Proceedings of the 2011 International Conference on Industrial Engineering and Operations Management
Kuala Lumpur, Malaysia, January 22 – 24, 2011

A Conceptual Framework on the Effects of Manual and Visual Distractions to Drivers Performance

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Abstract

Driving involves constant and complex coordination between vision, mind and body. Driver distraction refers to those instances when a driver's attention is diverted from the primary task of driving the vehicle in a way that compromises safe driving performance. These distractions can degrade driving performance and even cause fatal accidents. Visual distraction and manual distraction can be directly observed through the external behaviors of drivers, such as glancing at billboards or texting/ dialing a number from a cellular phone. Visual distraction usually coexists with manual distraction because visual cues provide necessary feedback when people perform manual tasks. In this study, a conceptual framework that relates manual and visual distraction to attention and driver performance was presented. The framework will be validated using a simulated driving experiment that introduces various types of distraction. Drivers' attention will be measured using an eye tracker.

Keywords: driver, visual distraction, manual distraction, attention

I. Background of the Study

In recent years, road accidents in the Philippines have consistently been growing as a major cause of death in terms of the frequency of occurrence and the ensuing repercussions, which could range from crippling injuries to loss of human life. In 2008, official data indicated that the number of reported road accidents rose by 28.3 percent to 14,794—up from 11,532 in 2007.

By the end of June 2009, deaths due to road crashes had reached 624, 8.7 percent more than the 573 deaths at the same period in 2008 [1]. The records of the Philippine Health Statistics show that on a per decade basis since the 1970's, there has been an exponential growth in the cumulative total number of fatalities due to traffic accidents. This behavior is graphically displayed in Figure 1.

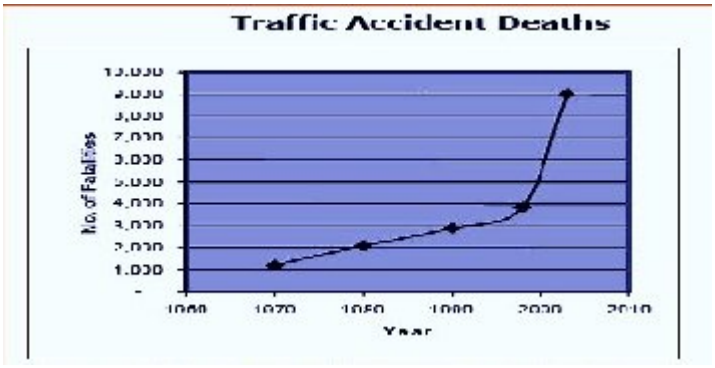

Figure 1 – Trend of Road Accidents in the Philippines

Road accident is now the fourth leading cause of death in the Philippines according to the Department of Health . In light of this, many researchers have tried to tackle the said issue by identifying the major reasons behind these accidents. Two of the most mentioned causes in literature are driver distraction and human error.

1.1. Driver Distractions

Driving is a skill that requires full attention in order to safely control the car and respond to events happening on the road. Driving involves constant and complex coordination between vision, mind and body[2] . Driver distraction refers to those instances when a driver's attention is diverted from the primary task of driving the vehicle in a way that compromises safe driving performance. The American Association Foundation for Traffic Safety (AAFTS) however, defines driver distraction as occurring "when a driver is delayed in the recognition of information needed to safely accomplish the driving task because some event, activity, object, or person within or outside the vehicle compelled or tended to induce the driver's shifting attention away from the driving task" the distraction source can either be internal or external to the vehicle[2].

Distractions happen daily on roads and freeways, putting every motorist at risk of an accident that could result in serious personal injury or death. Driver distraction seems to be a hefty contributing factor when considering past researches on the same topic. Moreover, research has also concluded that, when controlling for driving conditions and time on task, the impairments associated with using a mobile phone while driving can be as profound as those associated with driving while under the influence of alcohol. This suggests that it is equally important for one to stay focused and attentive when maneuvering an automobile, as it is to avoid drinking and driving.

Three major types of distraction have been widely studied: visual, manual and cognitive [3]. These distractions deflect drivers' visual and cognitive resources away from the driving control task. These distractions can degrade driving performance and even cause fatal accidents. Visual distraction and manual distraction can be directly observed through the external behaviors of drivers, such as glancing at billboards or releasing the steering wheel to adjust the radio. Visual distraction usually coexists with manual distraction because visual cues provide necessary feedback when people perform manual tasks. It was further suggested that visual and manual distractions interrupt continuous visual perception and manual operation essential for driving. This results in the absence of visual attention on safety-critical events [3].

