Effects of Internal and External Sources of Distraction to the Driving Performance of Filipino Drivers

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Abstract

Driving is a primary task that requires full attention. However, several factors could cause distractions and affect the attention of drivers. Distractions come from both internal and external sources. Internal distractions happen when a person engages into distracting activities inside the vehicle (Beanland et al., 2013) while external distractions come from outside of the vehicle wherein there is a delay in recognition of information needed to safely accomplish the driving task because there are events, activities, object, or person outside the vehicle that tend to induce the driver to shift his attention away from the driving task (Regan et al., 2011). Both external and internal distractions contribute to the interference of focus (Post and Schumm, 1997). Thus, this paper aims to analyze contributing factors in internal and external sources that affect the attention of drivers in the Philippines. Design of Experiment (DOE) has been used to simulate a model for driving performance of subjects to determine the effect or impact of factors in internal and external sources to the attention of drivers. Contributing factors of internal sources that were considered in the study are tasks, age, gender, driving experience and type of license used by drivers while factors for external sources include pedestrian crossing, vehicle cuts-in, vehicle emergency brakes and vehicle counter flows. On the other hand, measurements on the impact of driving performance that were considered in the study are change in speed, lane departure and collision count. Statistical analyses such as analysis of variance and Cramer's V test were employed in the study to determine the relationship of contributing factors to the impact of driving performance. The results of the study showed that among the contributing factors in the internal sources, eating while driving has the highest impact on the driving performance of subjects while for external sources, all contributing factors have significant impact on the driving performance of subjects. Therefore, the result of the analysis will serve as the basis for the researchers to propose policies and regulations to help drivers avoid driving distractions and ensure road safety.

Keywords
Driving distraction, road safety, internal distraction, external distraction, driving performance

1. Introduction

Driving is one of the most complex activities done by many people daily. It is an attention-demanding task because attention must be allotted to all the surrounding vehicles, objects along the roadways, and objects that are found inside the vehicle. When a driver is distracted by other activities and/or events, driving errors can happen and safety is at threat (Ericson et al., 2016). This was validated in a study that driving under the influence of distraction can be a factor in road accidents (Rupp et al., 2017 and Talbot et al., 2012)

Driver distraction is a type of driver inattention (NHTSA, 2016 and Regan et al., 2011) wherein it redirects the drivers' concentration in driving to perform other activities that reduces their ability to fully control the vehicle. This happens when the driver diverts his attention because he is momentarily focused on an object, person, task, or event that is not related to driving such as texting and/or calling while driving (Caird et al., 2014), hands-free texting (TIRF, 2013) eating and drinking, smoking (Stutts et al., 2005), looking at paper map, watching videos, checking the news via internet access and putting on a make-up and/or grooming (Braitman et al., 2017).

In previous studies, driver distraction has been classified to have two sources: internal and external (Talbot et al.,

2012; Klauer et al., 2015). Internal distractions happen when a person engages into distracting activities inside the vehicle such as in-vehicular use of gadgets, conversing with co-passenger, arguing with a family member and doing other tasks inside the vehicle (Beanland et al., 2013); On the other hand, external distractions came from outside of the vehicle wherein there is a delay in recognition of information needed to safely accomplish the driving task because there are events, activities, object, or person outside the vehicle that tend to induce the driver to shift his attention away from the driving task (Regan et al., 2011) such as looking at a billboard, looking at a construction along the roadway and when the driver gets distracted because of a pedestrian suddenly crossing the roadway. (Stutts et al., 2015).

The adverse impact of driver distraction is highlighted by the National Highway Traffic Safety Administration or NHTSA in which they claimed that there were 431,000 people or 18.43% of the total people injured in the U.S. were related to driving distraction (NHTSA, 2017) whilst some studies claimed that it might be as high as 35-50% (Talbot et al., 2013); and 29% of the fatalities under young adults ages 20-29 were because of distracted driving (NHTSA, 2016 and Hassani et al., 2017).

