Preventing and Reducing Distracted Driving Using Smartphone

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Abstract

This paper discusses the parameters causing distracted driving of automobiles, especially the use of mobiles during driving either replying on phones or texting. Also, it examines previous studies that have shed the light on this analysis of the responses of drivers on a survey prepared to measure and quantify this phenomenon in Kuwait state, and finally suggesting some approaches or technical methods -using Smartphone applications- to prevent or reduce the effects of distracted driving on driving cycles and accidents occurrence. A questionnaire is carefully designed to measure the spread of this phenomenon between drivers in Kuwait and reveal if such drivers knowing its bad effects on them and other human beings and insure the smoothness of driving on streets. The study includes about 735 drivers includes Kuwaiti, non- Kuwaiti, male and female drivers. SPSS is used here to analyze the responses and hypotheses testing. It is found that using mobiles with different applications contributes to distracted driving with high percentages and causes unsafe situations for drivers and passengers and may cause traffic accidents. The need for Distracted Driving Prevention System (DDPS) is crucial to decrease Distracted Driving (DD) and increase safety of driver and passengers. The implantation indexes of different parameters supporting the DDPS are over "very good" which indicates that if such parameters are controlled and drivers' commitment is good the DDPS will be in good level and DD will be decreased. It was found that 25% of drivers rarely use mobiles while driving, and about 17% have never used mobiles during driving. On the other hand about 60% of the drivers sample think that using mobiles during driving is very dangerous and 80% think that this may cause an accident. While the results showed that while stopping at traffic lights 15% of drivers never talk by mobile, 25% rarely talk and 36% are "sometimes" talk. The results section has more details of percentages of all cases discussed in this study.

Keywords: Distracted, Driving, Smartphones, Transportation, Accidents, driving cycles, Kuwait.

I Introduction

1.1 Background

Distracted driving is one of the most common and dangerous behaviors around the world. Mobile phone use while driving has been identified as one of the biggest concerns to global road safety. According to naturalistic driving studies conducted in the United States, drivers engaged in mobile phone visual-manual tasks had a 73% increased risk of a crash [1]. Distracted driving is the biggest cause of traffic accidents. However, minimal efforts have been made to detect phone distraction, which is an important input for implementing early safety actions. All three categories of phone distractions (visual, physical, and cognitive) can have an influence on the driver, increasing the probability of a crash by up to 23 times [1]. Though law enforcement and insurance penalty policies help to raise public awareness and reduce car accidents, their impacts are limited. According to reports, portable device distractions cause 1.6 million crashes in the United States each year, and over 400,000 people were wounded or killed in car accidents caused by cell phone use in 2018 alone [2]. Since the COVID-19 pandemic, there has been a 17% increase in driver phone use, as more people attempt to make Zoom calls, read Instagram messages, or text while driving. More measures are urgently needed to limit driver handheld phone use to improve traffic safety [3]. Figure 1 shows a driver using the phone while driving and how its effects on car drivability.

Figure 1 A driver using the phone while driving and how its effects on car drivability [16].

1.2 Physical Analysis and Safety Distance

To determine how far the vehicle will travel while braking, use the formula of

$$Distance\ while\ Braking = 0.5 * V0 * Tr + Trec \quad (1)$$

Where V0: is the initial velocity, Tr: time required to stop and Trec is Reaction time= reaction time of either 88 feet for a second delay in reaction time, or 176 feet for two seconds reaction time

Stopping time=Initial speed / vehicle deceleration rate (2)

Vehicle deceleration rate is usually 20 ft/s^2 or 62 m/s^2 [4].

1.3 Reducing Distracted Driving Software

The first program to limit distraction while driving is "Drivemode" which silences calls, messages, and alarms from your phone once you reach 15 miles per hour and can send out real-time autoreplies. It's free (although it contains advertisements), and parents with young drivers can set it to inform them when the app is deleted. The second app is "OnMyWay," which suppresses text and app alerts when you drive faster than 10 mph but allows you to answer calls if your phone is connected to your car's Bluetooth. Apps like Google Maps and Spotify will continue to function if they are engaged before you get on the road or while you are stopped. The software and its users, according to the business, averted over 23,500 crashes and saved over 150 lives in its first 14 months of use "with mathematical certainty." The third application, SAFE 2 SAVE, employs an incentive mechanism to urge drivers to refrain from texting and driving. You get two points for every minute of safe driving above 10 mph, and you can then redeem those points by clicking on icons. You can also get competitive by organizing games with friends, family, or coworkers to see who the safest driver is. TrueMotion, the fourth program, does not disable your phone while you are driving. Instead, it uses a rating scale to provide feedback on how you're performing. It can also tell you exactly when you were driving while distracted. The fifth application is "I'm Driving," which alerts you when someone on your contact list is driving so you don't text them. The user must, however, notify others that they are driving by starting and stopping a button on the pap. Other options include "Use Do Not Disturb Mode", "Use Car Mode on Your Favorite Apps", and "Try a Virtual Assistant" [5].

1.5 Literature Review

Many studies, papers, and chapters addressed the topic of distracted driving caused by using mobile devices while driving, including demonstrations of the problem, elements influencing the process, and possible solutions. Trespalacios et al. (2020) conducted a qualitative study to assess the acceptability of smartphone applications meant to prevent distracted driving in this publication. A total of 35 drivers (57 percent females) aged 19-44 years (Mean = 28.43) took part in interviews that investigated the acceptability constructs for in-vehicle intelligent technology as defined by Regan et al. (2012): usefulness, usability, effectiveness, social acceptability, affordability, and willingness to use the application functions. In general, drivers believed that these apps had the potential to improve safety and reduce both voluntary and involuntary mobile phone interactions while driving. Nonetheless, it was discovered that drivers prefer to preserve certain of their mobile phone's features, such as music playing applications, access to GPS/maps, and the ability to engage with specific groups of people while driving. Finally, the challenges to application adoption among drivers who use their cell phone while driving are examined. A common barrier that must be addressed is the driver's perceived need and pressure to reply to their phone while driving in order to communicate for business or with people with significant social links to the driver, such as a parent or spouse [6]. Khan et al. (2021) provided a thorough examination of the current solutions for identifying difficulties in smartphone activities. The examination started by investigating the flaws in present smartphone user interfaces using empirical evaluation and dataset-based evaluation. The findings revealed that using cellphones while driving can disrupt normal driving and cause rapid steering wheel changes, loss of focus, and increased cognitive load, all of which can lead to a disastrous situation. To back up their claims, an empirical study was conducted in which data of 98 drivers was collected via a maxed mode survey, which included questionnaires and interviews. The findings revealed that existing smartphone-based solutions are the least suitable due to a variety of issues (e.g., complex and rich interfaces, redundant and time-consuming activities requiring a high level of visual and mental attention, and contextual constraints making their effectiveness less viable for drivers). Based on the results of Ordinal Logistic Regression (OLR) models, it is suggested that interactions between drivers and smartphones be limited by building context aware adaptive user interfaces to reduce the likelihood of accidents [7]. Ali (2021) offered an overview of recent studies on in-vehicle driver distraction, with a focus on mobile phone usage, as this technology has received the most attention in the driver distraction literature. This evaluation discusses the effect of in-vehicle electronics on driving performance. The adaptive procedures that drivers utilize to maintain acceptable driving performance while distracted are explored, as are the instances in which these adaptive approaches can fail and how driving performance suffers as a result. Legislation preventing drivers from using cell phones while driving has had little impact, owing to a lack of regulation and enforcement. Behavior modification programs, improved vehicle safety, and public awareness campaigns have all been developed as viable preventive methods to reduce accidents caused by distracted drivers. [8]. Bergmark et al. (2016) reported the creation and preliminary evaluation of the Distracted Driving Survey (DDS) and score in this study. A research team used semi-structured interviews to generate survey items, which were then pilot-tested and evaluated in young drivers for validity and reliability. Questions centered on texting and driving, as well as the usage of email, social media, and maps on cellular phones, with particular questions about the driving speeds at which these activities are carried out. In 228 drivers aged 18 to 24, the DDS demonstrated strong internal consistency (Cronbach's alpha = 0.93) and relationships with reported 12-month crash rates. The score is given on a scale of 0 to 44, with 44 representing the most dangerous behaviors. The likelihood of reporting a car accident rises by 7% for every unit increase in the DDS score. The poll takes two minutes to complete, or less than five minutes if demographic and background information is provided. Text messaging was popular; 59.2 and 71.5% of respondents stated they had written and read text messages while driving in the previous 30 days, respectively. The DDS is an 11-item scale that assesses the risk of cell phone-related distracted driving and includes viewing and writing sub scores. In drivers aged 24 and younger, the measure indicated high validity and reliability. The DDS could be useful for calculating rates of cellphone-related distracted driving and evaluating public health measures aimed at reducing such behaviors [9]. Using a social- and delay-discounting paradigm, Foreman et al. (2019) investigated how the sender's relationship to the driver, as well as the delay to the destination, may influence the decision to text while driving. Ninety-four (94) undergraduate students participated in a hypothetical social- and delay-discounting exercise in which they estimated their likelihood of responding to a text message immediately vs waiting until they arrived at their destination. The sender's social distance and the delay to the target differed across experiments. For both social and delay discounting, the likelihood of responding and waiting reduced as a function of social distance and delay to the target, respectively. Participants were more likely to text while driving when the sender's social distance fell and the distance to the destination rose. Social discounting changed inversely as a function of destination delay: the shorter the delay, the larger the social discounting. The data suggest that the sender's social distance is an essential factor in the decision to text while driving. If the sender was less socially distant, participants were more likely to respond to a text while driving. When they were closer to their destination, they were less likely to respond to socially distant people. The role of social consequences in drivers' decisions to text and drive is examined [10]. George et al. (2018) investigated the functions of mobile phones used by young adult drivers while driving. Results: An online survey of 17-24-year-old drivers (N = 612; 428 females) and focus groups with drivers aged (N = 18; 8 females) revealed that mobile phone use while driving was a very common behavior, with more full license drivers using their phone to make/answer calls, send/read text messages, and browse the internet than Learner/ Provisional drivers. The purpose of mobile phone use while driving varies, with phones typically used for amusement (e.g., to play music), communication (through texting and/or voice calls), and navigation. Finally, young individuals utilize their phones for a number of purposes while driving. It is critical that young driver-targeted intervention initiatives recognize that numerous features of the mobile phone are used during the drive, and it serves multiple objectives. It is necessary to investigate the inhibitors and facilitators of mobile phone use and its many functions while driving, as well as to determine whether the use of specific mobile phone features is consistent across different driver cohorts [11]. Gliklich et al. (2016) Texting and other cellphone-related distracted driving are expected to cause thousands of car accidents each year, but studies on drivers' precise cell phone reading and writing habits are sparse. The purpose of this research was to determine the prevalence of cellphone-related distracted driving behaviors. In 2015, a national, representative, anonymous panel of 1211 US drivers was recruited to complete the Distracted Driving Survey (DDS), an 11-item validated questionnaire investigating cell phone reading and writing behaviors and the speeds at which they occur. Higher DDS scores indicate greater distraction. DDS and self-reported crash rate were used to analyze DDS ratings. Almost 60% of respondents indicated a cell phone reading or writing activity in the previous 30 days, with reading texts (48%), writing texts (33%), and examining maps (43%). Only 4.9% of those polled had signed up for a program aimed at minimizing cell phone-related distracted driving. DDS scores were substantially connected with crash rate (p b 0.0001), with every one-point increase associated with a 7% increase in crash risk (p b 0.0001). DDS scores were shown to be inversely associated to age (p b 0.0001). The DDS had a high level of internal consistency (Cronbach's alpha = 0.94). A national sample shows high rates of cell phone-related distraction. Distraction is linked to higher crash rates in all age categories, but it is most prevalent in younger drivers. The DDS can be used to assess the effectiveness of public health initiatives targeted at reducing cellphone-related distracted driving [12]. Hassani et al. (2017) the goals of this study were to create, test, and improve a distracted driving presentation for college students to modify their understanding, attitude, and behavior around distracted driving. A 30-minute multi-media presentation on distracted driving was given to 444 college students from 19 colleges and institutions (mean age 23.7 ± 7.0 years, 61% females, 39% men). Students took three surveys: one before the workshop (interview 1), one immediately after the workshop (interview 2), and one three months later (interview 3). By comparing the changes between interviews 1 and 2, it was discovered that 15 of the 15 attitude-knowledge-based questions improved considerably after the course. Furthermore, they examined changes between interviews 1 and 3 and discovered that 11 of the 15 attitude-knowledge based questions retained their importance. Responses to behavior-related questions at three months were also compared to baseline, and 12 of the 14 questions showed substantial changes. While this study was successful in altering short-term attitudes, knowledge, and behaviors related to distracted driving, more effort is required to sustain (and evaluate) long-term impacts [13]. Trespalacios et al. (2019) explored factors influencing the usage of voluntary smartphone apps to lessen the distraction associated with mobile phone use while driving. A total of 712 Australian drivers completed an online questionnaire about their preferences and thoughts about smartphone applications to minimize distracted driving. Statistical studies were performed, including a random-effects logistic regression model, to examine the impact of application functions on participants' propensity to install and activate the program. The ability to disable visual-manual chores and notifications and allow hands-free discussions determined participants' willingness to install and activate a mobile phone app. It was also useful to be able to set up automatic answers to notify contacts that they were driving. Females were far more likely to download and use the app. The restriction of visual manual interactions such as messaging and surfing while enabling programs that enhance driving such as GPS and Bluetooth were among the preferred functions. Participants also desired the option to use music-playing functions to be preserved. The ability to offer phone commands solely through audio utilizing a hands-free device or Bluetooth was also desired. When investigating favored functions, several age-related variances were discovered. Overall, the results showed that using app-based technology to limit exposure to high-risk behaviors among motorists, particularly young drivers, is a viable intervention option [14]. Trespalacios et al. (2020) investigated the utility of two versions of the technologies Acceptance Model (TAM), the Theory of Planned Behavior (TPB) and the Unified Theory of Acceptance and Use of Technology (UTAUT), for understanding the acceptance of distraction-reducing technologies. Participants were shown two distinct applications and asked questions about their views toward the criteria included in the TAM, TPB, and UTAUT, as well as their intent to use the technology. A total of 731 people took the survey, and their replies were examined. Davis' (1985) TAM was found to be marginally better in describing behavioral intent for both Mobile Phone Application (MPA) 1 and MPA 2, explaining 66.1% and 68.7% of the variance, respectively. Davis' (1989) TAM and TPB came in second and third, respectively, whereas the UTAUT explained the least in behavioral intent of all the models. Overall, the study's findings support the use of psychological theories to assess the acceptance of mobile phone applications [15]. Wang et al. (2021) present a phone-use monitoring system that detects the beginning of the driver's handheld phone use and immediately eliminates the distraction. The suggested system produces periodic ultrasonic pulses to detect whether the phone is held in hand or put on support surfaces (e.g., seat and cup holder) by collecting the unique signal interference caused by the contact object's damping, reflection, and refraction. To describe such impacts, short-time Fourier was constructed to transform from microphone data and train a CNN-based binary classifier to distinguish phone use between handheld and hands-free modes. Furthermore, they developed an adaptive window-based filter to correct classification errors and detect each handheld phone distraction occurrence, including its start, end, and length. Extensive testing with fourteen persons, three phones, and two automobile models reveals that our system recognizes handheld phone use occurrences with 99% accuracy and a 0.76-second median error in estimating the distraction's start time [3]. Jr (2022) stated that according to figures compiled by the National Highway Traffic Safety Administration in the United States, 3,142 persons were killed in incidents due by distracted driving in 2019, with texting being the most concerning distraction. Sending or reading a text, for example, takes your eyes off the road for five seconds. At 55 mph, that's equivalent to driving the length of a football field. Consider doing it with your eyes closed. Furthermore, according to the American Safety Council, one out of every four car accidents involve a cell phone, and drivers who use a cell phone are four times more likely to be involved in a crash. Despite the well-publicized consequences of texting and driving, drivers continue to engage in this risky habit. In a nationwide poll done by the AAA Foundation for Traffic Safety, 94.9 percent of respondents said reading from a phone while driving was extremely or very dangerous, and 95.5 percent thought texting or emailing was similarly harmful. However, 33.9 percent of those same respondents claimed to read from their phones while driving in the previous 30 days, and 22.7 percent admitted to composing a text or email. Is the true percentage likely to be higher? Yes! According to the National Conference of State Legislatures, up to 80% of the United States' 220 million wireless customers use their phones while driving. If this estimate is right, one conclusion to be reached is that not all offenders are willing to acknowledge to partaking in this type of risky behavior [16].