1.2. Driving in the Philippines

Filipino drivers are generally aggressive. Defensive driving is a must when driving in the Philippine road setting [4]. In a formal appraisal of the driving conditions in the Philippines, the U.S. Embassy declares that "Filipino drivers routinely ignore stoplights, lane markers and other traffic control devices and traffic rules are rarely enforced". In an assessment of the road conditions in the Philippines, traffic conditions are described as "often crowded and chaotic". Many roads are in disrepair and with large potholes.

According to Regidor, director of the UP National Center for Transportation Studies, Filipino drivers disregard traffic rules and regulations due largely to impatience. Combined with the "Filipino time" attitude of doing things at the last minute, Regidor explains that this impatience often results in Filipino drivers being forced to resort to overly aggressive driving. He further coins "road bullying" as a common practice of many Filipino drivers who "change their personalities once they get behind the wheel" as some of them "imagine themselves as F1 drivers on public streets"[5].

There is growing recognition that road user behavior is now the most important single accident contributory factor in the Philippines, with 85 percent of road accidents in the country being caused by driver error according to Aurora Corpus Mendoza a psychologist who did a study on road safety [5] . According to her study, factors that influenced behavior included driver's age, gender, education and driver type among others. Drivers without college degrees had significantly stronger intentions to commit traffic violations compared to college graduates. This certain finding points to the importance of a college education in the local setting, in terms of how it directly contributes to driver decisions in adhering to or violating rules.

II. Conceptual Framework

The conceptual framework of the study is made up of different constructs which are discussed in detail in the following section. The framework shows the relationship of the variables to be included in the study.

2.1. Manual Distraction

The capacity of a driver to keep his/her hands on the wheel at all times while driving is inversely related with a certain type of driver distraction called manual distraction. Manual distraction is anything external to the driver that may take his/her hands off the wheel for whatever reason. Examples would range from the driver fixing his/her hair to shifting radio stations [3]. When the driver is manually distracted, his attention is focused on the manual task at hand rather than on the road. As a result, driving errors are committed and important stimuli coming from the road are ignored.

The problem of manual distraction while driving can be explained by code interference in the visuo-spatial working memory of the driver. Tasks that impose high load on spatial working memory should not be done simultaneously with other tasks that require the same resources [6].

2.2. Visual Distraction

Too many visual distractions may affect the driver's ability to concentrate on looking at the road [7]. Vision is key to a person's perceptive capabilities since visual impairment hampers the person's capacity to perceive the environment around him. In a driver's case, it is tantamount to him/her seeing what's in front of the car at all times. It should also follow that the driver gets to occasionally see what's behind or beside his/her vehicle through the use of the rearview and side mirrors.

Visual distraction is defined as any type of distraction that takes the driver's eyes off the road [3]. Unlike other types of distraction, visual distractions could prove to be more costly in the event that perception, attention and working memory is compromised by some underlying factors such as low vigilance, driver drowsiness, and drunk driving among others.

2.3 Attention

Attention is the cognitive process of selectively concentrating on one aspect of the environment while ignoring other things. According to Almen [8] attention may be captured involuntarily by salient features of the environment, and it happens quite often that the attention drifts away and the driver gets distracted. In avoiding car accidents, it is crucial to find a way to control the driver's attention in a way that would keep the focus on driving and minimize unwanted capturing [8].

Distraction is attention to irrelevant stimuli or actions, and this implies a definition of what is relevant or irrelevant for a given goal, which in this case is driving from point A to point B [9]. It is imperative for a driver to be able to keep his mind on the primary task at hand especially since in such cases as driving, failure to do so could lead to accidents. Keeping attention at a high level would help in controlling the cognitive performance of drivers, and thus could help in minimizing risks, preventing accidents and injuries, and ensuring that the driver is able to get from point A to point B in a safe manner.

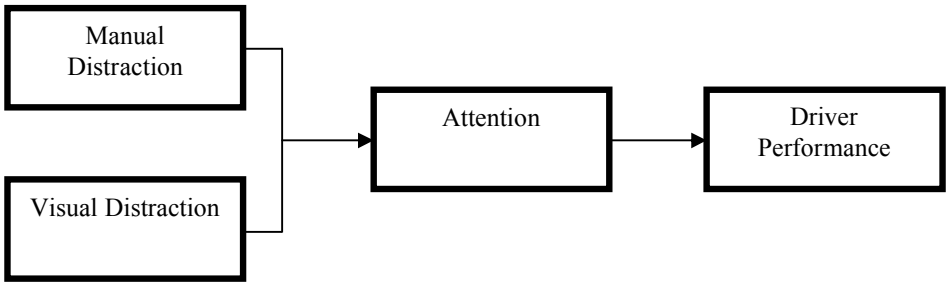

Figure 2. Conceptual Model

Figure 2 shows the conceptual model which displays the inter-relationships of the defined constructs with each other. Visual and manual distraction can or may affect the sensory processing and attention resources of the driver. This in turn can contribute to the information processing of the driver and will dictate how the driver will behave.