Recent studies confirmed that the highest among the listed distractions was the use of cellphone such as dialing, calling, texting and reading a text (Benton, 2013). This was also the result of 100-Car Naturalistic Driving Study (Klauer et al., 2006) which associated the risk of driving to the use of mobile phone. The risk of having a near-crash or crash among drivers is slightly higher if the person engages into sending or receiving a text message (Irwin et al., 2015). Contrary to this, some studies stated that composing a text message causes decrements on driving performance but having a phone conversation and text-message reading do not have any impact (Papadakaki et al., 2016 and Lee et al., 2014). In accordance to the ranking, the second highest effect in driving is known to be the external distraction like looking at something or someone outside the vehicle, for example, gawking at an accident or at people in other cars or looking at a billboard (Edquist et al., 2011).

As a countermeasure to distracted driving, safe driving legislations have been implemented to most countries to avoid road crashes because for the past decades, distracted driving has been the leading concern of the government, road safety researchers and the public (TIRF, 2013). The implementation of laws in different countries included hand-held phones as a main restriction if the driver is known to be in motion and to some countries even in a temporary stop would mean a violation. Some known distractions are not included in the law of other countries because these laws were legislated earlier such as Japan and Hong Kong. Therefore, while most countries concentrated on mobile use, there are some that considered advance technologies such as GPS, wearable gadgets and electronic gadgets (i.e., laptop, tablets and gaming consoles). Hands-free mobile is allowed to most of the countries but it has different implementing condition in their laws. These laws were implemented to solve the prevalence of distracting activities that would harm the people inside as well as outside of the vehicle. Evidently, the use of cellphone (hand held) is not allowed in 17 countries and only one country has disallowed the use of cellphone even if it is hands free. In the Philippines, Republic Act 10913 or Anti-Distracted Driving Act (ADDA) has prohibited the use of cellphone inside the vehicle whether in motion or in a red light unless it is in Bluetooth or voice-activated. Evidently, there are differences in the legislative orders of each country between the use of electronic gadgets and other distracting activities.

Given these conditions, the researchers aim to evaluate the interaction of internal and external sources of distraction to the driving performance of Filipino drivers. Contributing factors in the internal and external sources have been gathered based on review of related literatures, interview, survey questionnaire, direct observation and review of historical data. The overall aim of the study is to determine the contributing factors in the internal and external sources of distractions that has the highest impact on the driving performance of the subjects in terms of change in speed, lane departure and collision count.

This experimental study will provide benefit for all drivers by identifying which factors or activities could cause distraction and affect the driving performance of Filipino drivers. This study will also give knowledge to the inexperienced or novice drivers by providing information regarding safe driving and finally, the study would also serve as basis for lawmakers in emending the Anti-Distracted Driving Act in the country.

2. Methodology

2.1. Data Gathering

In order to identify contributing factors in internal and external sources of distraction that will be considered in the study, review of related literature, review of historical data and survey questionnaire were administered to the 267 respondents of the study. The survey questionnaire aims to identify difference types of distractions that were performed by the subjects while driving. Similarly, demographic profiles of subjects such as age, gender and type of license were also gathered from the survey questionnaire.

After which, a design of experiment using driving simulator set-up were used in order to measure the driving performance of subjects while they are exposed to different types of driving distractions. Driving performance such as change in speed, lane departure and collision count were measured based on the type of distractions the subjects are exposed with. The driving simulator set-up is an arcade-like setup which includes laptop connected to a projector via HDMI cable where a driver simulator application (City Car Driving Home) is installed. The driving set-up is shown in the figures 1 and 2 below.

Figure 1. Driving Simulator Setup

Figure 2. Preview of Driver Simulator Application

2.2. Statistical Analysis

In order to analyze and treat the data gathered from the study, the researchers applied Analysis of Variance (ANOVA) and Cramer's V test. Analysis of Variance is used to determine significant difference in the driving performance of the subjects based on different types of distractions they are exposed to. The factors in the analysis are tasks, gender, driving experience and type of license while the variables are change in speed, lane departure and collision count. In addition, Post-Hoc analysis was also performed in order to determine which among the variables have significant difference from one another using Cramer's V test. The Cramer's V test is used as a post-test to determine strengths of association after chi-square has determined significance.

