CHAPTER 5
EXPERIMENTAL AND ECONOMIC ANALYSIS

5.1 EXPERIMENTAL EVALUATION

Experimental studies use simplified and structured tasks in a laboratory or real track or road environment to better understand about the performance of the system or application build. Researchers prefer “real-world” studies and often assert that the findings of laboratory experiments are not relevant to real-world risk (Ranney 2008), (VTTI 2009). Since, in a laboratory experiment or driving simulator studies drivers know well in advance that they are under watch.

To measure the efficiency of the mobile application, C.A.P. application has been installed to about 164 drivers for the period of 3 months, out of 164 driver uses this application only 18 drivers got an emergency call while nearly 74 drivers also got the call while driving only for the 1st time, since C.A.P. started sending the SMS to the caller with approx. elapsed time of the driver to reach the destination. These callers made a call only after this elapsed time and by that time the user would have reached his destination safely. As a result, out of 164 users 18 of them are affected with the probability of risk associated with driving after installing this application, showing a risk rate of nearly 10.97% during incoming call. In case of an outgoing call, the risk associated with the driver after installing this application is 0%. Since, C.A.P. application blocks all outgoing call until the driver comes to rest or stops the vehicle in a safe place. The figure 5.1 shows
the number of driver received the calls while driving, number of driver’s call suppressed by the application and the number of driver’s call allowed by the application considering as emergency respectively.

![Bar chart showing efficiency of C.A.P. Application](image)

**Figure 5.1 Efficiency of C.A.P. Application**

From the case study, it is found that nearly 30% of the drivers admitted that they have met with an accident as a result of using a cell phone. As per the study estimates, out of 164 about 49 drivers would have met with an accident. In case, if all the 49 drivers would have installed the C.A.P. application then the number of accident would have been reduced to 18 (since C.A.P. application reduce the accident risk rate of 89.3%) which is almost 19% reduction in accidents when compared to our study estimation of 30% as shown in Figure 5.2.

It is very clear that, not only application can entirely prevent the driver from talking on phone, though the application can prevent the risk associated to the driver of using cell phone approximately by 89% it requires additional hardware or technologies in addition to this C.A.P. application,
which could completely restrict the driver from making or receiving a call unless there is a real emergency.

![Figure 5.2 Comparisons Before and After Installing C.A.P.](image)

The detection unit is developed to identify whether the driver if he/she was talking on the phone, and when there is an emergency call, a microcontroller detects whether the vehicle is in motion or not based on RPM values captured using a photo interrupter sensor. If a vehicle in motion is detected, then the microcontroller activate a voice chip and incase if the driver stops the vehicle within 8sec., then microcontroller allows the call else, a low range mobile jammer is used which will prevent the driver from receiving or making a call. From the time of emergency call to the activation of mobile phone jammer takes approx. 25 sec. Even this timeframe is sufficient for driver distraction. In order to prevent the user from talking on cell phone during this timeframe, the PIC microcontroller along with transmitter is used to transmit the vehicle number plate information to the receiver which is placed on a signal post. The experimental setup of the detection circuit along with other hardware setup is shown in Figure 5.3.
Figure 5.3 Real Time Hardware Setup of the Device on Vehicle

The experiment is carried out by installing the hardware setup with slight modification from the real hardware kit (Here, counter is used which start counting when both the jammer and vehicle in motion is detected, while, removing transmitter part which is used to send the vehicle number plate information to the police) in 18 cars on which the driver are affected by the C.A.P. application to know how far this hardware system helps in reducing the risk further. The complete operation of the system is explained to all the drivers. Exactly 3 months after the installation of the system, the details have been collected from the drivers and also from the counter attached on the hardware kit placed on the car, and found, out of 18 drivers only 2 of them use a cell phone while driving, while the rest of the 16 drivers also got the call but this time the driver stops the vehicle in a safe place, once the system notifies the driver that there is an emergency call via voice chip, and before the activation of mobile jammer. Since, the drivers knew well in advance that mobile jammer placed near driver seat will block the communication soon, which will force the drivers not to speak more. The Figure 5.4 shows the efficiency of only the C.A.P. application and the hardware system along with C.A.P. mobile application.
Therefore, the number of accidents, after installing the hardware and application has been reduced to 1.21% when compared to the case study. It is personally believed that, the risk percentage of accidents can be brought down further, if original hardware setup has been installed i.e., with the inclusion of transmitter module, which will transmit the vehicle number plate information to the police and by applying strict law enforcement, for example, taking strict disciplinary activities based on the level of negligence against the driver like penalizing for the first offense followed by canceling the license on the second offense.

