

The Interaction with Smartphones in the Brazilian Driving Context

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Abstract. This article presents a survey, constructed in an online platform, with the aim to analyze and understand the Brazilians' attitudes and strategies when interacting with smartphone in the driving context. The survey was composed of 30 questions with the purpose to gather information of the target group: Brazilians with 18 years old or more, with license to drive and with the habit of using the smartphone while driving. The results show that Brazilian drivers have non-safety behavior when interacting visually and manually with the smartphone inside the vehicle, which reflects an existing behavior in the context of Brazilian traffic.

Keywords: Driver behavior · Smartphone · In-vehicle devices · Interface design

1 Introduction

The usage of smartphones has been growing more and more and it's now part of the daily lives of many people, whether at home, at work or in commuting around town. According to report "The Mobile Economy in Latin America" [1], Brazil is the fifth-largest global smartphone market. In September 2014 the country had 89.5 million of smartphone connections, that means 32.4 % of smartphone adoption and the tendency is to grow until 72.2 % in 2020.

This higher demand for smartphones has provoked worldwide a raise in application sales in the biggest app stores (Apple App Store, Google Play e Windows Phone). With the GPS antenna on smartphones, many applications are now being developed to help users and drivers on their commutes. Nowadays, there are several smartphone apps designed to be used while driving a vehicle, whether to guide the driver along the way he should go, either to give information about the traffic and to warn about the events that are occurring in the traffic (such as accidents, road works, etc.), and many other services. This means that apps for drivers offer different possibilities, not limiting to information about traffic, which requires an intense manual and visual interaction with smartphones while driving.

However, the usage of smartphone apps into vehicles requires complete attention, because of the complexity of this context. Many researchers on road safety [2–4] affirm that the driving environment is very complex, so, the addition of any new service not directly related to the primary driving task (such as maintain the lateral vehicle control and share the route with other users) may impair the road safety.

The interference caused by the interaction with smartphones must be as minimal as possible during the driving task, in order to avoid driver distractions. Thus, it is necessary to understand the drivers' needs and attitudes when interacting with smartphones, in order to suggest better solutions, making the secondary tasks as natural as possible. According to Ramm et al. [5], the more natural the interaction with in-vehicle devices the less distractions may occur during the driving task.

The whole driving context does not include only the driver-smartphone interaction, but many others like different devices into the vehicle and external/internal interferences that may impair the good performance in the driving task [2]. Consequently, the context of use should be considered when designing mobile apps.

According to Wroblewsky [6] and Clark [7], smartphone apps cannot be dissociated to its context of use, so they must consider specific aspects of the environment it will be used. Each user has his way to do certain task, but knowing the user is not enough to understand how the tasks work. That's why many apps don't fit exactly with the user's needs. According to Schumman [8] apud Magnusson [9], every activity has social circumstances and different environments, so the focus must be in how the tasks are being done, what interferes and what changes its course. This will give the necessary background to develop products more suited to the real world.

2 Driving Context and the Interaction with in-Vehicle Devices

The traffic environment is a very big system, with too many variables involved, requiring much effort of the driver in many tasks. McKnight and Adams [3] proved that the driving task is composed by more than 1500 simultaneous mental activities, making the driver incapable to maintain the focus on the primary task, thus increasing the risk of accidents.

Alongside the complexity of the driving task, products for use into the vehicle are increasingly emerging in the market, but some of them are not focused on the driving task. Lee et al. [10] define the driving context as a constant struggle for attention between secondary tasks into the vehicle and the primary driving task. Each secondary task can severely impair the performance of the primary task, increasing the risk of accidents. Every time someone engages in a secondary task, our attention in the primary one lowers, so, in order to avoid risks, the demand of the secondary task must be alternated with the demand of the primary one. Every time there is a surge of demand of both tasks, the driver may not be able to handle both tasks effectively, which may cause risks [10].

When performing a secondary task in the driving context, many important points must be considered regarding the interaction with a given device, such as the driver's field of view, vehicle vibration, the reach of interface/controls, the information

presentation and so on. All these points are constantly competing for the driver's attention that must be focused on looking at the road. According to the NHTSA guidelines [11], there are three types of distraction when interacting with in-vehicle information and communication system: visual, when the user takes the eye off the road to see another information; manual, when the user takes the hand off the steering wheel to manipulate a device; and cognitive, when the user takes your mind away from the driving task. Many factors such as interaction frequency and duration can interfere directly on the impact of distractions. Secondary tasks that remain during a long period, even if they are low level, can be very dangerous. Meschtscherjakov et al. [12] apud Ramm et al. [5] argue that "contemporary cars are often cluttered with buttons, knobs and touchscreens" that causes "a high level of mental workload and distraction". However, the in-vehicle devices are not the only ones that can cause distractions. Portable devices like smartphones could also impair the driving task.