2 Methodology: Materials and Methods

A Survey is implemented here to measure the status of preventing distracted driving by addressing smartphone use in Kuwait state, the survey contains about 51 questions, the first 12 questions are related to demographic information about the selected sample, then the second category which composed from 25 questions are related to the behavior of the drivers with mobiles during driving the car, the third category (about (14) yes/no questions) are related to the use of applications used to reduce mobile phone distracted driving. Likert scale is used here to find the average scores of the questions such as: always (Very likely) =5, usually (Likely) =4, sometimes (Neutral) =3, rarely (unlikely) =2 and never (very unlikely) =1. For questions contains three scales: very much =5, neutral=3, and not at all=1. For yes/no questions: yes=5, No=1.

2.1 Study Questions and Hypotheses

-Study questions

The survey of this study presents 50 questions that target the objectives of this study. Most of the survey questions were based on previous research (Oviedo-Trespalacios et al. (2019), Hassani et al. (2017), and Atchley et al., (2012)). The rest of the questions were created in order to target the rest of the objectives that are specific to Kuwait drivers. The study's questions can be summarized as follows:

The study presents a lot of questions which can be summarized as follows:

-Is using mobile for calling or texting others during driving influence driving distraction?

- Is using mobile for calling or texting others during stopping on red light or traffic congestion influence driving distraction?

-Is using mobile for gaming or tracking GPS application and social media during driving influence driving distraction?

- Is using mobile for gaming or tracking GPS application and social media during stopping on red light or traffic congestion influence driving distraction?

- Has using a phone while driving ever caused the driver to feel unsafe or almost get into an accident?

- Are the applications used to reduce mobile phone distracted driving have the power to reduce or prevent distracted driving?

-Are the applications used to reduce mobile phone distracted driving have a positive effect on the driver and drivability of the car?

- Are the applications used to reduce mobile phone distracted driving are accepted by drivers?

To analyze the results of the survey, the distracted driving system has many variables which are divided into four main variables as shown in table 1 below.

Table 1. Variables of the study

	Number	Construct latent variable	Identifier
Distracted Driving Prevention System **(DDPS)**	1	Using Mobile for Different Applications While Driving.	UMDAWD
	2	Using Mobile for Different Applications While stopping	UMDAWS
	3	Applications used to reduce mobile phone distracted driving	ARMPDS
	4	Applications used to reduce mobile phone	ARMPDDLA

		distracted driving limitations acceptance.	

2.2 Study Hypotheses

The study has sixteen hypotheses as follows:

1- Using Mobile for Different Applications While Driving (UMDAWD)

$H1_0$: Using mobile for calling or texting others while driving has no influence on driving distraction (DD) and its performance and may cause an accident.

$H1_1$: Using mobile for calling or texting others while driving has a significant effect on driving distraction (DD) and its performance and may cause an accident.

$H2_0$: The place of keeping the phone in the car has no effect on driving performance (DP) during driving.

$H2_1$: The place of keeping the phone in the car has a significant effect on driving performance (DP) during driving.

$H3_0$: Sending a text message while driving has no effect on driving distraction (DD).

$H3_1$: Sending a text message while driving has a significant effect on driving distraction (DD).

$H4_0$: Using mobile while driving has no effect on the drivers' feeling unsafe or almost get into an accident /DDPS.

$H4_1$: Using mobile phones while driving has a significant effect on the drivers' feeling unsafe or almost get into an accident/DDPS.

$H5_0$: Posting on social networking sites while driving has no effect on the driving distractions (DD).

$H5_1$: Posting on social networking sites while driving has a significant effect on driving distractions (DD).

$H6_0$: The current laws related to using mobile devices while driving have no effect on driving distractions (DD).

$H6_1$: The current laws related to using mobile devices while driving have a significant effect on driving distractions (DD).

2-Using Mobile for Different Applications While stopping (UMDAWS)

$H7_0$: Using mobile for calling or texting others during stopping on red lights or traffic congestion has no effect on driving distraction prevention system (DDPS).

$H7_1$: Using mobile for calling or texting others during stopping on red lights or traffic congestion has a significant effect on driving distraction prevention system (DDPS)

$H8_0$: Using mobile for gaming or tracking GPS application and social media during stopping on red light or traffic congestion has no effect on driving distraction (DD).

$H8_1$: Using mobile for gaming or tracking GPS application and social media during stopping on red light or traffic congestion has a significant effect on driving distraction (DD).

$H9_0$: While stopped at red lights or traffic congestion, accessing a social networking site, and playing games has no effects on driving distractions (DD).

$H9_1$: While stopped at red lights or traffic congestion, accessing a social networking site, and playing games has a significant effect on driving distractions (DD).

$H10_0$: While stopped at a red light or stop sign, using mapping/GPS applications have no effects on driving distractions (DD).

$H10_1$: While stopped at a red light or stop sign, using mapping/GPS applications have a significant effect on driving distractions (DD).

3-Applications used to reduce mobile phone distracted driving (ARMPDS)

$H11_0$: The applications used to reduce mobile phone distracted driving have no power to reduce or prevent distracted driving (DDPS).

$H11_1$: The applications used to reduce mobile phone distracted driving have the power to reduce or prevent distracted driving (DDPS).

$H12_0$: The applications used to reduce mobile phone distracted driving have no positive effect on drivers and cars' drivability (CD).

$H12_1$: The applications used to reduce mobile phone distracted driving have a positive effect on drivers and cars' drivability (CD).

