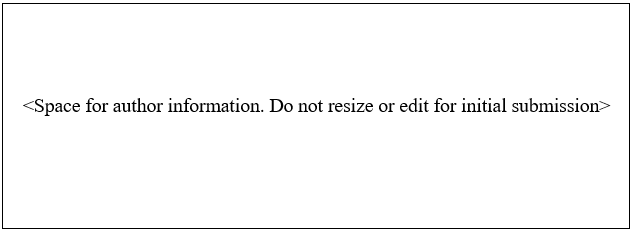
**The Impact of Mobile App Usage on Individual Behavior Changing: An Experimental Study of Driving Behavior**

*Research-in-Progress*

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**Abstract**

*Information technology is playing an increasingly essential role in driving safety by helping individuals to improve their behavior. The purpose of this research is to empirically examine the effects of IT (mobile app usage) on* *individual drivers. Based on motivation theory, this study investigates how the app usage (as well as OBD device usage) influences driver’s behavior changing and further influence their driving performance. A natural experiment is designed to collect the individual App usage and behavior data from 60 drivers. The research results will benefit both IT designer and drivers theoretically and practically.*

**Keywords:** App usage, behavior changing, driving performance, motivational theory

# Introduction

With the development of Internet of vehicles (IOV), increasingly more organizations including government agents and IT companies are paying attention to leverage information technology (IT) to improve driving behaviors.

It is acknowledged that the diffusion and deepening of the IT revolution is a hallmark of the emerging ‘information age’ (Castells 1997). And the rapid development of IT brings many gadgets with it, such as smartphones, personal computers, mobile apps and so on (Joorabchi et al. 2013; Mahmood et al. 2001; Nishad and Rana 2016). People use these IT products and applications for different purposes. And not surprisingly, as people use IT more frequently, researchers are studying the effects with growing interest (Greengard 2011).

Early studies have put more emphasis on their positive effects, including promoting the development of health care, education, business, communication, entertainment and global connectivity (Chen 2020; Cole-Lewis and Kershaw 2010; Green and Bavelier 2008; Hitt and Brynjolfsson 1996). As the research progressed, some researchers start using IT to influence human behavior (Årsand et al. 2010; Hebden et al. 2012; Hughes et al. 2010; Mattila et al. 2009; Sundaram et al. 2007; Varnfield et al. 2011). However, there is still a lack of its application on the purpose of driving safety. Thus, we planned to carry out a natural experiment to observe the changes in driving behavior and to assess the value of IT usage.

# Literature Review

## IT Usage and Behavior Changing

A typical objective of most prior IT research is to explain the factors influencing the IT usage and acceptance. In the last decades, researchers have built and tested several theorical models of IT usage, such as *theory of planned behavior* (TPB), and the *technology acceptance model* (TAM) (Taylor and Todd 1995; Venkatesh et al. 2003).

Another major objective of IT research is to assess the value of IT in terms of organizational performance. Studies show that IT usage is a key driver of good organizational performance and can effectively improve productivity (Devaraj and Kohli 2003; Hitt and Brynjolfsson 1996). Recently, IT has been used for the purpose of environmental protection. Prior researchers defined Green IT as the systematic application of practices that enable the minimization of the environmental impact of IT and allow for company-wide emission reductions based on technological innovations (Pablos 2012). Green IT is put forward because of the urgent need for sustainable development (Lubin and Esty 2010). We will definitely benefit a lot from Green IT such as saving our money, improving energy efficiency, lowering greenhouse gas emissions and so on (Erek et al. 2011; Loeser et al. 2011; Murugesan 2008).

However, only a few researchers have reported on the use of IT products and applications for individual behavior changing. Research is usually seen in certain fields such as public health and business. In the field of public health, Mattila et al. tried to record self-management of weight-related behaviors (Mattila et al. 2009), Hughes et al. developed an app for monitoring energy balance (Hughes et al. 2010), and others have monitored diet or physical activity as part of a program for diabetes (Årsand et al. 2010) or cardiac rehabilitation (Varnfield et al. 2011). When it comes to commercial field, Sundaram et al. suggested that the effective and efficient use of technology enhances salesperson performance (Sundaram et al. 2007).

## Driving Risks

In the past decades, several studies have assessed various contributing factors in driving risks. They can be roughly summarized as drivers’ driving behaviors, traits, the road condition, environment state and vehicle failures (Cai et al. 2016; Donovan and Marlatt 1982; Donovan et al. 1988; McMillen et al. 1992; Rolison et al. 2018).

