Chapter

Introductory Chapter: Analysis and Prevention of Accidents

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1. Introduction

A highly damaged car is pulled off, while another salvage one is across it. Police cars parked with blue and red top lights are on. One paramedic is zipping a "full" body bag, while the other two are carrying a victim to the ambulance in a hurry. Crumbled headlight glasses and leaked radiator liquid are all over the lane you drive through. You both avoid those on the ground and try to see what has happened a short while ago. At the same time, your eyes catch a police officer staring at you. He is waving his hand to make the traffic flow.

This is an unfortunate incident; however, it is a familiar scene we faced at least once in our lives while driving on the road. According to the World Health Organization [1], every year 1.35 million people die all over the world because of traffic accidents, while some 20–50 million people survived with nonfatal injuries; however, some of them still become disabled. A press release [2] by the US Department of Health and Human Services' Centers for Disease Control and Prevention suggests that in 2012 more than 2.5 million people visited emergency rooms of hospitals because of traffic accidents. However, this is only one facet of the traffic accident phenomenon.

Another report of the U.S. Department of Transportation's National Highway Traffic Safety Administration [3] provides a detailed cost analysis of accidents that occurred in America in the year 2010. According to this report, almost 33,000 people lost their lives, 3.9 million were injured, and 24 million vehicles are damaged as well. The report analyzes and groups the traffic accidents' nine pecuniary consequences under two categories: costs related to injury cases and expenses related to noninjury cases. The former consists of medical care ($ 23.4 billion), emergency medical services ($ 1 billion), market productivity ($ 57.6 billion), household productivity ($ 19.7 billion), insurance administrations ($ 20.6 billion), workplace ($ 4.6 billion), and legal costs ($ 10.9 billion), and the latter consists of congestion ($ 28 billion) and property damage ($ 76.1 billion) costs. Altogether, the accidents' financial burden on the US economy reaches $ 241.9 billion. The percentages of these costs are shown in **Figure 1** [3].

As seen so far, traffic accidents cause not only personal losses but also a significant burden on the gross domestic product of states. To avoid these consequences, each country develops and conducts its own policies and programs. While most of the causes of accidents look the same and can be handled together, in fact, the traffic accidents' causes differ from state to state with regard to its level of development.

The Korean Road Traffic Authority defines the causes of traffic accidents as unsafe factors, unsafe road environments, insufficient driver knowledge, failure to recognize the danger, and improper thinking [4]. The Government of Jharkhand's Transport Department lists the causes of traffic accidents as overspeeding, drunken

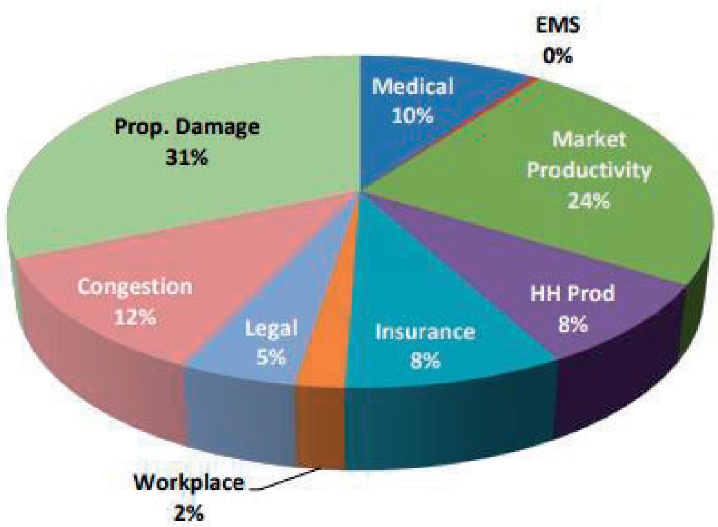

Figure 1.
Components of total economic costs.

driving, distractions to driver, red light jumping, and avoiding safety gears like seat belts and helmets [5]. A study prepared by the U.S. Department of Transportation's National Highway Traffic Safety Administration to be presented to the US Congress defines the causes of traffic accidents as driver-related, vehicle-related, roadway-related, and atmospheric condition-related factors [6].

From the view of a law firm in the United States, causes of accidents are long-listed as follows: distracted driving, speeding, drunk driving, reckless driving, rain, running red lights, running stop signs, teenage drivers, night driving, design defects, unsafe lane changes, wrong-way driving, improper turns, tailgating, driving under the influence of drugs, ice, snow, road rage, potholes, drowsy driving, tire blowouts, fog, deadly curves, animal crossings, and street racing [7]. Even though there seem to be many causes, it can be said that almost all of the accidents arise from the faults of humans. For instance, while drunk driving or running red lights are explicitly related to drivers, on the other hand, most of the vehicle- or road-related accidents such as tire blowouts (not changed in time) or unseen road signs (not controlled by road authority officials) are implicitly related to humans. This shows that humans must be in the center of the struggle for policies developed to prevent traffic accidents. Nevertheless, are the humans aware of that they are the main reasons for traffic accidents?