III. Research Objectives

The study aims to develop a framework that may be used to analyze causes of driver distraction in Metro Manila and recommend possible intervention to prevent these distractions from influencing driver performance.

Specifically the research aims to:

- Determine causes of driver distraction from past research and actual observations.
- Develop measures of driving performance related to distraction.
- Identify the relationship between distraction and driving performance.
- Recommend new policies to be implemented to improve road safety.

IV. Scope of the Study

- The study will focus on cases of road accidents, drivers, environments and traffic rules and regulations implemented in Metro Manila, Philippines.
- The study will make use of simulated driving environment (video recording of EDSA) in observing subject behavior.
- The study will focus on teen age drivers
- The study will consider the gender and skill of the driver
- The study will assess the driver's manual and visual performance through the use of the eye-tracker in the simulated driving environments.

V. Model Validation

Experimentation will be conducted in order to identify which of the visual and manual distractions greatly affect driver performance. The main challenge in this research is simulating the driving task and enabling the introduction of the experimental factors.

4.1. Profile of Subjects

A total of 30 drivers with ages 17-20 will be recruited to participate in this study. A screening questionnaire will be given to the participants to determine their years of driving experienced since participants will be divided into two groups: Novice and expert drivers. It is assumed that a driver is still considered a novice if he/she has a driving experienced of 2 years or less. Both genders will participate in this study.

4.2 Measurements

A real driving task was not deemed appropriate because it might endanger the safety of the participants. The eye tracking device to be used in the experiment was attested to be safe by the manufacturer for this kind of experiment but control will be an issue. As such, the researchers decided that it will be done in a laboratory where driving will be simulated using video clippings of the road condition including distractions.

The independent variables that will be considered in the study are summarized in Table 1:

Table 1. Independent Variables in the Experiment

Independent variables	Measurement	Levels
1. Billboard presence	Categorical	0: not present; 1: present
2. Billboard position	Categorical	1: left 2: right 3: top
3. Billboard characteristic	Categorial	1: indecent picture 2: decent picture
4. Presence of manual distraction	Categorical	0: not present; 1: present
5. Driver skill	Categorical	1: Novice 2: Expert
6. Gender	Categorical	1: Male 2: Female

Dependent variable for the study is driver's performance expressed as the correctness of response based on the factors introduced. This dependent variable is categorical and the value will be assessed by the researchers based on observation. Drivers can either have a correct or wrong response to the factor introduced. The other dependent variable is reaction time which will be measured in milliseconds.

4.3. Experimental Procedure

Participants Briefing
Before the actual experiment, the participants will be given a briefing. The objective of the experiment will be explained to them. The participants will be asked to sign a consent form for the test.

Testing Procedure
After briefing, the participants will be led to the testing area. Participants will be asked to wear the eye tracker device to measure attention and vigilance in driving. A simulated driving experience will be done on the subjects inside a controlled environment. Participants will be asked to watch actual driving video of a major thoroughfare (EDSA) in Metro Manila where billboard signs are present. Some distractions will be introduced to them during the experiment such as entertaining a call from their cellular phone or replying to a text message. Drivers will be given the option to be distracted during the experiment so that the impact of these distractions can be assessed.

Debriefing
After completing the experiment, the participants will be given a debriefing. During the debriefing, the participants are encouraged to express what they think about the whole experience. This session is important to establish rapport with the participant and encourage them to give their views about the whole experiment.

4.4 Data Analysis
Data that will be gathered from the experiment will be analyzed using logistic regression. This statistical method was chosen because it is capable of identifying which is the most significant variable in driver performance if the dependent variable is binary. The result of the analysis will be used to recommend meaningful regulations regarding billboard advertisement and use of cellular phones along major roads and highways.

4.5. Expected Result
The study will be able to determine the risks of distracted driving through simulation. The model that will be derived from the study will be used to identify which of the variables introduced has a significant influence to driver performance. It will be able to measure the attitude or behavior of driver towards manual and visual distractions (presence of billboard or use of cellular phone). The result will give researchers an understanding of the unique behavior of Filipino drivers while on the road. The information can be used by government agencies in implementing and coming up with laws on the placement of billboard and the use of cellular phone while driving.

At present, there are existing laws on the use of cellular phone while driving but the implementation had been lax. There are no laws regarding the placement of billboards on main thoroughfares probably because there had been no scientific studies done that identifies how they affect the drivers. The output of this study will give concrete information that will aid legislation that will promote road safety. It will be the first one that will show empirical data on visual stimuli that catches driver attention on the road.

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