$H13_0$: By experienced driving with an app to reduce mobile phone distracted driving, it has no effect on improving drivers' behavior and reducing driving distractions (DD).

$H13_1$: By experienced driving with an app to reduce mobile phone distracted driving, it has a significant effect on improving drivers' behavior and reducing driving distractions (DD).

4-Applications used to reduce mobile phone distracted driving limitations acceptance (ARMPDDLA)

H14$_0$: The applications used to reduce mobile phone distracted driving are not accepted by drivers (DDPS).

H14$_1$: The applications used to reduce mobile phone distracted driving are accepted by drivers (DDPS).

H15$_0$: Block texting, browsing, social media, and other non-driving apps that require vision are not accepted by drivers and influences on decreasing driving distractions (DD).

H15$_1$: Block texting, browsing, social media, and other non-driving apps that require vision are accepted by drivers and influences on decreasing driving distractions (DD).

H16$_0$: All functions of the Applications used to reduce mobile phone distracted driving have no positive effect on driving distractions (DD).

H16$_1$: All functions of the Applications used to reduce mobile phone distracted driving have a positive effect on driving distractions (DD).

3 Results and Discussion

3.1 Demographic information

Figure 2 shows the sample of the questionnaire distribution related to gender and nationality of the drivers within the sample.

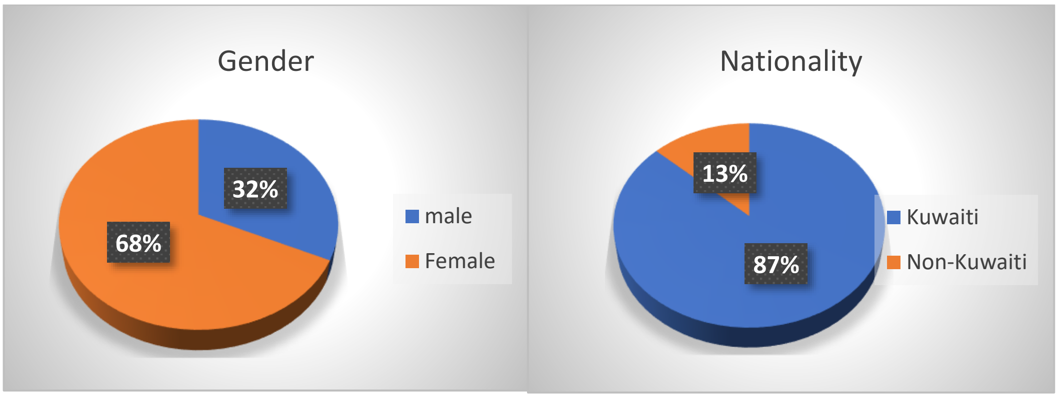


Figure 2. Samples' distribution related to gender and nationality.

Figure 3 shows the sample of the questionnaire distribution related to drivers age and employment status of the drivers within the sample.

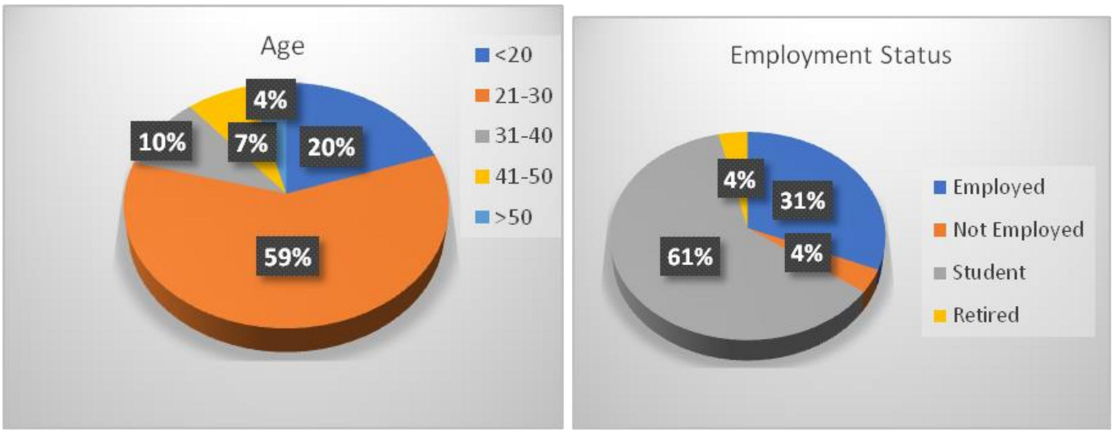


Figure 3. Sample of the questionnaire distribution related to drivers age and employment status.

Figure 4 shows the sample of the questionnaire distribution related to drivers' monthly income and marital status within the sample.

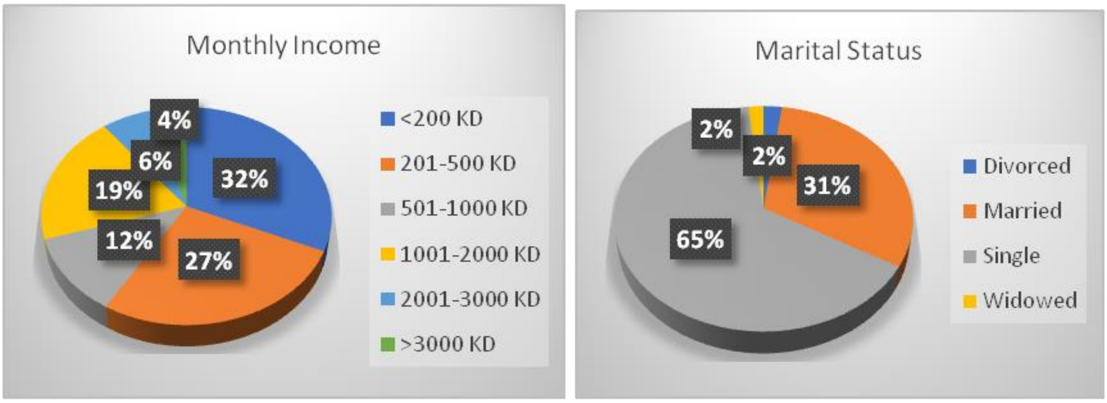


Figure 4. The sample distribution related to drivers' monthly income and marital status.

Figure 5 shows the sample of the questionnaire distribution related to drivers' time of driving daily and number of children within the sample.

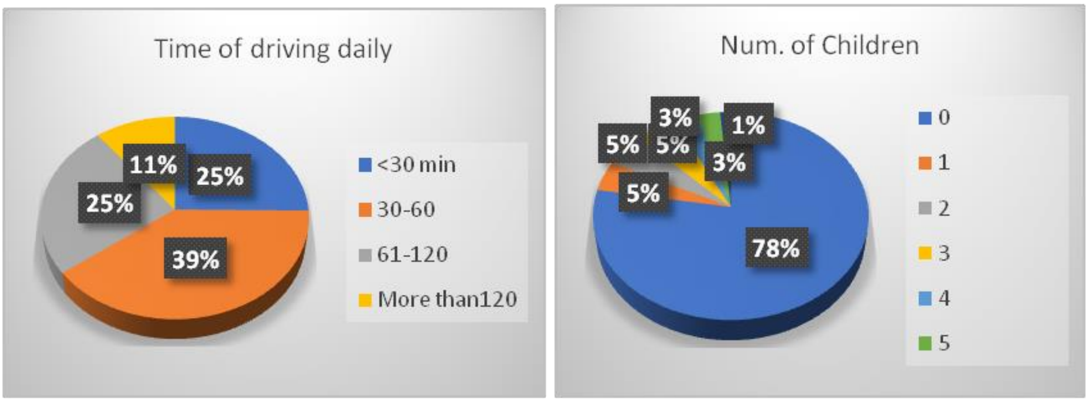


Figure 5. sample distribution related to drivers' time of driving daily and number of children.

Figure 6 shows the sample of the questionnaire distribution related to drivers' experience and number of times the driver has been ticketed during the last 2 years.

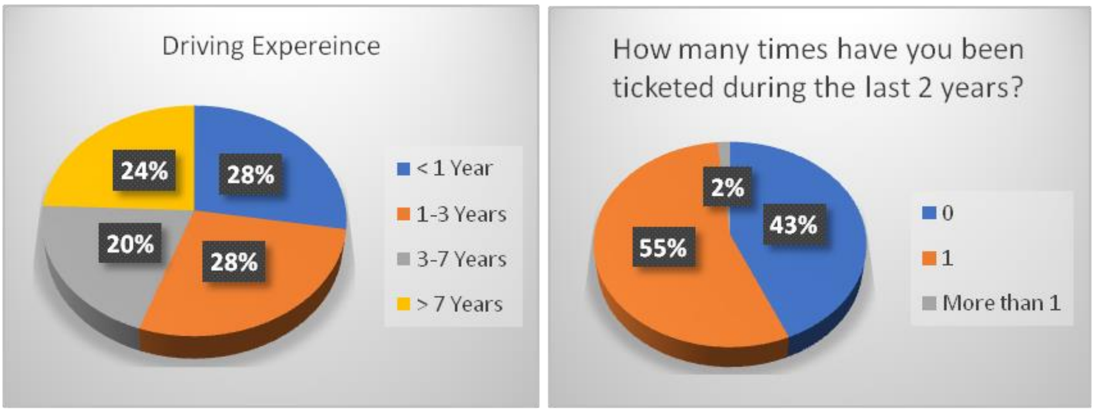


Figure 6. Sample of the questionnaire distribution related to drivers' experience and number of times the driver has been ticketed during the last 2 years.

Figure 7 shows the sample of the questionnaire distribution related to the number of times the driver had been involved in an accident during the last 2 years.

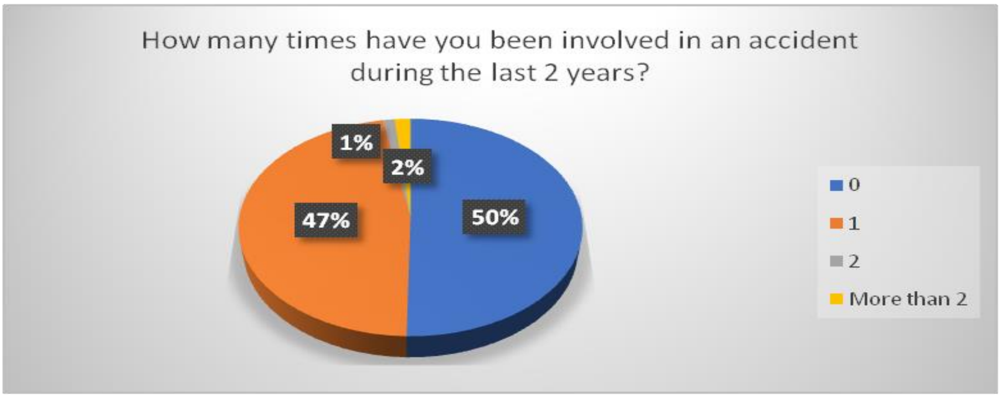
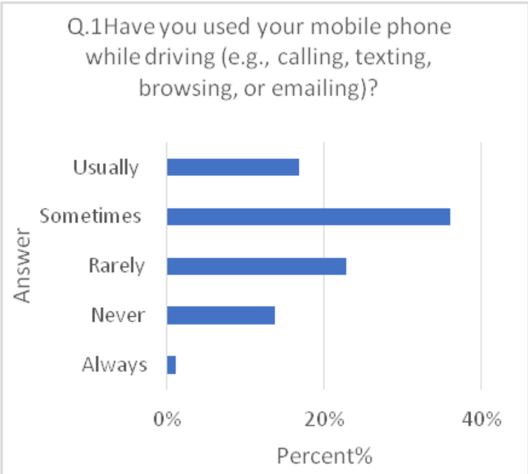


Figure 7. Sample of the questionnaire distribution related to the number of times had been the driver involved in an accident during the last 2 years.