3. Result and Discussion

Based on review of related literature, review of historical data and result of survey questionnaire, the researchers were able to identify contributing factors in the external and internal sources of distractions. The summary of result is shown in the table 1 below.

Table 1. Summary of Factors for Different Sources of Distractions

SOURCE	
External	Pedestrian Crossing Vehicle cuts-in Vehicle emergency brake Vehicle counter flow
Internal-External	Phone conversation during rain Adjusting the radio during rain eating during rain Drinking during rain Talking to passenger during rain

SOURCE	DISTRACTION
Internal	Phone conversation Adjusting the radio Eating Drinking Talking to passenger
Internal-Internal	Taking to passenger while drinking

3.1. Result of Analysis of Variance

In order to further analyze and treat the data gathered from the study, the researchers performed analysis if variance (ANOVA) in order to determine if there are significant difference in driving performance of respondents while exposed to different types of distractions. The result of the analysis is shown in the table 2 below.

Table 2. Result of ANOVA

Source	P-Value	Analysis
Change in Speed Versus:		
Task	0.00	With significant difference
Gender	0.19	No significant difference
Experience	0.00	With significant difference
Type Of License	0.00	With significant difference
Lane Departure Versus:		
Task	0.00	With significant difference
Gender	0.50	No significant difference
Experience	0.34	No significant difference
Type Of License	0.20	No significant difference

The result of the analysis proved that drivers showed significant difference in change of speed based on tasks performed while driving, years of driving experience and type of license used. On the other hand, lane departure only showed significant difference in type of tasks performed while driving.

3.2. Result of Cramer's V Test

In order to determine which among the factors have significant effect on the driving performance of the respondents, Cramer's V test were used in the study. However, in order to determine which among the factos will be considered in Cramer's V test, backward elimination method must first be employed. Only factors with p-value of less than 0.05 will be considered in the analysis, the result showed that only tasks, gender, experience, type of license, interaction among task and gender and interaction among task and license will only be considered for further analysis. The result is shown in the table 3 below.

Table 3. Result of Backward Elimination Method

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Model	77	25984.8	337.47	8.01	0
Linear	21	20020.6	953.36	22.62	0
Task	14	15529.9	1109.28	26.32	0
Gender	1	48.6	48.55	1.15	0.285
Experience	3	1133.5	377.84	8.97	0
License	3	1278.2	426.07	10.11	0

2-Way Interactions	56	3657.4	65.31	1.55	0.022
*Task*Gender*	14	1080.3	77.16	1.83	0.04
*Task*License*	42	2874.3	68.43	1.62	0.02
Error	132	5563.1	42.14		
Total	209	31547.9			

Finally, the significant factors are analyzed using Cramer's V test in order to determine the overall effect of distractions to the driving performance of the respondents. The result of the analysis is shown in the table 4 below.