From the perspective of drivers themselves, research often distinguishes between driving skills and driving style (Rolison et al. 2018). The skills component includes practice, exposure to the diversity of traffic situations and reaction time (Boyce and Geller 2002; Groeger and Brown 1989; Lajunen and Summala 1995; Li et al. 2016; McMillen et al. 1992; Özkan and Lajunen 2006). Driving style means the ways an individual chooses to drive (Rolison et al. 2018).

For all research in this area, some explains driving characteristics a complex interaction of diving skills and styles. For example, driving experience was confirmed to be a significant predictor of safety and skill-oriented driving (Lajunen and Summala 1995), for which researchers explains that practice and increased exposure to the diversity of traffic situations could be expected to improve skills, but also increase subjective control over driving and reduce concerns about safety (Näätänen and Summala 1976; Spolander 1983). And of course, age may be related to driving experience, thus many of the younger drivers tend to have higher risk of driving than older drivers (Sharkin 2004).

Many efforts have been taken to improve the driving risk assessment. However, the ways to reduce the driving risks are not taking full advantage of technology. Given that mobile apps are a novel technology that can be used to deliver behavior change interventions directly to individuals and have the potential to make a difference (Hebden et al. 2012), and little research explores the IT in terms of human driving behaviors, this study will investigate the relationship between individual level driving behavior changing and App usage behavior of the drivers.

# Theoretical Foundations

Although research on the impact of mobile Apps on individual behavior is still relatively young, theory on factors for arousing and directing a person’s behavior has already existed (Halepota 2005; Iso-Ahola 1980), and the theory is emerging as an appropriate lens for its examination (Chang et al. 2013; Lee et al. 2005). Motivational theories are such a group of theories, most of which differentiate between intrinsic and extrinsic factors: the former are concerned with the performance of an activity for no apparent reinforcement other than the activity per se. Extrinsic motivations focus on the outcome of the activity i.e. individuals are driven by the outcome rather than the activity itself (Deci and Ryan 2010; Moon and Kim 2001; Ramayah et al. 2003).

In the past decades, people’s intrinsic and extrinsic drives have been utilized to account for individual behavior. For example, researchers put perceived enjoyment, perceived ease of use as intrinsic motivation while perceived usefulness as extrinsic motivation of Internet usage (Lee et al. 2005; Moon and Kim 2001; Ramayah et al. 2003; Teo et al. 1999; Zhang et al. 2008). And referring to Steg and Vlek (Steg and Vlek 2009), behaviors can be motivated by informational strategies aiming to influence perceptions and knowledge, and by structural strategies aiming to change external factors such as policy and technology.

Thus, since the goal of our work is to explore the impact of mobile app usage on individual behavior changing, after understanding humans’ behavioral motivation, we plan to design our experiment and explain the results based on the prior theories. In our research, the participants will have access to an App which will send alert to them when it detects risky driving behaviors and provide a performance ranking at the end of the day. Considering that the App has feedback and reminder function, we will take the app as a prime extrinsic motivator for individual behavior changing. Besides, the willingness of using our app and improving their driving behavior reflects drivers’ intrinsic motivation.

In short, as our participants’ different behavior of app usage, attitude towards improving driving performance and actual changes of driving behavior can be clearly observed, the experiment is definitely feasible and reasonable.

# Research Model and Hypotheses Development

This research investigates the effects of App usage and desire for correct guidance on individual driving performance, and how their influence will differ across habits. Our research model is illustrated in Figure 1.

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**Figure 1. Research Model**

Based on motivational theories, the App probably could help improving individual driving performance as a form of extrinsic motivation by informing drivers of their driving behaviors every day. Besides, drivers’ desire for correct guidance is definitely their intrinsic motivation to change behavior. Thus, we hypothesize:

* H1: Users with higher desire to improve their driving skills will have a better driving performance.
* H2: The usage of driver-assistance App is positively correlated with better driving performance.