3.2 Results of Questionnaire Analysis-Part 2

Figure 8 shows the answers distribution (%) to the questions " Have you used your mobile phone while driving (e.g., calling, texting, browsing, or emailing)?" and "Do you think it is dangerous to use a phone while driving?".



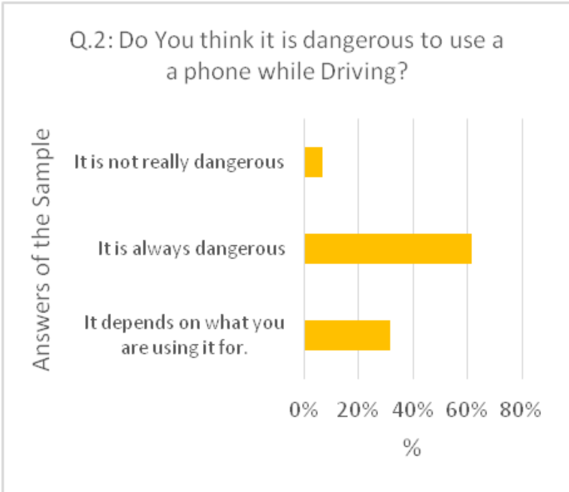
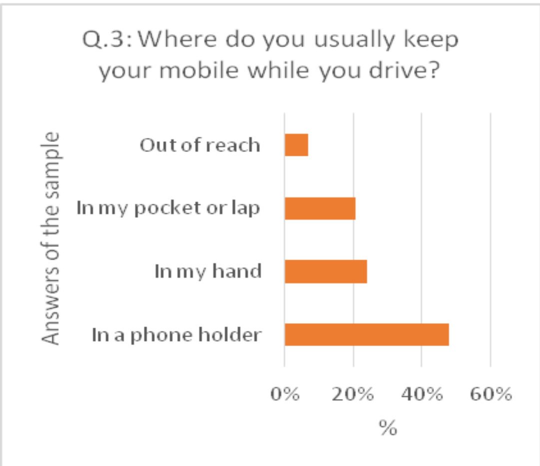


Figure 8. Answers distribution (%) to the questions: " Have you used your mobile phone while driving (e.g., calling, texting, browsing, or emailing)?" and "Do you think it is dangerous to use a phone while driving?".

Figure 9 shows the answers distribution (%) to the questions: "Where do you usually keep your phone while you drive?" and "Have you looked continually at the phone for more than two seconds, while driving?".



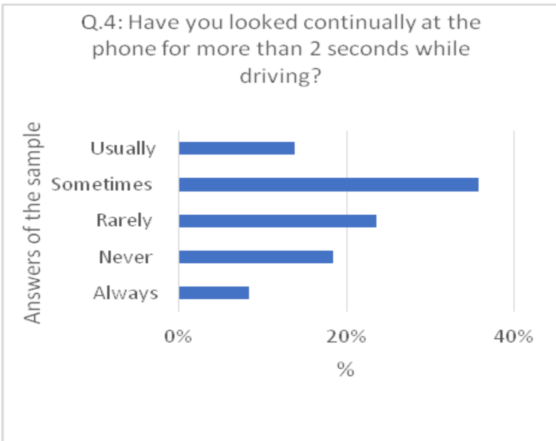


Figure 9. The answers distributed (%) to the questions: "Where do you usually keep your phone while you drive?" and "Have you looked continually at the phone for more than two seconds, while driving?".

Figure 10 shows the answers distribution (%) to the questions: "How much do you believe using a cell phone while driving affects driving performance?" and "How dangerous do you think it is Ok to read a text while driving?"

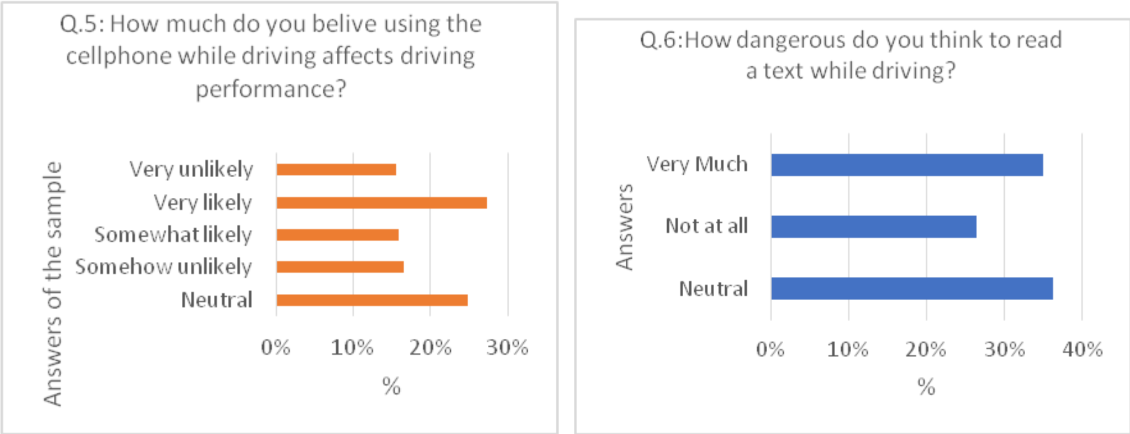


Figure 10. The answers distribution (%) to the questions: "How much do you believe using a cell phone while driving affects driving performance "? and "How dangerous do you think it is Ok to read a text while driving?".

Figure 11 shows the answers distribution (%) to the questions: ''How dangerous do you think it is to send a text while driving?'' and '' How dangerous do you think it is to talk on the phone while driving?''.

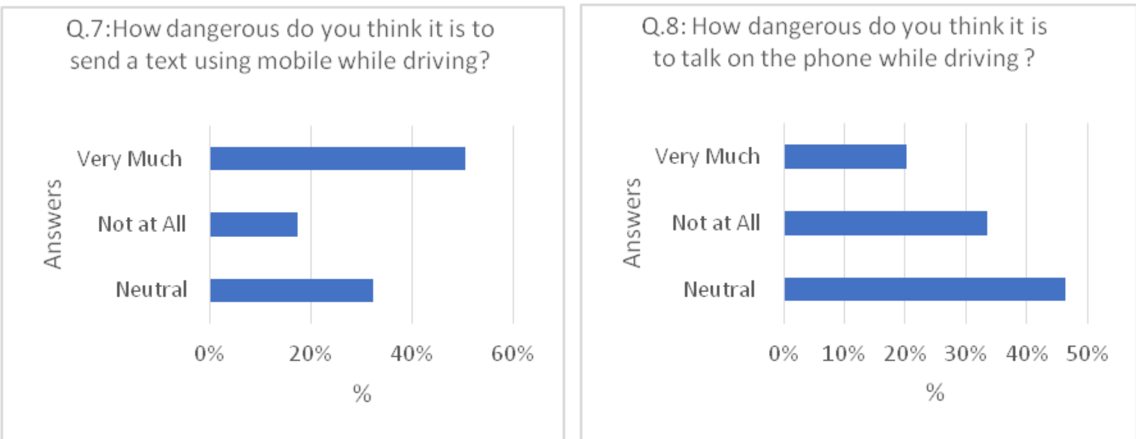


Figure 11. The answers distribution of questions ''How dangerous do you think it is to send a text while driving?'' and '' How dangerous do you think it is to talk on the phone while driving?''.

Figure 12 shows the answers distribution (%) to the questions: ''How dangerous do you think it is to make a call on the phone?'' and '' Have you monitored/read conversations without writing back, while driving?''.

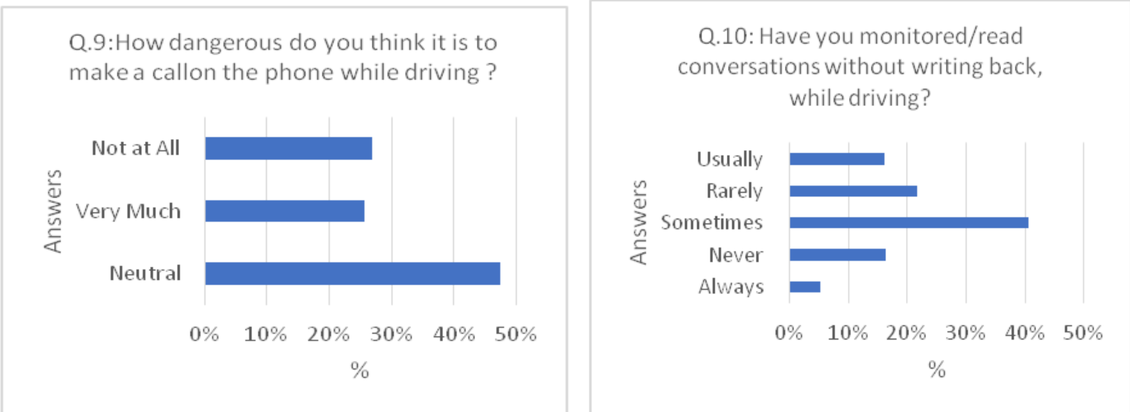


Figure 12. The answers distribution (%) to the questions: : ''How dangerous do you think it is to make a call on the phone?'' and '' Have you monitored/read conversations without writing back, while driving?''.

Figure 13 shows the answers distribution (%) to the questions: ''has using a phone while driving ever caused you to feel unsafe or almost get into an accident?'' and '' has using a phone ever caused you to get into a major or minor accident?''.

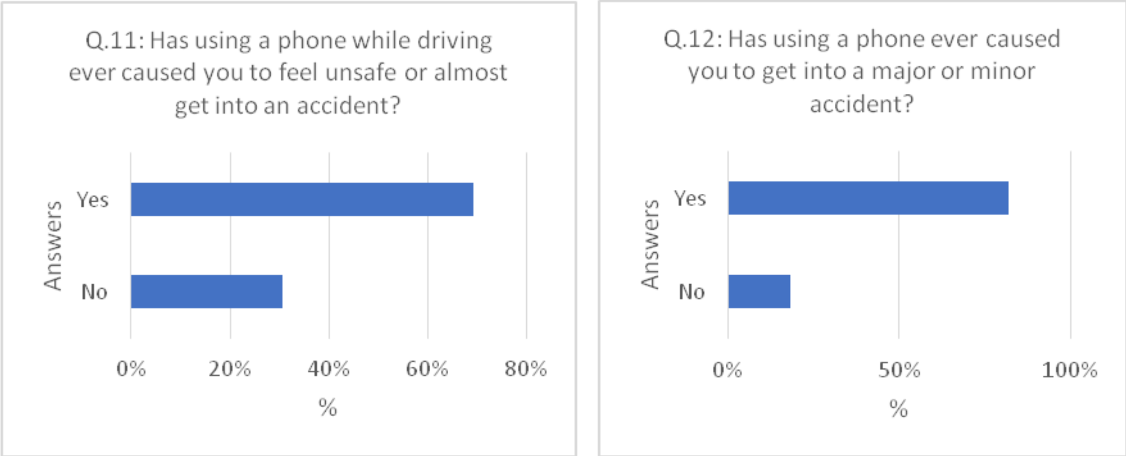


Figure 13. The answers distribution (%) to the questions: ''Has using a phone while driving ever caused you to feel unsafe or almost get into an accident?'' and '' Has using a phone ever caused you to get into a major or minor accident?''.