3 Brazilian Context of Driving

The Brazilian driver has some characteristics that reflect the history of the country. According to Machado [13], the traffic is not above the society, but is a product of it. A society that is discriminatory, inhuman and disorganized will have traffic with the same characteristics. "The personality doesn't change when we sit against the steering wheel of the car. The change that may happen is that some characteristics are normally exalted in our coexistence with other, starting to manifest themselves more deeply: the desire of being the best, the braver, the need to show that we are capable to take risk without accidents, etc. Normally one can say that the man drives the way he lives" [14].

Damatta [15] declares that the traffic is regulated by public rules, that are applied to each people equally, but, due the fact that most vehicles are individual environments, people tend to feel "apart" and "beyond" these rules, which means that everyone tends to overestimate their personal abilities over both rules and other users of this public space. This phenomenon is enforced in Brazil; because of historical issues related to problems on traffic supervision and road infrastructure collaborates on an inconsequent behavior [13].

Considering the Brazilian drivers and their context of driving, some questions must be answered: How drivers have been using their smartphones while driving? What kind of information they access while driving? What is the frequency of use of apps while driving?

4 Methodology

This study aimed to analyze the most common attitudes and strategies of Brazilian drivers in interacting with smartphones while driving. This is part of a wider research that the main goal is to create usability guidelines to the design of smartphone applications for drivers based on a user centered design perspective.

In order to achieve the proposed objectives, the study used a direct user approach to understand the way drivers use their smartphones while driving, taking into account their opinion, constraints and use strategies. The method chosen was an online survey, due its wide range of distribution and accuracy of findings [16].

The full survey consisted of 27 closed-end questions and three open-ended questions divided into four sections, with some of them focused directly in identify the drivers' attitudes, strategies and behavior. Section 1 composed by 6 questions was used to screen out the target participants for this research: Brazilians with 18 years old or more, with license to drive that had the habit of using the smartphone while driving. All the respondents that did not fit in this profile were guided directly to the end of the survey. Section 2 was focused on gathering information about the interaction with the smartphone, not related to the software interaction, but to the physical environment and the hardware. Section 3, in opposition to the last one, was totally focused on the interaction with the apps. At last, Sect. 4 was composed by demographic questions, to better understand the sample of respondents.

With the purpose to eliminate any bias due to order effects, in all the questions of this survey in which the order of answers options was irrelevant (not a scale) the options were randomized. The reason behind this was to eliminate possible order effects when asking participants about their behavior using their smartphones while driving.

The Eval & GO system (www.evalandgo.com) was used to create the survey and promote online via Internet access. The survey was distributed by email and by direct link, which were followed by a recruiting message, calling for participants. The emails were sent to mailing lists; to the student corpus of PUC-Rio University and to volunteers, that accepted to distribute the survey to their own contacts network. The direct link was posted in many Brazilian blogs and forums related to smartphones or to vehicles (where it was believed to have people that may fit to the research profile) and in social networks (like Facebook, Twitter and LinkedIn).

Branching structures were used in the survey design to conduct the participant to certain pages according to his profile and skip logics were also used to avoid respondents to face questions that were not relevant, based on their previous responses. The average time spent to complete the survey was approximately fifteen minutes. The system was protected against the possibility of one same participant repeat the survey based on IP address. The survey was available online from October of 2014 to January of 2015 for a period of 3 months and a half.

5 Results

The survey gathered the total of 381 responses, being 244 corresponding to the target respondents' profile. Most respondents were in the ranges 18–29 years old and 30–39 years old, corresponding to 64 % of total respondents. Overall, the gender distribution of the sample was pretty similar, being 52 % male and 48 % female. All the sample of this study was composed by Brazilian people and can only be representative for this population, due to specific variables from Brazilian driving context. The findings of this study were divided in three main topics, each one with its own scope:

5.1 Smartphone Interaction

The data showed that smartphones have been largely used alongside the driving task. 79 % of the respondents said that they use their smartphone while driving, which is a substantial number, considering all the implications to the use of portable devices while driving. It is believed that due to the new dynamics of communication and the ubiquity of several technologies in our daily life, the use of smartphone while driving is now commonsense. Wroblewsky [6] affirms that because of its mobility, smartphones can be used in almost any context or situation, becoming one companion to almost any task, and driving is no exception.

