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Adoption of Information and Communication Technology in Road Accident Reduction

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Abstract - This study assessed the level of information and communications technology use in reducing the road accidents in Kerala. For primary data collection, point-to-point physical observations were made. Traffic and accident statistics was collected from the published data sources of various government organizations. The study revealed that agencies or organizations responsible for reducing the road accidents are using one or other form of ICTs. Some organizations provide ICT-based services to the public. The challenge of funding, lack of trained personal, low bandwidth, complexities of the parameters to be monitored as well as lack of cooperation among various departments in the coordination were identified. It was recommended that an integrated ICT policy for the transportation sector is to be developed, incorporating the roles and responsibilities of the various stakeholders. Also, employees of various government departments should be trained in various technological applications and trends in information service and delivery to enhance the services they provide. Finally, the political leadership must prioritize the acquisition and use of ICTs in various zones of the different agencies across the state and make budgetary allocation that could support that drive.

Keywords - *Breath analyzer, Camera surveillance, Enforcement, ICT tools, Signalized intersection, Speed detection and response system, Road safety.*

1. Introduction

The number of road accidents is increasing in Kerala. Kerala Police (2013) revealed that in the year 2013, 4258 persons were killed, 40346 persons got injured and 1675 persons escaped without any injury through 35215 reported road accident cases. Poor design and condition of the road, increased vehicle density and vehicle population, over speeding, rash and negligence in driving, violation of the rules and regulations, improper condition of the vehicles, changes in climate etc. are some of the major reasons for the accidents resulting in the high mortality rate. The basic engineering design of the road and improving the conditions of the road are addressed in the transportation design stage. Improving the conditions of the road either in the navigation or in the control through technology belongs to the Information Communication Technology (ICT). This study reviews the effectiveness of the ICT in reducing road accidents in Kerala.

ICT tools can be dispensed in three different levels. The higher level focuses to prevent serious injury and death crashes, second level focus is on real time risk reduction and mitigating action and in third level it is reducing the crash risk by applying road design standards, guidelines, driver behavior and law enforcement by ICT tools.

2. Objectives

1. To find out various ICTs that have been adopted by various departments to ensure road safety
2. To find out ICT based services in the transportation sector
3. To find out the financial aspects of the ICT dispensation
4. To identify the challenges of ICT use in the transportation sector in Kerala
5. To analyze the accident data in the context of ICT dispensation.

3. Research Questions

1. What ICTs are used in the transportation sector?
2. What services in the transportation sector are ICT based?
3. What are the sources of funding for ICTs used in the sector?
4. What are the challenges faced in the application of ICT in the transportation sector in Kerala?
5. How much is the effectiveness of the dispensation of ICT?

4. Literature Review

Road safety measures can be categorized as user related measures, training and education, traffic law, incentive, enforcement and vehicle related measures as suggested by Jacob Thomas (2009). The application of ICT measures will be belonging to the areas like training and education, traffic law enforcement, vehicle related measures and infrastructure related measures.

Road safety is known to be influenced by factors such as weather changes, increased police and camera -based enforcement, hot spot remediation programs as suggested by David Wallington et al (2014). Enforcement of the speed control regulations and effective monitoring of speed limits of vehicles at various stretches by ICT aids of the road is important in this aspect.

So Young Sohn (1999) suggested that area specific control policy if adopted would minimize various severity levels of road accidents such as deaths, major injury, minor injury and property damage. It requires the usage of a systematic approach to derive local specific policy to deal with several severity types of accidents along with bench marked information. Effective police alert can ensure the physical presence of enforcement team which can extend the scope in the collection of data and integration of MIS.

Ross Oven Philip et al (2011) suggests that various enforcement strategies including safety campaigns can reduce the number of road accidents. Intoxicated or drunken driving is a menace, which accelerates the road accidents, and can be controlled properly if the intoxicated persons are caught easily and penalized appropriately.

William Young et al (2014) assess the state of the art in the use of computer models to simulate and assess the level of safety in existing systems. While ascertaining that there is no single measure, which will link deriving environment, events or behavior or crashes to provide a single measure of the safety for all the parts of the road system, he suggests checking which one or which combination will work exactly.