Figure 14 shows the answers distribution (%) to the questions: ''How dangerous do you think it is to post on social networking sites while driving?'' and '' Are you familiar with the current laws related to using your mobile device while driving?''.

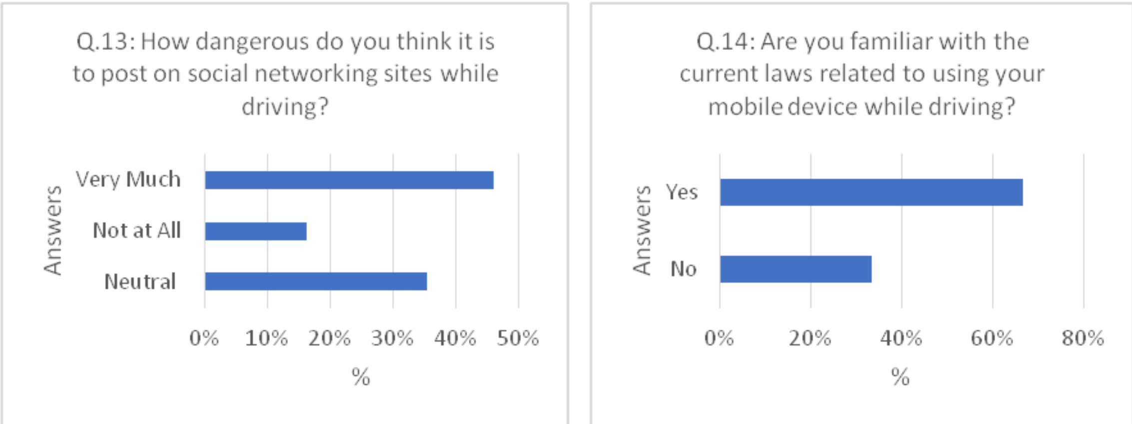


Figure 14. The answers distribution (%) to the questions: ''How dangerous do you think it is to post on social networking sites while driving?'' and '' Are you familiar with the current laws related to using your mobile device while driving?''.

Figure 15 shows the answers distribution (%) to the questions: ''While stopped at a red light or traffic congestion, how likely are you to text?'' and '' While stopped at a red light or traffic congestion, how likely are you to talk on the phone?''.

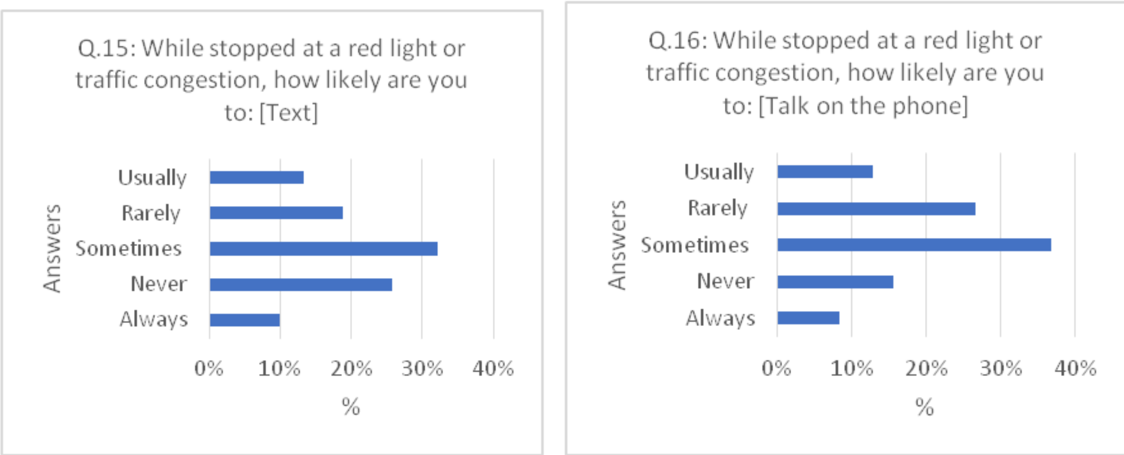


Figure 15. The answers distribution (%) to the questions: ''While stopped at a red light or traffic congestion, how likely are you to text?'' and '' While stopped at a red light or traffic congestion, how likely are you to talk on the phone?''.

Figure 16 shows the answers distribution (%) to the questions: ''While stopped at red light or traffic congestion, how likely are to access a social networking site?'' and '' While stopped at a red light or traffic congestion, how likely are you to play games?''.

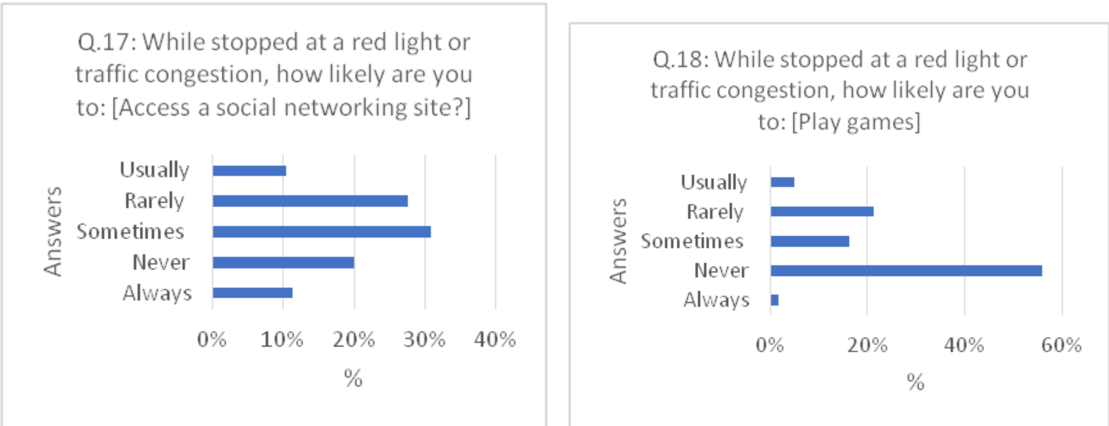


Figure 16. The answers distribution (%) to the questions: ''While stopped at red light or traffic congestion, how likely are to access a social networking site?'' and '' While stopped at a red light or traffic congestion, how likely are you to play games?''.

Figure 17 shows the answers distribution (%) to the questions: ''While stopped at a red light or stop sign, how likely are you to use mapping/GPS applications?'' and '' While actually driving, how likely are you to text?''.

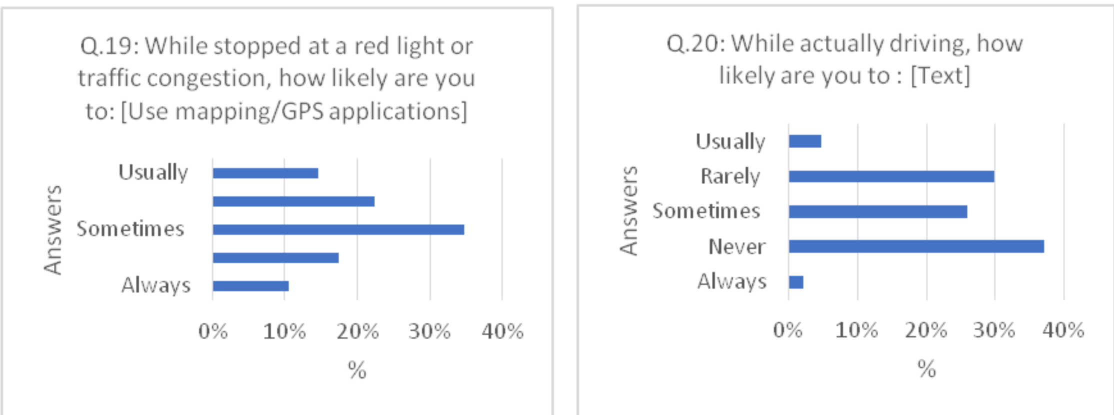
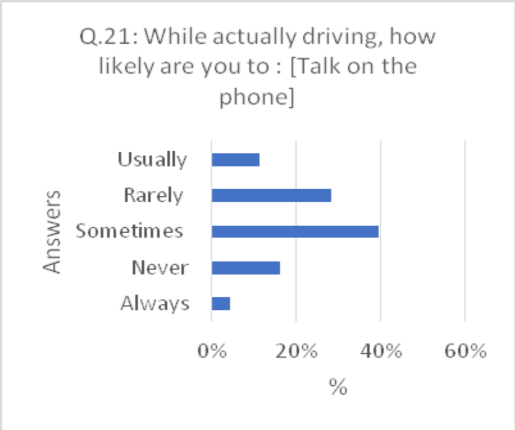


Figure 17. The answers distribution (%) to the questions: ''While stopped at a red light or stop sign, how likely are you to use mapping/GPS applications?'' and '' While actually driving, how likely are you to text?''.

Figure 18 shows the answers distribution (%) to the questions: ''While actually driving, how likely are you to talk on the phone?'' and '' While actually driving, how likely are you to access a social networking site?''.



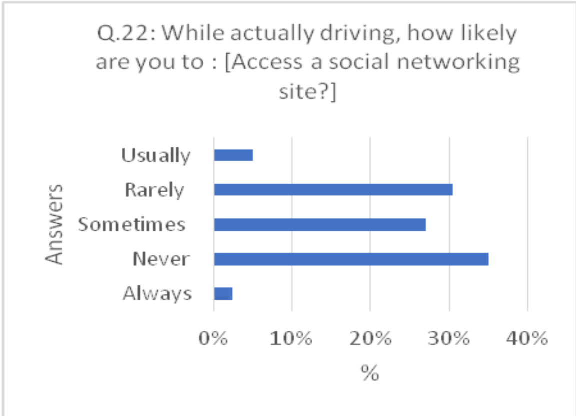
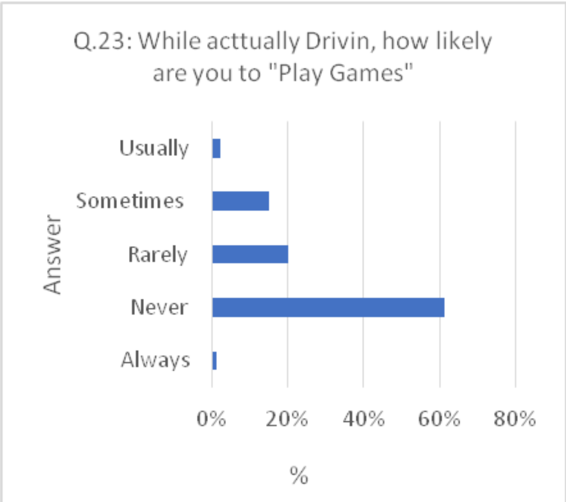


Figure 18. The answers distribution (%) to the questions: ''While actually driving, how likely are you to talk on the phone?'' and '' While actually driving, how likely are you to access a social networking site?''.