Table 4. Result of Cramer's V Test

	GENDER		DRIVING EXPERIENCE				TYPE OF LICENSE			
TASK	FEMALE	MALE	< 1 YR	≥ 1 YR; < 3 YRS	≥ 3 YRS; < 7 YRS	≥ 7 YRS	PROFESSIONAL	NON-PROFESSIONAL	STUDENT	NONE
Phone Conversation	0.866 0.026 *	0.886 0.061 *	0.708 0.007 *	0.645 0.003 *	0.59 0.044 *	0.587 0.038 *	0.511 0.162 *	0.71 0.011 *	0.515 0.041 *	0.535 0.077 *
Adjusting the Radio	0.711 0.197 *	0.823 0.088 *	0.71 0.006 *	0.56 0.02 *	0.511 0.107 *	0.509 0.102 *	0.584 0.16 *	0.585 0.091 *	0.587 0.024 *	**0.82** **0.002 ***
Eating	**0.711** **0.197 ᵇ**	**0.823** **0.088 ᵇ**	**0.501** **0.122 ᵇ**	0.549 0.013 *	0.635 0.017 *	0.467 0.155 *	0.635 0.05 *	**0.549** **0.1 ᵇ**	0.517 0.038 *	0.478 0.156 *
Drinking	0.711 0.197 *	0.618 0.348 *	0.593 0.071 *	0.646 0.007 *	0.584 0.099 *	0.582 0.098 *	0.584 0.16 *	0.585 0.091 *	0.587 0.024 *	0.709 0.006 *
Talking to the passenger	0.741 0.123 *	0.721 0.205 *	0.72 0.034 *	0.724 0.009 *	0.711 0.049 *	0.709 0.049 *	0.584 0.16 *	0.585 0.091 *	0.585 0.091 *	0.598 0.052 *
Ped. Crossing	**0.823** **0.037 ᵇ**	**0.669** **0.18 ᵇ**	**0.501** **0.122 ᵇ**	0.49 0.06 *	**0.549** **0.071 ᵇ**	**0.635** **0.016 ***	0.558 0.072 *	**0.614** **0.042 ᵇ**	0.539 0.027 *	0.535 0.077 *
Cut	**0.711** **0.197 ᵇ**	**0.669** **0.18 ᵇ**	**0.614** **0.03 ᵇ**	0.522 0.038 *	**0.614** **0.028 ᵇ**	0.558 0.032 *	**0.71** **0.017 ᵇ**	**0.71** **0.11 ᵇ**	0.539 0.027 *	0.515 0.103 *
Sudden Braking	**0.711** **0.197 ᵇ**	**0.669** **0.18 ᵇ**	**0.614** **0.03 ᵇ**	0.522 0.038 *	**0.614** **0.028**	0.558 0.032 *	0.667 0.04 *	**0.82** **0.003 ᵇ**	0.606 0.018 *	0.587 0.068 *
Counterflow	**0.711** **0.197 ᵇ**	**0.823** **0.088 ᵇ**	**0.501** **0.122 ᵇ**	0.49 0.06 *	**0.549** **0.071 ᵇ**	**0.635** **0.016 ***	0.614 0.044 *	**0.614** **0.042 ᵇ**	0.539 0.027 *	0.515 0.103 *
Talking x Drinking	0.741 0.123 *	0.721 0.205 *	0.72 0.034 *	0.724 0.009 *	0.711 0.049 *	0.709 0.049 *	0.711 0.082 *	0.713 0.066 *	0.714 0.016 *	0.724 0.024 *
Phone Conversation - raining	0.711 0.197 *	0.618 0.348 *	0.645 0.021 *	0.61 0.01 *	0.59 0.041 *	0.587 0.038 *	0.584 0.16 *	0.585 0.091 *	0.587 0.024 *	**0.82** **0.002 ***
Adjusting the Radio - raining	0.711 0.197 *	0.618 0.348 *	0.645 0.021 *	0.61 0.01 *	0.59 0.041 *	0.587 0.038 *	0.59 0.067 *	0.592 0.056 *	0.645 0.004 *	0.645 0.015 *
Eating - raining	**0.823** **0.037 ᵇ**	**0.823** **0.088 ᵇ**	**0.501** **0.122 ᵇ**	0.49 0.06 *	**0.635** **0.017 ***	0.467 0.155 *	0.635 0.05 *	**0.549** **0.1 ᵇ**	0.517 0.038 *	0.478 0.156 *
Drinking - raining	0.741 0.123 *	0.721 0.205 *	0.72 0.034 *	0.724 0.009 *	0.711 0.049 *	0.709 0.049 *	0.711 0.082 *	0.713 0.066 *	0.714 0.016 *	0.724 0.024 *
Talking to the passenger - raining	0.741 0.123 *	0.721 0.205 *	0.72 0.034 *	0.724 0.009 *	0.711 0.049 *	0.709 0.049 *	0.711 0.082 *	0.713 0.066 *	0.714 0.016 *	0.724 0.024 *

0.000*	Fisher's Exact
0.000ᵇ	Pearson's Chi Square
Text	Not significant
Text	Significant

Associations among significant contributing factors to the driving performance were revealed by the Cramer's V test as illustrated in the table above. The result indicates that for gender factor, both male and female have significant effect on driving performance when they are exposed to distractions such as eating, pedestrian crossing, vehicle cuts-in, sudden breaking, vehicle counter flow and eating during rain. Similarly, driving experience factor has significant effect on driving performance when drivers are exposed to distractions such as eating, pedestrian crossing, vehicle cut-in, vehicle counter flow and eating during rain, and finally, for type of license factor, distractions that have significant effect on driving performance are adjusting the radio, eating, pedestrian crossing, vehicle cut-in, sudden breaking, vehicle counter flow, phone conversation during rain and eating during rain.