5.2  COMPARISON WITH OTHER SYSTEM/APPLICATION

Table 5.1 shows how far the C.A.P. application is effective when compared to other top Cell phone distracted application.
### Table 5.1 Comparison of C.A.P. with Applications

<table>
<thead>
<tr>
<th>Name</th>
<th>Application (APP)/ Hardware (HW)</th>
<th>Driver Detection</th>
<th>Human Intervention</th>
<th>Trigger</th>
<th>Notification to Caller</th>
<th>Technology Required</th>
<th>Subscription / price</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cell Control</td>
<td>App HW</td>
<td>No</td>
<td>Required</td>
<td>Speed</td>
<td>No</td>
<td>Bluetooth</td>
<td>Yes $25-$8 per month</td>
</tr>
<tr>
<td>iZUP</td>
<td>App</td>
<td>No</td>
<td>Required</td>
<td>Speed</td>
<td>No</td>
<td>GPS</td>
<td>Yes; $20 per year</td>
</tr>
<tr>
<td>Drive Assist</td>
<td>AppHW</td>
<td>No</td>
<td>Required</td>
<td>Speed</td>
<td>Yes</td>
<td>GPS</td>
<td>Yes</td>
</tr>
<tr>
<td>KeyZSafe diving</td>
<td>App.HW</td>
<td>No</td>
<td>Required</td>
<td>Ignition</td>
<td>No</td>
<td>Bluetooth</td>
<td>$99.95</td>
</tr>
<tr>
<td>Drive Smart Plus</td>
<td>App</td>
<td>No</td>
<td>Required</td>
<td>Speed</td>
<td>No</td>
<td>GPS</td>
<td>$4.99 per month</td>
</tr>
<tr>
<td>Cell TRAKR</td>
<td>App</td>
<td>No</td>
<td>Required</td>
<td>Speed</td>
<td>Yes</td>
<td>GPS</td>
<td>Free</td>
</tr>
<tr>
<td>Phon Enforcer</td>
<td>App</td>
<td>No</td>
<td>Required</td>
<td>Speed</td>
<td>Notify to predefined number. Not to the caller.</td>
<td>GPS</td>
<td>Yes/Price depends on various versions.</td>
</tr>
<tr>
<td><strong>C.A.P.</strong> (Cellphone Accident Preventer)</td>
<td>HW/App</td>
<td>Yes</td>
<td>NOT Required</td>
<td>Voice or Data communication</td>
<td>Yes</td>
<td>GPS if Required</td>
<td>Free</td>
</tr>
</tbody>
</table>
### Table 5.2 Comparison of Hardware System with Other Techniques

<table>
<thead>
<tr>
<th>Category</th>
<th>Types</th>
<th>Method</th>
<th>Strength</th>
<th>Weakness</th>
</tr>
</thead>
<tbody>
<tr>
<td>Driver Behavior Information</td>
<td>Physiological Feature</td>
<td>Measuring the heart, Pulse rate and brain activity</td>
<td>It is possible to accurately measure the inattention level</td>
<td>It is intrusive because equipment must be attached to the driver</td>
</tr>
<tr>
<td></td>
<td>Visual Feature</td>
<td>Tracking head, eye, Shoulder movements, recognizing facial expression</td>
<td>It is not intrusive to the Driver</td>
<td>It require additional devices like camera</td>
</tr>
<tr>
<td>Driving Behavior Information</td>
<td>Monitoring vehicle speed, Steering movement, lane keeping, acceleration, braking and gear change</td>
<td>It does not require an additional camera or biosensors.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Driver Detection</td>
<td>Monitoring user micro-moments, detection based on acoustic approach</td>
<td>It is not intrusive to the Driver</td>
<td>It require built-in Bluetooth in cars, Its work based on many assumptions.</td>
<td></td>
</tr>
<tr>
<td>Proposed Method</td>
<td>Detect voice Communication use of cell phone</td>
<td>It is not intrusive and it’s able to detect drivers the driver head.</td>
<td></td>
<td>It require hardware circuit attached above</td>
</tr>
</tbody>
</table>

The proposed hardware system is capable of differentiating whether the cell phone used is either by the driver or the passenger. Though, the proposed system requires hardware unit to be attached above the driver seat it is not intrusive because it does not require any equipment or device attached to the driver. Added advantage of this system is, even if the driver tries to kill or stop the C.A.P. application the hardware part designed is able to identify whether the cell phone is operating either by the driver or passenger. Once it detected that the driver is operating a phone, it automatically sends the vehicle number plate to the LCD display which is attached on the signal post.