Figure 19 shows the answers distribution (%) to the questions: ''While actually driving, how likely are you to play games?'' and '' While actually driving, how likely are you to use mapping/GPS applications?''.



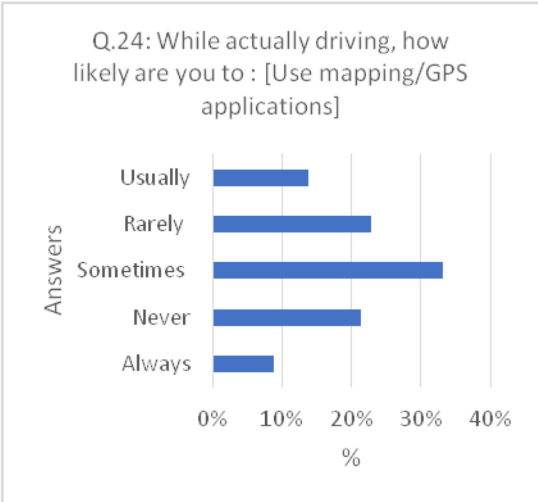
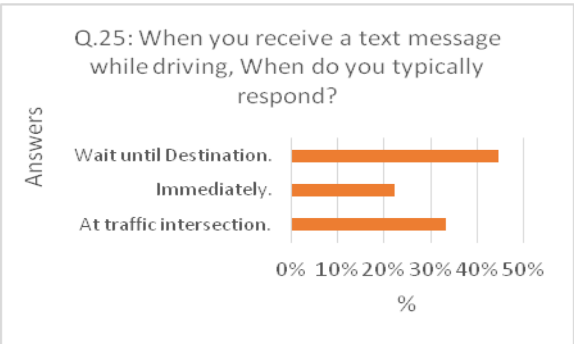


Figure 19. The answers distribution (%) to the questions: ''While actually driving, how likely are you to play games?'' and '' While actually driving, how likely are you to use mapping/GPS applications?''.

Figure 20 shows the answers distribution (%) to the questions: ''When you receive a text message while driving? When do you typically respond?'' and '' Have you heard about apps to reduce mobile phone distracted driving?"



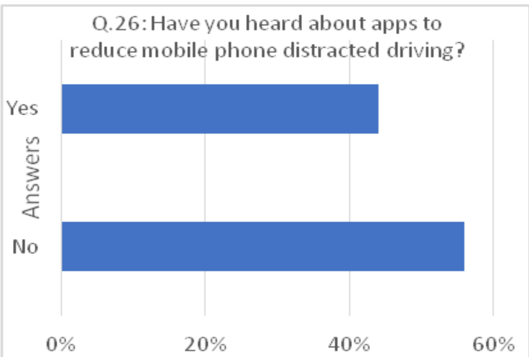


Figure 20. The answers distribution (%) to the questions: ''When you receive a text message while driving? When do you typically respond?'' and '' Have you heard about apps to reduce mobile phone distracted driving? ''.

Figure 21 shows the answers distribution (%) to question ''Have you ever experienced driving with an app to reduce mobile phone distracted driving?''.

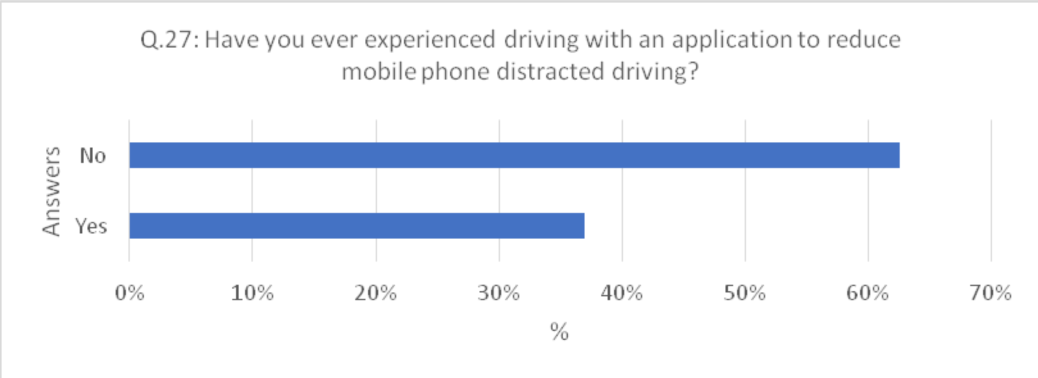
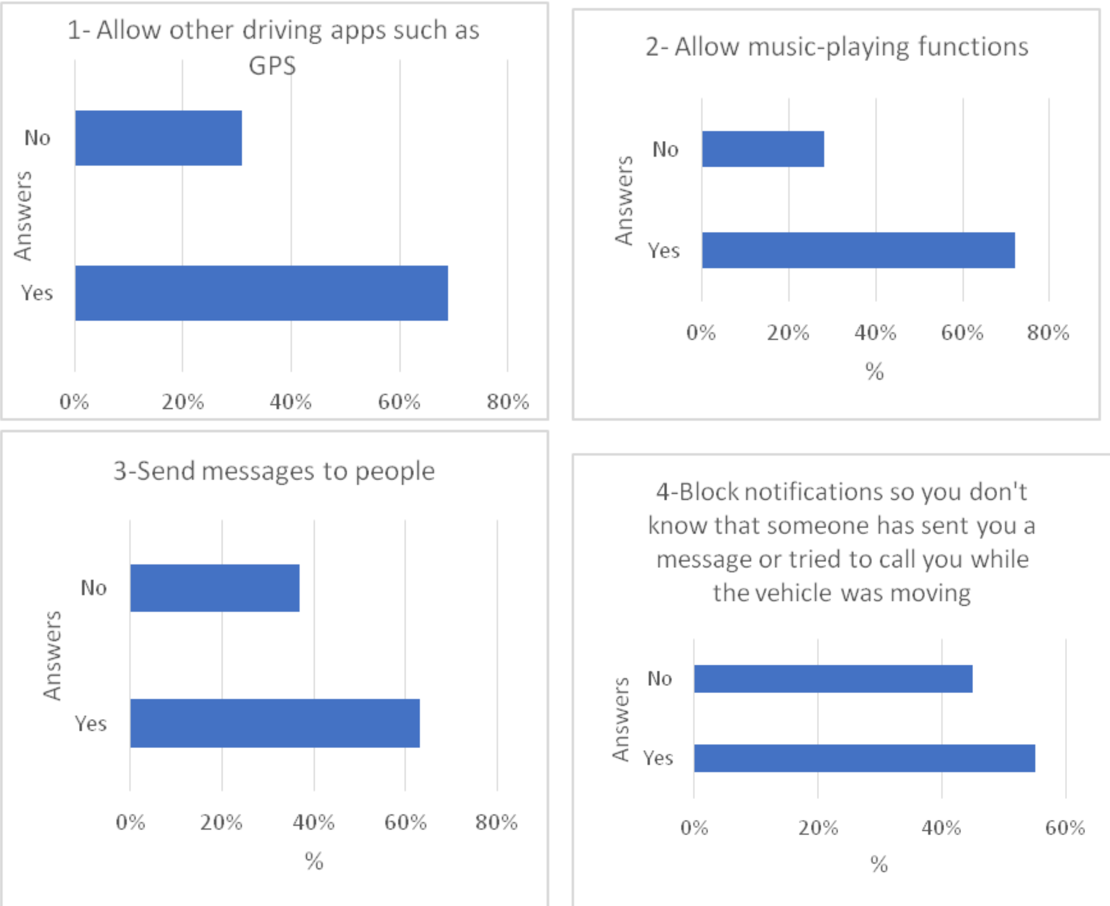
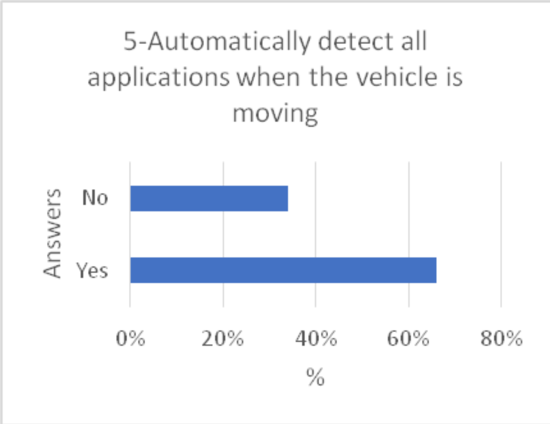


Figure 21. The answers distribution (%) to the question ''Have you ever experienced driving with an app to reduce mobile phone distracted driving?''.

The following part shows the answers to the questions related to the general question "If you are willing to download an app to prevent mobile phone distraction while driving, what are the functions that you are willing to accept to be enabled on the app of preventing driving distraction & vice versa".

Figure 22 shows the answers to the questions related to the applications may be affected by using the application of the "apps of preventing driving distraction".





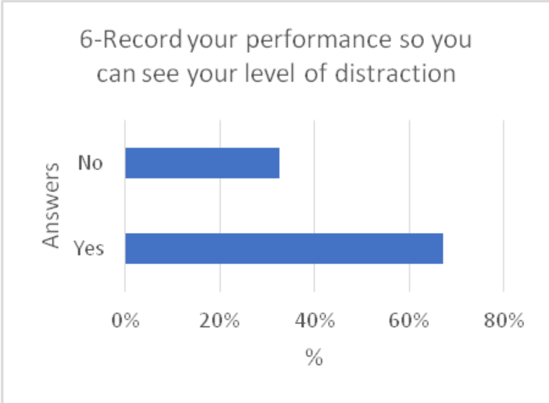


Figure 22. The answers to the questions related to the applications may be affected by using the application of the "apps of preventing driving distraction.

Figure 23 shows the answers of the sample on the questions related to the condition I: "If you are willing to download an app to prevent mobile phone distraction while driving, what are the functions that you are willing to accept to be enabled on the app & vice versa. [Make exceptions for people predefined by you (in your favorite list) so you can receive their notifications when they text you]".