Also, the data presented a straight relationship between the judgment of driving skills the respondent believes to have and the smartphone frequency of use while driving. The Fig. 1 shows that the major part of the respondents that believes to have very good driving skills uses smartphone apps every time they drive (54 %), while those that consider to have good driving skills have a more distributed smartphone apps frequency of use. On the other hand, most of the people (87 %) that consider to have an average driving skills use smartphones apps two times a week or less. So, it can be assumed that the more confidence someone has in his driving skills, the higher is the probability to use smartphone apps while driving.

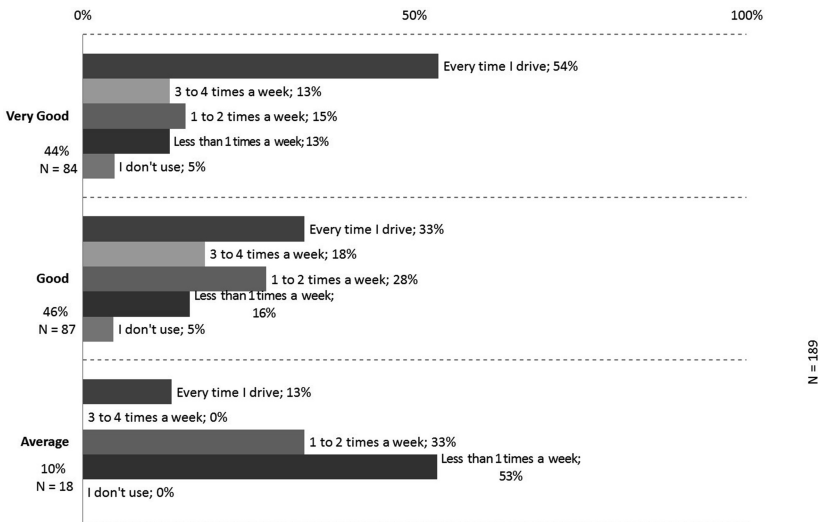


Fig. 1. Judgment of driving skills and the smartphone apps frequency of use

According to McKnight and Adams [3], it is believed that due to the complexity of the driving task, many people may struggle to keep a good performance on the primary task while performing a secondary one. However, as attested by Damatta [15], some drivers in their vehicles tend to feel more capable of performing tasks than the average

of the population, assuming that they are fully capable of perform both activities without serious damage on their performance. As can be seen, the respondents present a risk behavior because most of them consider themselves to have very good (44 %) or good (46 %) driving skills, and no one considers to have skills below average. In addition, they consider themselves able to perform secondary tasks with frequency simultaneously to driving task without realizing the aggregate risks in this performance, despite the use of mobile phones inside the vehicle be prohibited in Brazil.

Considering other devices that may be used while driving beyond the smartphone (Fig. 2), the data showed that most people use the OEM audio system (70 %) alongside the smartphone, followed by OEM/portable GPS system (46 %), MP3 players/iPod connected to the vehicle (39 %), trip computers (17 %) and OEM/portable DVD player or TV (7 %). This behavior is entirely reasonable because, in general, smartphones have additional functionalities to OEM audio system, while the functionalities of other devices may be replaced by applications available for smartphones, such as GPS systems and MP3 players/iPod (which were formerly used before the advent of smartphones). Gradually the convergence of many technologies for smartphones is becoming a reality, that is, a tendency for a near future.