3.3. Development of Policy for Anti-Distracted Driving

Researchers were able to develop policies and regulations that will help improve the anti-distracted driving act in the country based on the contributing factors for driving distractions identified in the study. Hence, the following policies are proposed.

1. All vehicles should have an advanced safety system in which it can mitigate a crash in all kinds of situation. There should be a legislative procedure in which all vehicles, whether private or public, should have this kind of technology. This system includes the following:

    a. Automatic Emergency Braking (AEB) – Brakes are automatically applied to prevent a collision or reduce collision speed.

b. Forward Collision Warning (FCW) – Visual and/or audible warning intended alert the driver and prevent a collision.
c. Blind Spot Warning (BSW) – Visual and/or audible notification of vehicle in blind spot. The system may provide an additional warning if you use your turn signal when there is a car next to you in another lane.
d. Rear cross-traffic warning – Visual, audible or haptic notification of object or vehicle out of your camera range but could be into it.
e. Lane-departure warning (LDW) – Visual, audible, or haptic warning to alert the driver when they are crossing lane markings.
f. Lane-keeping assist (LKA) – Automatic corrective steering input or braking provided by the vehicle when crossing lane markings.
g. Lane-centering assist – Continuous active steering to stay in between lanes (active steer, auto-steer, etc.)
h. Adaptive cruise control – Adaptive cruise uses lasers, radar, cameras, or a combination of these systems to keep a constant distance between you and the car ahead, automatically maintaining a safe following distance. If highway traffic slows, some systems will bring the car to a complete stop and automatically come back to speed when traffic gets going again, allowing the driver to do little more than pay attention and steer.
i. Rear automatic emergency braking (Rear AEB) – Brakes are automatically applied to prevent backing into something behind the vehicle. This could be triggered by the rear cross-traffic system, or other sensors on the vehicle.

2. Cellular phones should have an automatic disable of phone use when driving. This is called Driving Mode. Thus, only latest phones and mobiles with the latest operating system has it. It should be a standard that all cellphones regardless of the operating system, should have a driving mode.

3. Lawmakers should pass a legislation wherein vehicle drivers who engaged to counter flow, vehicle cut, and emergency braking should be penalized. Thus, it should be a requirement for all types of vehicle to install dash cam in order to provide concrete evidence of the act.

4. Department of Public Works and Highways (DPWH) should only put pedestrian lanes near stoplights.

5. Lawmakers should implement a policy that prohibits eating while driving. Currently, the passage of the Anti-Distracted Driving Act in the Philippines is not as effective as it should be since most of the private vehicles have a window tint of 50%-75%, making it hard for enforcers to have a clear vision of the driver while driving. It should be stated that in order to have a clear view of what driver is doing inside, an allowable grade of 35% for car tint should be implied. Law violators should be penalized depending on how frequent the driver has violated the law.

4. Conclusion

Based on the result of the experiment, the following conclusions were drawn:

(1) The result of initial survey revealed that subjects were exposed to different types of distractions while driving both from internal and external sources. From internal sources, majority of the respondents are exposed to distractions such as phone conversation, adjusting the radio, eating, drinking and talking to passenger. For external sources, respondents are exposed to distractions such as pedestrian crossing, vehicle cuts-in, vehicle emergency brakes, and vehicle counter flows.
(2) The result of the analysis of variance proved that internal and external distractions that affect the driving performance of respondents in terms of change in speed, lane departure and collision count differs in terms of gender of drivers, years of driving experience and type of license use.
(3) Cramer's V test revealed that for internal sources of distraction, factor that has the highest effect of driving performance is eating, while for external sources, factors that affect driving performance are pedestrian crossing, vehicle cuts-in, sudden breaking and vehicle counter flow.

(4) The researchers were able to develop policies in improving the anti-distracted driving act in the country based on the result of the study.

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