W. Murray et al (2012) recommend using Extensive Management Information System to allow the visibility of data and use of it to provide quantification of even individual interventions.

Significant findings of Kerala Police (2013) is that increasing deaths in road accidents are due to the reasons related to the driver of the vehicle with wrong driving habits and aggressive driving, over-speeding and drunken driving. Ignorance of the rules and violation of the rules and poor road conditions play other vital role. Based on the analysis it is understood that there is a tremendous scope for incorporating ICT aids at various levels in reducing the road accidents in Kerala. Available literature does not explain the status or extent of the influence of ICT aids in the monitoring or control of road accidents in Kerala.

5. Study Area

Being a continuous township from the southern capital city to the northern district head quarter, Kerala has a lot of bottlenecks in the city limits. When it comes to the densely populated towns it is a challenge for the planners to sort out the issues related to traffic in each city. The undulating and semi mountainous terrain, the ribbon development on highways, make the development plans critical. The road network extends through the from Kaliyikavila to Mannuthi, the NH 47 as the main channel which makes a deviation to east to Palghat and then to Tamilnadu, and Edappally to Manjeswaram through the NH 17 the next channel passes and enter into Karnataka. Other national highways are towards the east, through the Ghat sections to Tamilnadu; hill roads with limited features of a national highway, in major stretches, almost similar to a state highway.

6. Methodology

The data related to various types of ICT used in different departments was collected directly from the field after physical verification, through various sources. Supplementary information like the extent of the ICT services and financial aspects are collected from the respective government agencies. Initial source of information is newspaper reports but later justified/ verified with the real physical data or secondary data. Accident statistics was collected from Kerala Police. Effectiveness of ICT dispensation was analyzed using various statistical tools

7. Results of the Study

7.1 ICTs used by various departments to ensure road safety:

7.1.1 Camera Surveillance

The motor vehicle department in coordination with Kerala Road Safety Authority (KRSA) and Kerala police

had established automatic speed detection and response systems. The pilot test was successful in the automatic traffic enforcement systems in selected places in Thiruvananthapuram district and Cherthala- Mannuthy stretch of NH 47. The initial proposal, was to install the cameras in Mannuthy - Manjeswaram stretch by KRSA and Cherthala- Kaliyikkavila stretch by Kerala Police. Initially 75 cameras were installed at six accident-prone stretches, identified by the Kerala Police (2009). The number of cameras installed will cross 200 before April 2014 and 700 at the completion of the project.

7.1.2 Signalized Intersections

Due to the tremendous increase in vehicle population, only option for the vehicles to be separated in the real time is by giving a time lag in the signalized intersections. Reduction of either conflict points at the time of turns, to the left or right or U-turn is achievable if the green time of the automated signal is properly set. The provision of computerized signals at road intersections became an effective tool in reducing the confusion and traffic block at intersections. The major benefits are derived in the cities like Thiruvananthapuram, Kottayam, Kochi, Palakkad and Kozhikode. Traffic was almost to a standstill before the inception of the automated signalling system in Vyttila Junction and Edappalli junction in Kochi. Recently introduced space separation of turning vehicles with automated signaling system in Kottayam also is very effective. All the signalized intersections are again monitored by surveillance cameras for red light crossing (violation) and similar other type of offences.

7.1.3 Breath Analyzers

Intoxicated driving is a serious concern when road accidents are considered. The motor vehicle department and police are monitoring the drivers whether they are driving the vehicle in an intoxicated condition by using Breath analyzers. It can detect the presence of alcohol in the body, with a threshold toxicity of 30 mg/ 100 ml. Penalty/ fine will be imposed from the offenders if they are found positive in the breath analyzer test and a confirmatory medical test. The breath analyzer or Alco meter used by Kerala police is based on electrochemical fuel cell technology. The breath sample will be taken between 3 to 6 seconds. The instrument is having a capacity to store 10000 measured values with date and time on FIFO basis. It is possible to statistically evaluate the data for MIS reporting. The response time is 5 to 45 seconds for a negative or positive test at 0 or 500 mg/ 100 ml alcohol content.[10]