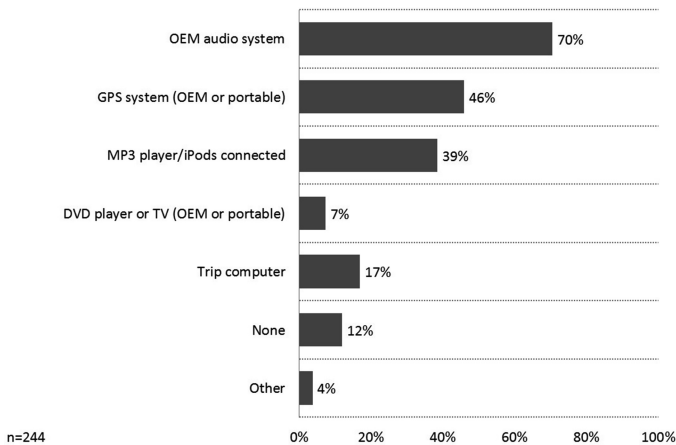


Fig. 2. Other devices used while driving beyond the smartphone

Regarding the number of devices that may be used while driving beyond the smartphone (Fig. 3), the data showed that most people (76 %) use 1 to 3 devices alongside the smartphone into the vehicle and the percentage decreases as the number of used devices increases. Despite this decline, many devices seem to be used concomitantly with smartphones, which is worrisome because the chances of the driver to engage in multiple secondary tasks are much higher. The greater the number of devices in the vehicle, the stronger is the possibility of driver distraction, the higher the risk of

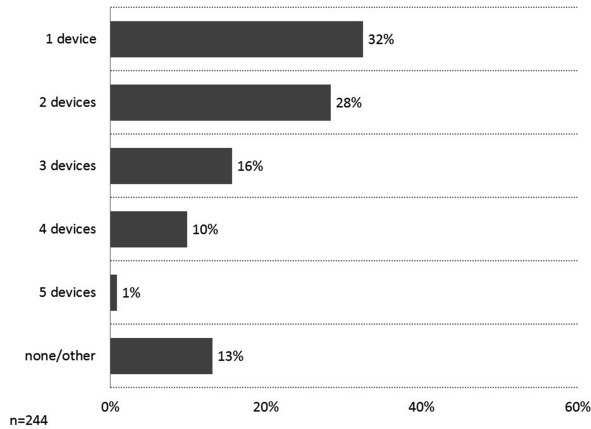


Fig. 3. Number of devices used while driving beyond the smartphone

accidents. The convergence of technologies and functionalities into a single device can be a solution, but it will only be successful and safe if the system interface is well designed, in a way that it does not interfere in the driving task.

5.2 Smartphone's Location and Access

With respect the question that focused on the place where the respondents locate their smartphone into the vehicle (Fig. 4), it was found that the most common places are near the gear shifter (45 %) and on the lap of the driver (35 %). Probably, these places are used to allow an easy arm/hand reach to grab and drop the smartphone, once text messaging is one of the most frequent tasks performed with mobile phones [17]. So, people tend favor closer places to locate their smartphones rather locate them on windshield mounts (15 %) or dashboard mounts (14 %), which are safer places considering the visual attention that the driver must to keep to look at the road. Locating the smartphone far below the driver's line of sight looking at the road can offer risks to him by both diverting his sight off the road to grab and interact with the smartphone and keeping his hand off the steering wheel to hold the device [11].

It is believed that this behavior is related to some factors that favor its occurrence. The first factor to be pointed out is the security of the driver when exposing the smartphone (very expensive in Brazil) for muggers through the vehicle's windows. Machado [13] says that Brazil has epidemic problems related to road security: "We feel constantly threatened, frightened, hoping that urban violence not catch us". Thus, using safer mounts on windshields or dashboard may expose the smartphone too much, making the driver a target for urban violence. This may be a reason why drivers "hide" the smartphones on their laps or near the gear shifter.

Another reason to be pointed out is the comfort in holding the smartphone by hand during the interaction. Since vehicles are in constant trepidation and the difficulty to touch small targets on touchscreens, the respondents may prefer to hold the device by