According to research on driving risks, individual road users differ in their personal balance between subjective, perceived safety and objective, physically or statistically determined safety, for a variety of reasons, cognitive, motivational, as well as physiological (Klebelsberg 1971; Klebelsberg 1977; Michon 1985). Specifically, increasing driving experience and exposure to traffic increases the sense of subjective control and decreases the sense of subjective risk while decreasing concern for safety aspects (Näätänen and Summala 1976; Spolander 1983). Once the driving habit has been developed, it will be difficult to change. Hence, experienced drivers are more skilled at driving but need every effort to change their driving styles. Those young novice drivers, on the contrary, will tend to have a lower-level understanding of their driving skills and make a change of driving style more easily.

Thus, although the intrinsic motivation and extrinsic help of App may drive people to change behaviors, the positive effects are constrained differently by drivers’ driving habits. Accordingly, we introduce driving habits as a moderate variable in our research model and expected that App usage and desire for correct guidance will be more influential in the group of novice drivers.

# Methodology

## Natural Experiment Design

The hypotheses will be tested by means of a natural experiment with the use of a 2 x 2 between-subject design. The treatments will be app usage (yes versus no), and desire to improve driving skills (high motivation group versus low motivation group). And we will randomly assign the drivers based on their driving habits to the 4 different groups.

In order to eliminate the error caused by different car models, we will recruit 60 different drivers from a Chinese taxi company and collect their driving behavior data in a year or so from July 2019using On-Board Diagnostic (OBD) systems, which have been incorporated into the computers on-board new vehicles to monitor vehicle components and driving behaviors in recent years (Wei et al. 2020; Yang et al. 2016).

Before the natural experiment, we will first carry out a questionnaire survey to record some demographic variables such as the participants’ age, gender and driving experience. Then participants will be presented with a mobile App that we designed for the experiment and be asked to check in if using the App. In the experiment, we’ll mainly tested two instruments. One is the drivers’ intrinsic motivation for driving in a better manner, and we will get drivers’ willingness to improve driving behavior directly from a question asked before using the App. Another is the extrinsic factor (App usage) to encourage drivers to driving better. All drivers will be paid for their participation.

## Measures

Drivers’ driving performance will be related to individual level driving behaviors. We will take the abnormal operation including the rush for driving speed, nasty brake and urgent to wait into account to calculate a driving score. Then we’ll measure driving performance by the driving score in a given day as the dependent variable. The App usage behavior of drivers (app\_usage) will be the key independent variable of interest in our estimation. It will be used to identify whether a driver has used the App, measured by the driver's check-in status in the App in a given day. Another contributing factor, drivers’ desire (high/low) for changing, will be directly gotten through a question before signing up in the App. In addition, driving habits will be seen as a moderate variable measured by driving experience (driving\_experience), which indicates the driving months of a driver.

Several control variables are considered to ensure the model robustness. For example, tired\_driving refers to hours of tired driving per day, Speed\_KMH refers to average driving speed per day and Totalmile is the total range. The demographic variables including age and gender are viewed as control variables as well.

## Procedures

Subjects will be recruited from a Chinese taxi company. We are to conduct our experiment in the following order:

* First, we will distinguish novice drivers from experienced drivers bounded by the median of all drivers’ driving experience (Brown and Groeger 1988; Underwood et al. 2003). In the next steps, drivers will be randomly assigned to each group based on their driving experience.
* According to a questionnaire survey, drivers will be divided into Group1 (high motivation group) and Group2 (low motivation group) based on the self-perceived willingness to improve driving skills.
* In each separate group, different behaviors of app usage (whether have used or not) in a given day will be observed. And then in the two groups of drivers using and not using app, driving behavior before and after using the app will be measured and recorded respectively.
* Finally, we will assess the impact of app usage on individual behavior changing.

# Preliminary Contributions

This paper paves the way for future work on empirically investigating the impact of mobile app usage on individual behavior changing. We plan to use driving score as a measure of driving behavior, and try to explain our experiment design philosophy and the expected results based on motivational theories. We hope the findings of our research can:

* Extend the current understanding of motivational theories.
* Promote further discussion of the positive impact of IT on individual behavior.
* Assist relevant organizations to develop apps aiming to help make correct guidance of driving behavior and improve driving safety.

And there are also limitations of the research that:

* The experiment uses data of drivers located in China. In spite of this, given that traffic laws and road conditions vary from country to country, one would expect that the usage of App might play a different role in individual level behavior changing in other countries.
* Over the past year, the Covid-19 epidemic has had a major impact on all sectors of society and it may have certain influence on drivers' driving behavior along with the App usage, thus causing bias.

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