The proposed system along with C.A.P. is capable of reducing the driver’s risk of using cell phone while driving dramatically. The complete system reduces the risk associated with driving due to cell phone use by 96.28%.
5.3 ECONOMIC ANALYSIS

Road traffic injuries (RTIs) and fatalities have emerged as a major public health concern, with RTIs having become one of the leading causes of deaths, disabilities and hospitalizations which impose severe socio-economic costs across the world. Many developing countries including India have a serious road accident problem (Road Accidents in India 2010). In India, fatality rates (defined as, road accidental death per 10,000 vehicles) are quite high in comparison to developed countries. For example, fatality rate in India given by Sikdar and Bhavsar (2009) shows, Indian fatality rates are 15% to 20% higher than those of developed countries. In developed countries like Europe and America the situation is normally improving, but in the case of developing countries they face a worsening situation. Apart from the humanitarian aspects of the problem, road accidents cost the developing countries at least 1-3 percent of their GDP each year.

As per data registered by the World Health organization, in 2010 nearly 1.4 million people are known to die each year due to road accidents globally. Out of this figure nearly 1.34 lakhs people die in India. This shows about 369 people die every day on Indian roads which is nearly 10% of daily global road accident. According to World Health organization (WHO) report on the Decade of Action for Road Safety 2011–2020 states without any action on road safety would lead to the loss of around 1.9 million lives on the roads each year by 2020.

There is an alarming increase in accidental deaths on India roads. Figure 5.5 gives the year-wise road accident and fatality destruction from 2001-2010. In 2010, for every 3.56 minute one death and one injury for every minute took place respectively which was alarmingly dangerous when compared to 4.14 minute and 1.13 minute for one death and one injury in 2009. Between 1970 and 2009 the number of accidents has quadrupled (1.1
lakhs in 1970 to 4.22 lakhs in 2009) with nearly 7.5 fold increase in injuries
(0.7 lakhs in 1970 to 5.27 lakhs in 2010) and nearly 9.6 fold increases in
fatalities (0.14 lakhs in 1970 to 1.34 lakhs in 2010). An estimated 2 million
people have a disability that results from a road traffic crash (Gururaj 2006),
(WHO 2009).

Figure 5.5  Road Accident and Fatality Destruction From 2001-2010

Road crashes deserve to be a strategic issue for any country’s
public health and can lead to overall growth crisis, if not addressed properly.
Road traffic injuries was the leading cause of death globally among
15-19 year-olds, while for those in the 10-14 years and 20-24 years age
brackets, it was the second leading cause of death (WHO 2007a). The study
carried by (Dinesh 2009) shows road traffic fatalities were increasing at about
8% annually from the last ten years and show no signs of decreasing. The
projected 40% increase in global deaths resulting from injury between 2002
and 2030 is predominantly due to the increasing number of deaths from road
traffic accidents (WHO 2007b). The financial loss due to road accidents is
estimated by Mondal et al (2011), in 2009 nearly 1.27 lakhs people died in road accidents in India resulted to a financial loss of about ₹1,36,000 crores approximately.

Tables 5.3 and 5.4 have shown the statistics of road accidents around the globe and India of the years 2009 and 2010. According to the statistics obtained from Indian Ministry of Road Transport and Highways at least 15 people die every hour in road accidents in 2010 when compared to 14 in 2009 as listed in Table 5.3.