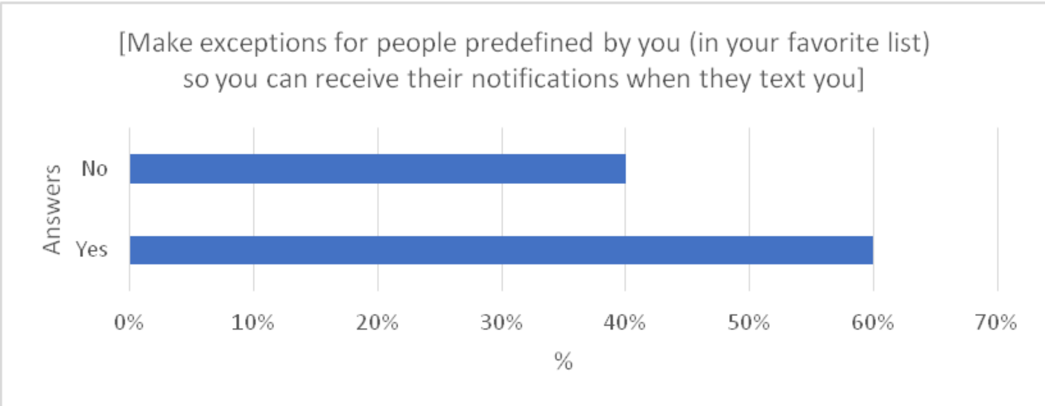


Figure 23. Percentages of the condition I.

Figure 24 shows the answers of the sample on the questions related to the condition II: "If you are willing to download an app to prevent mobile phone distraction while driving, what are the functions that you are willing to accept to be enabled on the app & vice versa. [Allow you to give commands to the phone exclusively through audio using a hands-free device or Bluetooth. The phone will read your text messages and write a response that you dictate.]".

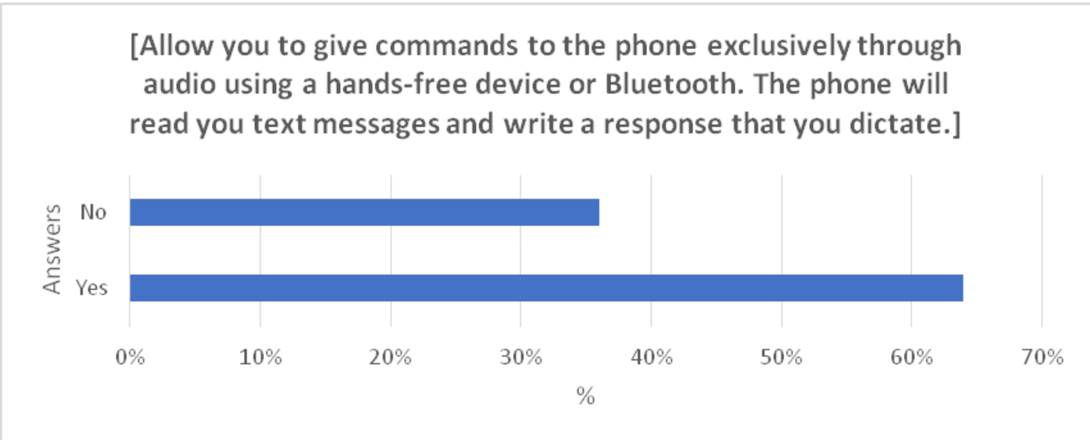


Figure 24. Percentages of the condition II.

Figure 25 shows the answers of the sample on the questions related to the condition III: "If you are willing to download an app to prevent mobile phone distraction while driving, what are the functions that you are willing to accept to be enabled on the app & vice versa. [Select where or when is safe to use a phone for a task]".

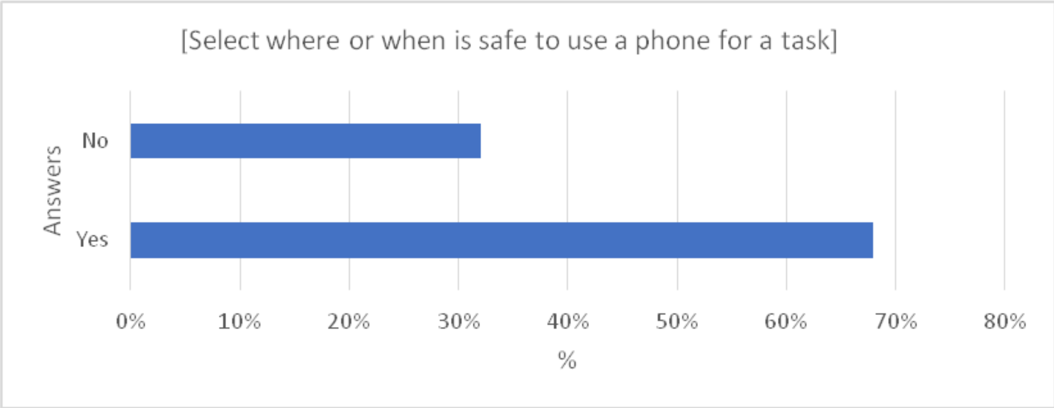


Figure 25. Percentages of the condition III.

Figure 26 shows the answers of the sample on the questions related to the condition IV: "If you are willing to download an app to prevent mobile phone distraction while driving, what are the functions that you are willing to accept to be enabled on the app & vice versa. [Allow conversations and incoming calls only through Bluetooth or an in-vehicle audio system]".

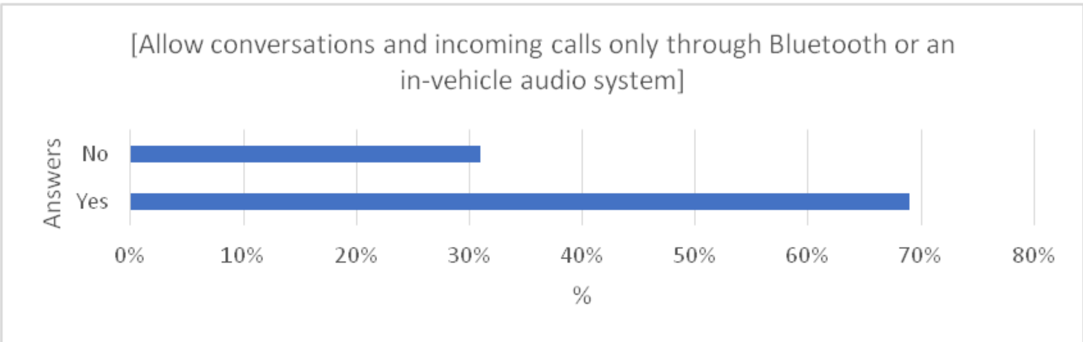


Figure 26. Percentages of the condition IV.

3.3 Implementation Index

To estimate the Implementation Index (II) for each DDPS latent, the total score average for all received responses were computed and divided by 5, 4 or 2 (5 times the number of questions for this latent), as shown in Equation 3 below. The number “5” or "3" or "2" refers to the used Likert scale which is here “five points”. The results can be interpreted according to Table 2.

$$\text{Implementation Index (II\%)} = \frac{\sum Scores\,average\,for\,each\,question}{(5) * Number\ of\ Questions} \times 100 \tag{3}$$

Table 2. Statistical standard for the interpretation of the arithmetical averages of variants DDPS latents

Implementation index II	0 < II ≤ 20%	20 < II ≤ 40%	40 < II ≤ 60%	60 < II ≤ 80%	80 < II ≤ 100%
Interpretation	Poor	Fair	Good	Very Good	Excellent

Table 3 shows the average score and Standard Deviation of all questions of the questionnaire.

Table 3. Average score and Standard Deviation of all questions of the questionnaire.

Part 1: Using Mobile for Different Applications While Driving (UMDAWD)		
Question	Score Average	Standard Deviation
1-Have you used your mobile phone while driving (e.g., calling, texting, browsing, or emailing)?	2.41	0.85
2-Do you think it is dangerous to use a phone while driving?	4.13	0.92
3- Where do you usually keep your phone while you drive?	3.75	0.85
4-Have you looked continually at the phone for more than two seconds, while driving?	3.04	0.82
5-How much do you believe using a cell phone while driving affects driving performance?	3.25	0.84
6-How dangerous do you think it is Ok to read a text while driving?	3.27	0.82
7-How dangerous do you think it is to send a text while driving?	3.88	0.85
8-How dangerous do you think it is to talk on the phone while driving?	2.77	0.82
9-How dangerous do you think it is to make a call on the phone?	2.97	0.85
10-Have you monitored/read conversations without writing back, while driving?	2.90	0.82
11- Has using a phone while driving ever caused you to feel unsafe or almost get into an accident?	3.80	0.90
12-Has a using a phone ever caused you to get into a major or minor accident?	4.20	0.95
13-How dangerous do you think it is to post on social networking sites while driving?	3.59	0.88
14-Are you familiar with the current laws related to using your mobile device while driving?	3.60	0.87
Average of UMDAWD practice	3.40	0.86
UMDAWD implementation index	85%	-
Interpretation	Excellent	
Part 2: Using Mobile for Different Applications While stopping (UMDAWS)		
	Score Average	Standard Deviation
15-While stopped at a red light or traffic congestion, how likely are you to text?	2.54	0.79
16-While stopped at a red light or traffic congestion, how likely are you to talk on the phone?	2.05	0.82
17-While stopped at red light or traffic congestion, how	2.80	0.81

likely are to access a social networking site?		
18-While stopped at a red light or traffic congestion, how likely are you to play games?	1.95	0.85
19-While stopped at a red light or stop sign, how likely are you to use mapping/GPS applications?	3.35	0.82
20-While actually driving, how likely are you to text?	2.15	0.83
21-While actually driving, how likely are you to talk on the phone?	2.69	0.81
22-While actually driving, how likely are you to access a social networking site?	2.15	0.80
23-While actually driving, how likely are you to play games?	1.61	0.88
24-While actually driving, how likely are you to use mapping/GPS applications?	2.69	0.83
25-When you receive a text message while driving? When do you typically respond?	3.44	0.79
Average of UMDAWS practice	2.31	0.76
UMDAWS implementation index	77%	
Interpretation	Very Good	
Part 3: Applications used to reduce mobile phone distracted driving (ARMPDS)		
	Score Average	Standard Deviation
26-have you heard about apps to reduce mobile phone distracted driving?	2.98	0.75
27-Have you ever experienced driving with an app to reduce mobile phone distracted driving?	2.48	0.76
Average of ARMPDS practice	2.73	0.76
ARMPDS implementation index	91%	-
Interpretation	Excellent	-
Part 4: If you are willing to download an app to prevent mobile phone distraction while driving, what are the functions that you are willing to accept to be enabled on the app & vice versa. (Binary ans. Yes/No) (ARMPDDLA)		
	Score Average	Standard Deviation
Allow other driving apps such as GPS	3.76	0.81
Allow music-playing functions	4.12	0.82
Send messages to people trying to contact you letting them know that you are not available (customized by you)	3.48	0.81
Block notifications so you don’t know that someone has sent you a message or tried to call you while the vehicle was moving	3.22	0.75
Automatically detect when the vehicle is moving	3.68	0.81
Record your performance so you can see your level of	3.64	0.81

distraction		
Make exceptions for people predefined by you (in your favorite list) so you can receive their notifications when they text you	3.40	0.80
Allow you to give commands to the phone exclusively through audio using a hands-free device or Bluetooth. The phone will read you text messages and write a response that you dictate.	3.60	0.81
Select where or when is safe to use a phone for a task	3.72	0.82
Allow conversations and incoming calls only through Bluetooth or an in-vehicle audio system	3.76	0.81
Average of ARMPDDLA practice	3.64	0.81
ARMPDDLA implementation index	91%	-
Interpretation	Excellent	

3.4 Hypothesis Analysis

To highlight the hypothesis testing results, state whether the null hypothesis H_0 was rejected or not at a defined significance level (α-value). The "P-value" is the smallest level of significance. (Montgomery and Runger, 2011) define the P-value as "the probability of obtaining a value of the test statistic that is at least as extreme as that observed when the null hypothesis is true. *P*-value represents the probability of Type I error, or the probability of rejecting the null hypothesis while the hypothesis is true. Operationally, once a *P*-value is computed, a significant level of 0.01 is considered for this study. A hypothesis will be rejected if the *P*-value is less than significance level of α= 0.01. In this study, it is not easy to compute the exact *P*-value for statistical tests manually. IBM SPSS statistics is used to conduct the needed statistical procedures to report the results of hypotheses testing in terms of *P*-values., namely, a paired sample correlation and a paired sample test. The result of the conducted statistical testing is illustrated in Table 4. To analyze the hypotheses listed in the next sections, let us consider the hypothesis H_1 as an example. Hypothesis H_1 suggests the following:

$H1_0$: Using mobile for calling or texting others while driving has no effect on driving distraction and its performance and may cause an accident.