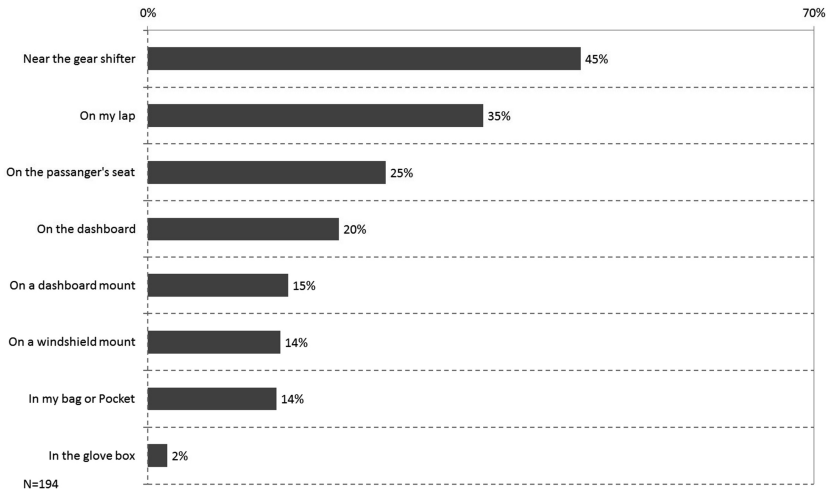


Fig. 4. Places where the smartphone are located into the vehicle

their hands to have more accuracy in typing. Moreover, they use apps that require to typing on small keyboards, like chats (see also Fig. 5).

The location where people place their smartphone into the vehicle influences some other decisions related to the interaction, such as the finger used to interact with the interface. The data shows that in most cases users prefer to use thumb (55 %) over index (42 %) and middle (7 %) fingers for interacting (minor and ring fingers were not selected as a option).

The only smartphone locations where the index achieved higher rates were for windshield mount and dashboard. It is believed that the location of the smartphone display right in front the driver’s view may favor the reach of the index, but, even with this result, the rate of the thumb is still very high. As said before, the vehicle vibration may be a factor that favors the holding of smartphone by hand during the interaction. Another reason to be considered is that, outside the vehicle people usually interact with their smartphones with the thumb finger, and that may be a factor that favors the permanence of this behavior inside the vehicle.

5.3 Safety Aspects

Concerning the safety issues, the results showed that by many reasons, most of Brazilians do not have a safety oriented driving behavior. As seen before, most of people locate their smartphones in places that can lead to visual and manual distractions. Also, they are using multiples devices while driving that can compete to the control of the vehicle.

Another factor that presents a non-safety oriented behavior is the use of smartphone apps not related to the driving task, like chat apps, social networks, e-mail and SMS/MMS. Figure 5 shows that there is a high percentage of use of chats apps (51 %)

and SMS/MMS (23 %) while driving, most of them to be more available to family or friends according to other questions.

Many researchers are studying the effects of text messaging while driving and the risks to road safety. In a study conducted by Hosking et al. apud Hallet et al. [17], they found out that participants drivers spent up 400 % more time text messaging than performing other tasks. Not only the visual and manual distraction is a concern when analyzing the effects text messaging, but also the cognitive distraction should be taken into account when considering this behavior. Regan et al. [2] affirms that texting while driving is one of the topics of research in driver distraction, and is considered one of the main sources of distraction. Campaigns like the distraction.gov (<http://www.distraction.gov/>) promoted by NHTSA alert about the serious risks related to the texting while driving, but even so, people still present a high percentage of use of chat apps.

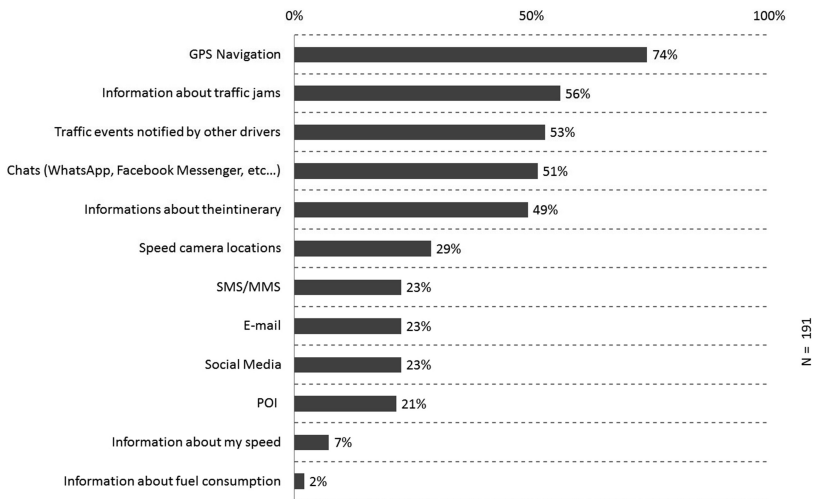


Fig. 5. Information accessed while driving

Even ignoring some safety issues, respondents seem to be concerned about their own safety. Figure 6 shows an analysis of the level of agreement with the statement “I wouldn’t mind to use some apps functions that might distract me while driving”, using a 7-point Likert scale. The data presented show a very disperse result with no answer above 40 % of agreement, which shows some divergent opinions, but with the bell curve tending to disagree with the statement. This means, according to the data, that respondents do mind to use apps that may cause distraction. There is a clear controversy in these data, showing that drivers with a non-safety oriented behavior are concerned about their safety. It is almost evident that there is no perception about the risk inherent in their attitudes, and they think they are not exposed to risks. It is also believed that this phenomenon is related to the fact that drivers inside their vehicles tend to feel above of any danger in the traffic, blaming the outside environment for all the risks [13, 15].