Table 5.3  Road Accident Death 2010 Vs 2009

<table>
<thead>
<tr>
<th>Road Accidents</th>
<th>Daily Statistics</th>
<th>Hourly statistics</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Statistics</td>
<td>World</td>
</tr>
<tr>
<td>Death (2010)</td>
<td>3837</td>
<td>369</td>
</tr>
<tr>
<td>Death (2009)</td>
<td>3561</td>
<td>344</td>
</tr>
</tbody>
</table>

Table 5.4 Total Accident in 2010

<table>
<thead>
<tr>
<th>Statistics</th>
<th>World</th>
<th>India</th>
<th>World</th>
<th>India</th>
</tr>
</thead>
<tbody>
<tr>
<td>Death (2010)</td>
<td>3837</td>
<td>369</td>
<td>160</td>
<td>15</td>
</tr>
<tr>
<td>Injuries (2010)</td>
<td>109,539</td>
<td>1369</td>
<td>4566</td>
<td>57</td>
</tr>
<tr>
<td>Death + Injuries (2010)</td>
<td>113,426</td>
<td>1738</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Due to coordinate inter agency approaches in developed countries, the situation is improving. Road crashes significantly inhibit economic and social development burdens on developing nations like India estimating 3 percent of gross national product. However, the price being paid for this is exorbitant. The estimated cost includes compensation, asset loss, and loss of
man power, loss of productivity, high medical expenses, costly management, property damage and many others. It also includes victims lost wages and the replacement cost of lost household work. In India, as on 2012, the compensation is proposed to be hiked in case of a death in a road accident from ₹25,000 to ₹1 lakh. In case of serious injury, compensation will be ₹50,000.

There are various studies carried out by Wang et al (1996), Sussman (1985), Robertson (2003), Stutts et al (2001) which estimated about 25 to 37 percent of traffic accidents involved driver distraction and causes approximately $50 billion social and economic costs annually. The National Highway Traffic Safety Administration (NHTSA) and the Virginia Tech Transportation Institute (VTTI) found that 80 percent of crashes and 65 percent of near-crashes involved some form of driver inattention within three seconds of the crash. According to our study estimates that 30% of crashes are caused by a driver using his or her cell phone with financial losses of 1-3% GDP every year.

From the Table 5.4, it is estimated that the total number of crashes which includes death and injuries was 1738 per day as per the record obtained from India Ministry of Road Transport and Highways in 2010. If the financial loss of road accident is calculated based on Mondal et al (2011) cost estimation, it has been found approximately ₹372 crores of financial loss per day for the road accident crashes. According to our study findings 30% of the total crashes is due to cell phone use. Therefore, 521 crashes would be as a result of cell phone use while driving.

Therefore, the cost associated with 521 crashes would be ₹111.6 crores. If C.A.P. application has been installed in all the cell phones while driving, the chances of involvement in crashes will be 10.3% i.e.,
10.3% of 521 = 53.6 (approx. 54). Hence, it can save nearly 467 crashes which in turn reduce the economic loss of India of about ₹100 crores along with personal family benefits. So, the total cost associated with 54 accidents will be ₹11.6 crores as shown in Figure 5.6.

![Graph showing financial loss reduction](image)

**FL : Financial Loss**

**Figure 5.6 Reductions of Financial Loss/Per Year After C.A.P.**

In order to further reduce the economic loss due to cell phone accident (i.e., ₹11.6 crores) a hardware system along with C.A.P. application is implemented. The implementation of the complete system can reduce the risk further to 1.21% when compared to 10.3% of only C.A.P application.

So, 1.21% of 54 = 0.653 (Approx. 1)

Thus, only one user would have the met with crash due to cell phone use while driving. Hence, it can save nearly 53 crashes which in turn further reduce the financial loss of about ₹11.38 crores. Thus, the implementation of a complete system will almost reduce the financial loss due to cell phone accident of about ₹111.38 crores per day i.e., nearly ₹40,653.7 crores per
annum can be saved from the total cost of ₹1,36,000 crores spent on road accident fatalities as shown in Figure 5.7.

![Graph showing financial loss reduction](image)

**FL: Financial Loss – Statistics per Year**

**Figure 5.7 Total Reduction of Financial Loss Due to Accidents**

### 5.4 SUMMARY

The results obtained from the proposed system have been discussed in this chapter. It is shown that the installation of only C.A.P. application on the driver cell phone would eliminate the risk associated with driver of using cell phone by 89% and it would reduce the accident rate of about 19% from 30%. If the hardware setup along with C.A.P. application is installed, than the risk associated with the use of cell phone is decreased by 96.28% and reduces the accident rate further to 28.79% from the total accident rate of 30% as obtained from the case study. This chapter also links the accident with economic loss and shows the implementation of a complete system would reduce the financial loss of about ₹111.38 crores per day i.e., it can save nearly ₹40,653.7 crores per annum from ₹1,36,000 crores rupees spent on road accident fatalities.