7.2 ICT Based Services in the Transportation Sector

7.2.1 Portal facilities, Networking and Online Payment

Kerala police has started a web site for making the payments online by the offenders of various traffic laws. The person can make the payment through the web site [www.payment.keralapolice.gov.in] after retrieving the relevant data as per requirement. It is made very user friendly. Customer can easily access the list of unpaid charge memos and select the particular charge memo for which they have to make the payment. Payment can be made through net banking or by credit card or debit card through an intermediate collection service provider Bill Desk. After payment an invoice will be generated for future reference. This is a well-accepted initiative from the Kerala police in enabling IT services for the betterment of the services to the public.

Kerala motor vehicles department is having an exclusive web portal for providing all IT based services [http://www.keralamvd.gov.in]. The vehicle registration, vehicle tax payment, etc. can be made through the portal. The services of the department in the entire state are networked and the officials can retrieve any real time data. The ownership details, payment status, registration details, financial status, hypothecation status etc. can be easily retrieved. The issue of licenses and permits are also computerized. Online transaction facilities are also provided.

Many fleet operators as well as passenger carriers embed GPS based tracking system in their vehicles. Over-speeding of the vehicle as well as abnormalities during driving including the use of mobile phones while driving can be monitored at the control room of the operator. GPS based road navigation also helps in proper route selection thereby avoiding congested routes.

7.2.4 Highway Alert System

Enforcement of traffic laws and prevention of road accidents is achieved through the Highway police alert system introduced in 2002 with the aid of ICT. The High tech Highway way Patrol System has 30 Base Stations (Police Stations) on Highways, with each Highway Police Vehicle having assigned an ‘Operational area’ and a Base Station. Forty-two new vehicles carrying various records, arms, and other traffic-related equipment (including stretchers, first-aids boxes, traffic enforcement items) with a Wireless Mobile Communication system is functioning as Highway Police Patrols. Through the general alert

telephone number and the mobile telephone number of each patrol vehicle, the alert team can be contacted at any time, in case of any distress call. Without any loss of time, the Highway Patrol can reach the spot. The location of the patrol vehicle can be monitored at any time with the ICT aids and services can be extended at any required time through Wireless & Mobile Phones.

7.3 Financial Aspects of the ICT Dispensation

The dispensation of ICT in road monitoring is a costly affair. The long stretches of the NH, SH and district roads are to be monitored with individual surveillance units connected to the CMS. For implementation of this, phase one allocation of funds for 150 speed detection and responses systems is 400 million Rupees and phase two allocation for 50 automatic speed detectors at 25 locations is 50 million Rupees.

The penalties collected from the offenders are a good source of income for the department in extending the camera services and maintenance of it. During the period of 1st April to December 31st of 2013, the violations recorded in the five camera locations of Thrissur district through 15 cameras is 1524178 each costing a minimum penalty of Rs. 400/- amounting to 609.6 million rupees. (Table 1). This is more than the cost of installation of Phase 1 and Phase 2.

Table 1: Violations reported in Cameras

Camera Location	***Number of cameras***	***Number of violations reported***
Amballur	5	684118
Chalakudy	2	212101
Koratty	4	278882
Nadathara	2	93074
Nandhikara	2	256003
Total	15	1524178

If the collection of penalty is intensified, from all camera locations in the state, the source of finance for extending the infrastructure will not be a problem. Maintenance issues also will not be constrained because of shortage of funds. In the long run, automatically, the number of violations will be reduced resulting in increased road safety, thereby reducing the cost of accidents.

7.3 Challenges of the ICT Dispensation

For camera installation and maintenance, the technical support is provided by Kerala State Electronics Development Corporation (Keltron). Various private service providers ensure the connectivity through broadband. First phase camera Locations in Thiruvananthapuram to Mannuthy stretch are listed in Table 2.