$H1_1$: Using mobile for calling or texting others while driving has a significant effect on driving distraction and its performance and may cause an accident.

The paired sample correlation and paired sample test confirm that H_1 has *P*-values of zero (i.e., *P*-value < 0.01) which means that $H1_0$ can be rejected at a significance level of 0.01. Thus, we can say that the alternative hypothesis $H1_1$ is true. The hypotheses (from H_2 to H_{16}) found to have *P*-values below 0.01 that indicates that the null hypotheses of them are rejected, and the proposed alternative hypotheses are true.

Table 4. Results of the hypotheses testing for the DDPS model

Alternative Hypothesis	**Relationship**	**Paired Sample Correlation**		**Paired Sample Test**			**Decision**
		Pearson	*P*-value	*t*-value	DF	*P*-value	
$H1_1$	UMDAWD-DD	0.984	0.000	10.832	734	0.000	Reject $H1_0$
$H2_1$	UMDAWD-DP	0.965	0.000	19.541	734	0.000	Reject $H2_0$
$H3_1$	UMDAWD-DD	0.978	0.000	11.409	734	0.000	Reject $H3_0$
$H4_1$	UMDAWD-	0.963	0.000	3.500	734	0.001	Reject $H4_0$

	DDPS						
$H5_1$	UMDAWD-DD	0.991	0.000	4.125	734	0.000	Reject $H5_0$
$H6_1$	UMDAWD-DD	0.960	0.000	13.950	734	0.000	Reject $H6_0$
$H7_1$	UMDAWS - DDPS	0.980	0.000	2.486	734	0.016	Reject $H7_0$
$H8_1$	UMDAWS -DD	0.979	0.000	5.046	734	0.003	Reject $H8_0$
$H9_1$	UMDAWS -DD	0.989	0.000	12.832	734	0.000	Reject $H9_0$
$H10_1$	UMDAWS -DD	0.963	0.000	19.541	734	0.000	Reject $H10_0$
$H11_1$	ARMPDS-DDPS	0.983	0.000	11.409	734	0.000	Reject $H11_0$
$H12_1$	ARMPDS-CD	0.961	0.000	4.518	734	0.001	Reject $H12_0$
$H13_1$	ARMPDS-DD	0.989	0.000	3.959	734	0.000	Reject $H13_0$
$H14_1$	ARMPDDLA-DDPS	0.960	0.000	13.950	734	0.000	Reject $H14_0$
$H15_1$	ARMPDDLA-DD	0.980	0.000	3.036	734	0.016	Reject $H15_0$
$H16_1$	ARMPDDLA-DD	0.982	0.000	2.946	734	0.003	Reject $H16_0$

3.5 Model Fitness

Many indices exist in literature for evaluating the "goodness-of-fit" of the model, goodness-of-fit reflects how the structural equation model matches the data, chi-square, relative chi-square ratio, root mean square error of approximation, comparative fit index, and *t*-test can be used for this purpose.

1. Chi-Square (χ^2)
   Chi-Square (χ2) is described a classic goodness-of-fit measure. It is a useful technique for testing whether the observed data are demonstrative of a particular distribution. It tests the difference between the observed and expected occurrences. A high value of χ^2 implies a poor fit between these occurrences, a small value indicates a good fit.
2. Relative Chi-Square Ratio
   Chi-square ratio that is yielded by dividing the chi-square value over the corresponding degrees of freedom (DF) (Armstrong and Tan, 2000), if this ratio is less than 5, then the model is accepted. Table 5 shows that the relative chi-square ratios for all hypotheses are below 5. This indicates that the DDPS is accepted.
3. Root Mean Square Error of Approximation (RMSEA)
   RMSEA value of about 0.05 or less in relation to the DF would point to a good fit of the DDPS model, and RMSEA value of 0.10 or more means poor fit. All the RMSEA values for the DDPS model are less than 0.05 as shown in Table 5. Thus, the DDPS model fitness is supported by RMSEA.

4.CFI evaluates the fit of a user-specified solution in relation to a more restricted, nested baseline model, in which the covariance among all input indicators is fixed to zero or no relationship among variables is posited. CFI ranges from 0 for a poor fit to 1 for a good fit. However, a value of 0.9 means good fit. Under this test, the DDPS model exhibits a good fit as shown in Table 5.

Table 5. Results of the hypotheses testing for the developed SEM

Alternative Hypothesis	χ^2	DF	χ^2-Ratio	RMSEA	CFI	*P*-value	Risk Estimated	Decision
$H1_1$	1238.5	735	4.5	0.009	0.91	0.000	0.95	Reject $H1_0$
$H2_1$	1347.5	735	4.9	0.0180	0.90	0.000	0.95	Reject $H2_0$
$H3_1$	1120.3	735	4.10	0.0102	0.92	0.000	0.92	Reject $H3_0$
$H4_1$	1322.03	735	4.11	0.0151	0.94	0.000	0.90	Reject $H4_0$
$H5_1$	889.95	735	3.15	0.0088	0.91	0.000	0.93	Reject $H5_0$
$H6_1$	1178.44	735	4.28	0.0191	0.92	0.000	0.98	Reject $H6_0$

$H7_1$	1183.01	735	4.37	0.0181	0.93	0.000	0.91	Reject $H7_0$
$H8_1$	1219.39	735	4.43	0.0198	0.94	0.000	0.91	Reject $H8_0$
$H9_1$	1201.2	735	4.41	0.0180	0.88	0.000	0.93	Reject $H9_0$
$H10_1$	862.68	735	3.17	0.0080	0.91	0.000	0.95	Reject $H10_0$
$H11_1$	859.95	735	3.16	0.0086	0.90	0.000	0.93	Reject $H11_0$
$H12_1$	1168.44	735	4.30	0.0190	0.92	0.000	0.98	Reject $H12_0$
$H13_1$	1193.01	735	4.47	0.0180	0.93	0.000	0.91	Reject $H13_0$
$H14_1$	1209.39	735	4.45	0.0198	0.94	0.000	0.92	Reject $H14_0$
$H15_1$	1201.2	735	4.41	0.0171	0.88	0.000	0.93	Reject $H15_0$
$H16_1$	862.68	735	3.20	0.0081	0.91	0.000	0.94	Reject $H16_0$

3.6 Structural Equation Model

The structured equation model shows the relation between different latent variables and DDPS and between latent variables themselves. Figure 27 shows the SEM of the DDPS. This figure contains seven latents; the seven rectangles represent the seven DDPS practices (i.e., independent variables) and the circle represents the DDPS (i.e., dependent variable). Furthermore, there are a set of arrows that depict the interactions between the seven items. Note that the thick black arrows represent the relationships between each practice and the DDPS, and the blue thin arrows represent the relationships between each practice and the other. Each arrow is also represented by its associated hypothesis.

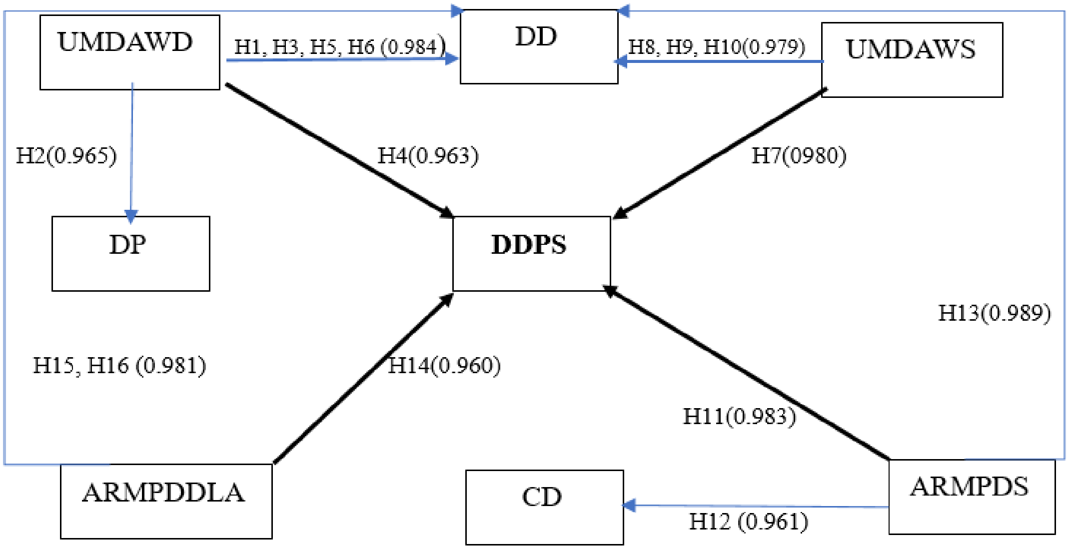


Figure 27. The proposed structural equation model (SEM) and the estimates of the relationships

3.7 Results Discussion

The results shows that the usage of mobile for any purpose like talking, texting or using any of the social media applications will cause and contribute to driving distractions. The driving distraction prevention system composed from many parameters to be controlled like using mobile phones during driving, using mobile phones during stopping for some short time slots, using applications of preventing the use of mobile phones while driving and the acceptance of effects of such applications on different mobile applications. Such parameters have inside and outside effects on DDPS and DD which are represented in SEM diagram. All null hypotheses are rejected while alternative hypotheses are accepted by SPSS analysis. The need for DDPS is crucial to decrease DD and increase safety of driver and passengers. The implantation indexes of different parameters supporting the DDPS are over "very good" which indicates that if such parameters are controlled and drivers' commitment is good the DDPS will be in good level and DD will be decreased.

4 Conclusions

This paper discussed a very important issue related to the drivers and passengers' safety during driving their vehicles. The application of regulations of DDPS will decrease DD and increase safety of drivers and passengers. The acceptance of using DDPS in Kuwait is good which indicates that the need to apply such applications can be executed successfully.

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