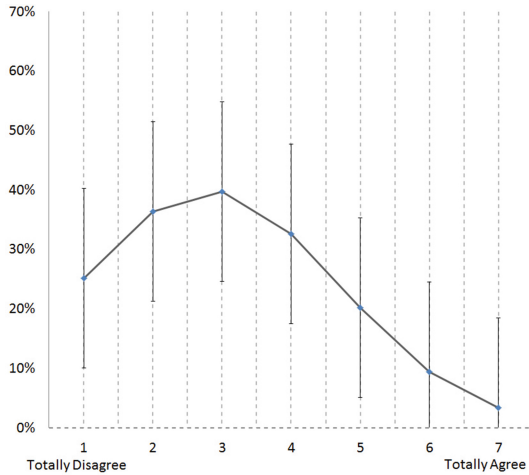


Fig. 6. The level of agreement with the statement “I wouldn’t mind to use some apps functions that might distract me while driving”.

6 Discussion and Conclusion

This study aimed to analyze the most common Brazilian attitudes and strategies when interacting with their smartphones while driving. To achieve this objective, an online survey was conducted and many issues related to road safety were found.

The research concluded that most of the drivers uses their smartphones while driving, alongside some other devices, such as OEM audio system and a GPS navigation system. It was also found that most of the drivers prefer to place their smartphones in locations that allow them to easily grab/drop the device. Considering this, it is clear that people prefer to hold their smartphones by hand, and not place it on windshield or dashboard mounts, where is safer due to the visual demand required by driving task. This behavior can be related to many factors, such as the use of chats apps while driving, the habit of using the smartphone holding by hand in other contexts or even the comfort to grab/drop the device easily at any time. Those facts also interfere in the way drivers connect their smartphones with the vehicle, in order to allow the free mobility of the device by hand (the most common connection is by Bluetooth).

It is believed that most of the decisions about the use of smartphone while driving are narrowly related to the driver’s self-confidence and to social/cultural aspects that may affect the way drivers concern themselves to the safety aspects [14]. As said before, self-confident drivers may feel themselves above all the rules and immune to the dangers related to the traffic environment [13, 15], without even perceiving them, consequently favoring comfort aspects rather than safety ones (e.g. placing the smartphone on the lap).

Considering the influence that self confidence and the low/non consideration of safety aspects may have in the way people interact with their smartphones while driving, it can be concluded that those variables are crucial factors for the interaction

process, defining attitudes, strategies and approaches. If those variables are so crucial for the interaction, they cannot be ignored in the design of applications for drivers. Designers must be aware of all those factors and how they affect the interaction, in order to adapt the product to the real context of use, mitigating the potential risks inherent to them.

Even knowing the sample of respondents of this research is restricted to Brazil, the findings of the study are similar to other researches about drivers' behavior in other countries, with a whole different environment for driving task. Studies conducted by Hallet et al. [17] in New Zealand, by Magnusson et al. [9] in Sweden and Heikkinen et al. [18] in Finland, also concluded that drivers tend to have a non-safety oriented behavior while driving. It is believed that this is a tendency directly related to the driving context, being so; this must be a top priority for studies related to the road safety. Some projects seem to indicate this awareness, such as the Open Mobile Alliance, led by Google Inc. and some automakers, in order to develop safe technology for vehicles based on the Android system. Apple Inc. also released in partnership with some automakers the CarPlay, a technology that connects the iPhone to the built-in display of the vehicle with the goal of a safer interaction. However, this technology is still restricted to few expensive vehicles.

This study is part of a wider research about usability of smartphone applications for drivers. For the next step, the research will conduct field studies to better understand the data found in this survey and validate some hypotheses, to transform them in guidelines for the design of applications for drivers.

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