his back doors open or the random pedestrian walking into the road may be a hard translation for a driverless vehicle, resulting in its stopping due to information overload.

5.5 Trust

Moving on, a brief mention will be made of the massive area of trust. An analysis of that section brought up this point that needs clarifying through more coding. A user would not trust a system of this scale until evidence of its benefit and application was shown, this achieved through rigorous testing stemming from controlled tests to user experiments. The concept of trust usually builds between interactions, this is still the case here but more importantly, strong evidence is required to convince users.

5.6 The Price of Change /System Availability

Undoubtedly, with an advanced system such as this, cost is a serious obstacle. Not just the cost of purchase, which is predicted at being high, but the cost of maintenance of such a system, especially when it is doubtful users will be able to do this themselves. This point leads out to very interesting areas such as system regulation, liability and loss of control.

5.7 Possible Application of Findings

Concerning a project as open ended, exciting and unpredictable as this, some boundaries or expectations have to be in place to rein in and truly understand the data and findings. An appropriate framework had to be developed that would contain all that is uncovered, while not stifling the creativity or unexpected knowledge flowing out from the findings.

Some of the possible application areas are:

- **Model-** The key area of application concerning these results is a model, similar in theory to the Technology Acceptance Model (Davis, 1989). This model will encompass the defined learning's that arise from the findings all compacted and presented in an orderly format. The schematic representation will break down the data to a multi-level understanding to display the depth that exists in the different categories. Figure 3 shows a model conducted for aviation automation, it will loosely follow the teachings from that model but will take further steps in giving the rich detail required to understand this area.
- **Baseline-** Being an early excursion into this area, it would be important to set a baseline or foundation in this area with all the learning. This foundation can support further research to delve into more specific areas that require more research. This point has come about recently due the high volume of data passing through this analysis and the realisation that one thesis is not enough to properly decipher everything learnt, rather a sterling effort to lay some foundations to allow for the author and fellow researchers to build upon.
- **Advice-** This point possibly ties in with the above point, but concerns information for fellow researchers and areas including the nature of responses within the findings. Interface Designers, Legal Colleagues, Change Managers to name but a few of those that would benefit from some of the practical advice and findings that this thesis is dealing with. In doing this, the participants' of this study can find solace in their concerns and advice being transferred to the correct groups and one of the aims of this thesis (promoting public engagement) can begin to take place.
- **Transferability-** Lastly, as a by-product, consideration has been given to creating a model which allows for autonomy related areas to be applied to other studies. In similar way to the Technology Acceptance Model which has been implemented for a wide range of projects and has seen many revised versions released; this research effort could create a similar kind of model.

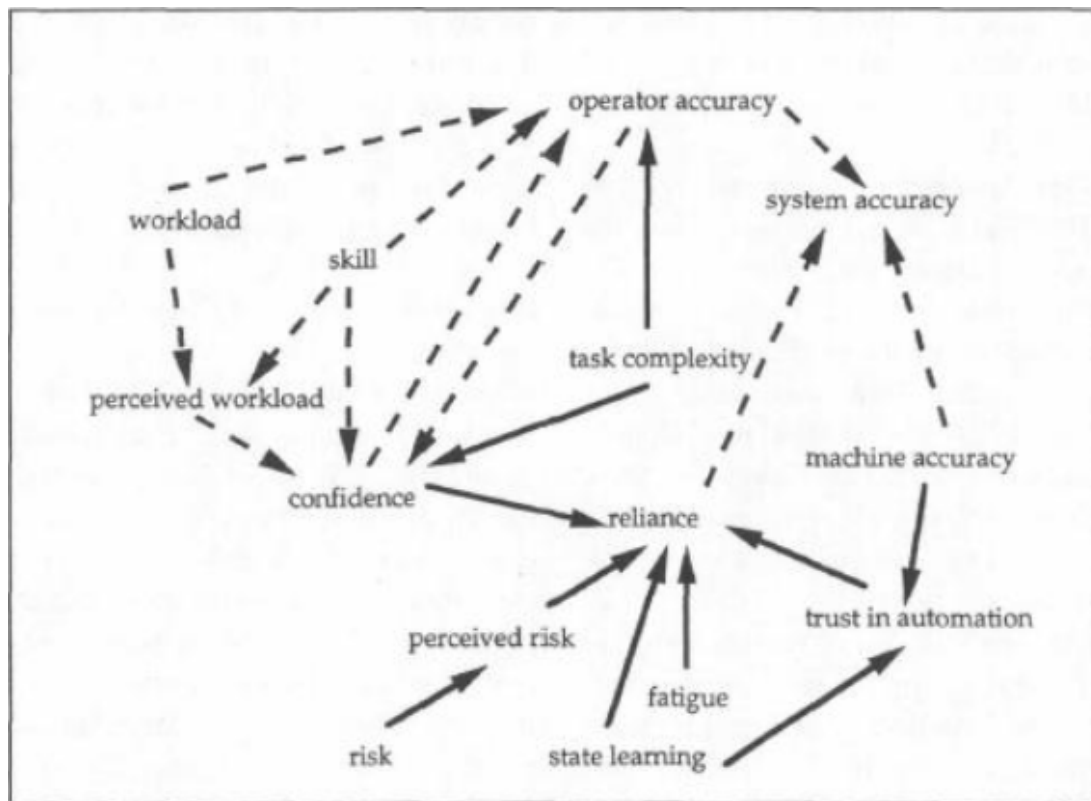


Figure 3- Interaction between factors concerning Automation Use (Parasuraman et al 1997)

6. Conclusion

This position paper proposes a technique to decipher the currently unknown area of user perception of driverless vehicles using the Grounded theory approach. In using this method the key element of the system, the user, is focal to the study and to the phenomenon. Research of this kind is currently missing from the ARTS community research studies and the continuation of this work will only yield much needed models at a time when driverless cars are being readily prepared for our roads.

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