A recent study [8] researched the reasons behind the accidents by gathering data from the interview with police officers and drivers and also from traffic accident reports. Two of the main findings of the study are:

- The reasons for accidents differ between the genders and across the age groups.
- When police officers and drivers are asked to assign reasons to accidents, they only generated 25 possible causes; however, real accident reports included 63 accident causes [8].

The second finding mentioned above shows that the perceptions of people regarding accidents' causes are inadequate to understand the reasons and dynamics of accidents. Conversely, some factors such as uncorrected eyesight were listed by police officers and drivers; however, that did not take enough place in crash reports.

Traffic accidents cause inevitable and devastating individual, social, and economic impacts, and thus preventing those accidents is of great importance. So what can be done to solve this issue? The answer is quite simple: "What gets measured get managed" [9].

Since the end of the twentieth century, traffic accidents began to be analyzed by professionals in order to reveal the real underlying causes of traffic accidents. Projects like German In-Depth Accident Study (GIDAS) [10] are done to analyze and reconstruct traffic accidents. GIDAS project's objectives are the development of legislation, biomechanical research, automotive engineering arrangements, and public relations [11]. Similar studies are conducted all over the world; however, using scientific methods are far better than classical accident reporting methods. Because:

> *Underreporting due to inconsistent law enforcement practices may also explain why uncorrected or defective eyesight was frequently generated as a factor by police officers (and the public), but was rarely reported in the accident records. Policymakers rely on road accident statistics to inform their recommendations and new policy initiatives. Based on our current findings, we recommend that police officers and policymakers be cognizant of potential underreporting of factors associated with driver risk [8].*

Improving active and passive anti-collision systems, educating people, and conducting detailed (data) analyses are necessary in order to define policies. This kind of studies collect great amount of data for each accident [12], calculate several variables such as road friction coefficients [13], reconstruct accidents, and then evaluate several aspects of accidents such as injury probability functions for pedestrians and bicycles [14]. In addition to policymaking, improving vehicle safety, and educating people, there is another way to ensure safe roads: the use of smart technologies, in other words autonomous vehicles.

Artificial intelligence, one of the most popular phenomena of the last few years, is basically defined as "the capability of a machine to imitate intelligent human behavior" and "a branch of computer science dealing with the simulation of intelligent behavior in computers" [15]. Similarly, autonomous vehicles (AVs) are also expected to imitate human drivers' behaviors. Typically, in addition to a conventional vehicle, an AV has sensors to see its surrounding environment, complex CNN[1] or DNN[2] type (or similar) algorithms to analyze the data gathered, a powerful processor to make decisions, and other parts to convert the decisions to necessary actions.

Today, hundreds of thousands of AVs are on the roads. Besides, that number is anticipated to climb up, and autonomous cars are expected to constitute 25% of cars worldwide in 2035 [16]. However, what makes these AVs so unique? Is it the hi-tech equipment they have or the comfort they provide? Essentially, the prominent benefits they bring us are freedom of movement of incapables such as children or visually impaired people, better management of traffic flow, and the reduced number of accidents.

Nevertheless, some cannot trust in AVs and claim that AVs are not safe, at least 100% safe. Also, a recent research paper suggested that Level 2 and even Level 3 AVs would involve in accidents on German motorways [17]. But, are the AVs responsible for these accidents?

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1 Convolutional neural network (CNN): A specific type of artificial neural network that uses perceptrons and a machine learning unit algorithm, for supervised learning, to analyze data. CNNs apply to image processing, natural language processing, and other kinds of cognitive tasks.

2 Deep neural network (DNN): A neural network with a certain level of complexity and a neural network with more than two layers. Deep neural networks use sophisticated mathematical modeling to process data in complex ways.

DMV (Department of Motor Vehicles) of California, shares the data of traffic accidents and according to related data, there are 234 accidents in which AVs are involved that happened in California from January 1, 2014 to December 31, 2019. However, this number does not mean that in all cases, the AVs are responsible [18]. In most cases, AVs are not the primary actors in these accidents, because they are equipped with several systems to prevent accidents such as lasers, high-powered cameras, radars, and even sonars. While they are not entirely safe, AVs are still in the developmental phase, and until Level 5 (fully automated, driverless) AVs set on roads, drivers will stay behind the wheels. Thus, people will be the main actor in traffic accidents. Due to the fact that 94% of the severe accidents stemmed from human errors [19], most policies and training programs must focus primarily on people.

Awareness creation, strict implementation of traffic rules, and scientific engineering measures are listed as methods for accident prevention in Ref. [20]. It is suggested that successful strategies for accident prevention must focus on six main areas that are national programs and target setting, safer driving behavior, safer vehicles and roads, safer pedestrians and vulnerable road users, education, training and publicity, and data systems (for analyses for policymakers) [21]. A detailed literature review of accidents that happened in the East and South Africa claims that related studies focused on four main fields: road safety policy, health education, safety equipment, and data collection.

As described so far, humans are the primary reasons for traffic accidents, and regardless of a driver's age, where he or she lives, or his or her country's developmental level, all policies shall put the humans in the center of their focus. Overall, setting high standards for licensure of drivers, strictly implementing traffic regulations, increasing public awareness, and promoting public transportations seem to be the best means in the field to prevent traffic accidents.

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