The cameras monitor the speed violations and road rule violation. The work will be done without any human interference, and the offenders are not let off without paying the fine. The collection of the penalty is not centrally coordinated. The user/ the defaulter have to arrange to pay it, even though the computerization is made for that. At present, the follow up is not centrally coordinated.

Video camera records and stores the visuals for 30 days with Laser based speed radar system at a distance measuring range 3 m to 1800 m. Distance image

TABLE 2- CAMERA LOCATIONS

Sl No.	Camera Location	SL NO.	Camera Location
1	Kovalam	17	Karuvatta
2	Muttatahara	18	Thottapailly
3	Chakkai	19	Ambalapuzha
4	Attinkuzhy	20	Cherthala
5	Pallipuram CRPF camp	21	Thuravoor
6	Thonakkal	22	Eramallor
7	Attingal Byepass	23	Aroor
8	Kallambalam	24	Maradu
9	Chathanoor	25	Kundanoor
10	Kottiyam	26	Vyttila
11	Sankaramangalam	27	Koratty
12	Karunagapally	28	Chalakudy
13	Oachira	29	Nandhikkara
14	Kayamkulam	30	Amballur
15	Cheppadu	31	Paliekkara
16	Haripadu	32	Nadathara
		33	Mannuthy

First phase camera locations as on October 2013

capturing range with legible number plate is 50 to 300 m. Modular construction with easy serviceability, operability and reparability is adopted. Laser measuring time is less than 0.3 s. Laser beam divergence 0.2 milli-radians or less at 100 m. Speed range is 0 to 320 km/hr. Distance accuracy ± 0.2 m.

Speed accuracy ± 2 km/hr upto 100 km/hr speed and ± 3 km/hr above 100km/hr speed. Dual speed mode is set to identify speed limits for light and commercial vehicles. Day and night Infrared camera with spectral response of

7-14 micron or better with a digitising resolution 12 bits or higher is used in many places. [09]. The average penalty is Rs.400/- and high penalty imposed for red light violation is Rs. 1000/-.

Kerala motor vehicles department started to use round the clock traffic rule enforcement in Thiruvananthapuram, Kochi and Kozhikode, using surveillance and speed detection cameras to nab traffic violators. The high-quality, tamper-proof cameras with night vision capability cameras have already been installed in five junctions each in all the three cities and linked to the control room attached to the office of the Zonal Deputy Transport Commissioner. The cameras are linked through a secure fibre optic network. They can track and capture fast-moving objects with exceptional clarity even at night. The images and the inputs will be stored in the central database of the MVD for three months. This database will be shared with the police who had installed similar cameras in select junctions in these cities. The Deputy Transport Commissioners will issue memos to traffic rule violators. This project is implemented by the Kerala IT Mission and executed by Airtel.

Since all are automated processes with the aid of ICT, infringements are less. The statistics show that the recorded incidents of violations are more indicating a tendency of reduction in over-speeding at least near the camera locations. Since the camera locations are hot spots, the reduction in number of road accidents are considerable.

The number of accidents is considerably reduced in the stretches were cameras are installed. But maintenance of the camera functioning is a real challenge, across the state, since it ranges from southern border of the state to the northern border extending to more than 600 km of the highway stretch. If regional offices are assigned with the task of monitoring the health and functioning of the camera as well as its maintenance, efficiency may be high. But coordinating with various inter departmental government organizations is still a challenge. The technical support for this is not available round the clock and so, any defect in the surveillance camera unit remain unsolved for weeks or months.

Other than this, the spots installed with the speed detectors include Kovalam - Kottiyam (NH), Venjaramoodu - Chengannur (SH), Sakthikulangara - Ambalappuzha (NH), Alappuzha - Changanassery (SH), Thrissur - Kuttippuram (NH), and Palakkad - Malappuram (SH), in a phased manner.

Intoxicated driving detection using breath analyzers is done at randomly selected sites. The sampling is done individually. The breath analyzers contain three distinct parts, the body, plastic mouth piece and disposable straw to be used with mouth piece. The person who is suspected to have consumed alcohol is requested to blow a sample of breath into the straw. At this time the mouth of the person comes in contact with the straw of the breath analyzer. So the straw is to be disposed of immediately after the test. [11].

The breath analyzer or Alco meter used by Kerala police works on the basis of individual breath samples collected, which will take 3 to 6 seconds. The response time is 5 to 45 seconds for a negative or positive test at 0 or 500 mg/ 100 ml alcohol content with a threshold toxicity of 30 mg/ 100 ml.[10] The instrument is having a capacity to store 10000 measured values with date and time on FIFO basis. It is possible to statistically evaluate the data for MIS reporting. The accuracy is ±5 mg/100 ml, when the instrument working in a temperature range of 10^0C to 50^0C.

7.5. Analysis of Accident Data in the Context of ICT Dispensation

The government decision to strengthen the enforcement of law through various ICT aids to reduce road accidents was taken in year 2012. The changes are visible from the year 2013.

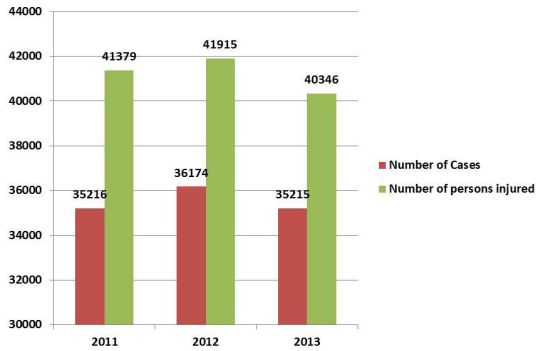

Figure 1 Road accident statistics

The number of reported accident cases and the number of persons injured in the accidents for the years 2011 to 2013 are provided in Figure 1. There was a 2.79% increase in road accidents in 2012 while there was decline of 2.69% in the year 2013. The reduction is because of massive safety awareness campaigns and intensive law enforcement through ICT.

The implementation of ICT aids started from April 2013 intensively, and thereafter except in the immediate month May, there was a significant reduction in the number of accidents, number of injured persons and number of persons killed in road accidents. Until May, the trend was ascending, but even in the rainy month of June, the trend started descending owing to the reasons of strict law enforcement. The percentage reduction in accidents comparing to the previous year in June (5.37%), July (8.88%), August (5.36%), September (7.83%), October (7.84%), November (6.75%) and December (2.19%) is evident from the Figure 2.

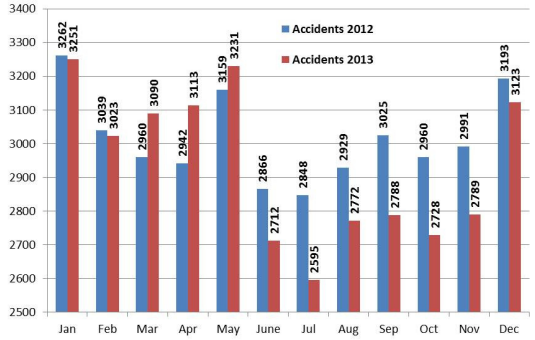

Figure 2 Number of accidents in various months

The number of persons killed due to the reasons related to driving in road accidents in the year 2012 was increased by 5.64% than the previous year but decreased by 2.48% in 2013 as in Figure 3 to 5.

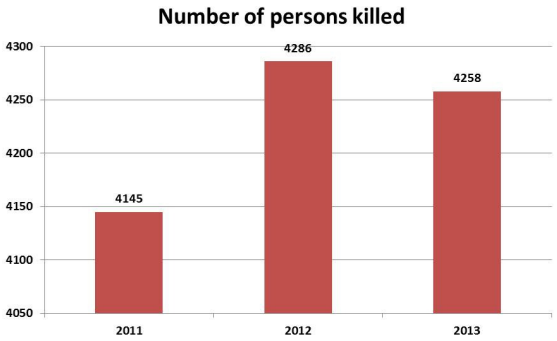

Figure 3 Number of persons killed due to reasons related to driving

At the same time, the percentage reduction in the number of accidents happened during the year 2013 is 2.68, bringing the number back almost to the same as in year 2011. This is a significant achievement when we consider the average annual increase in the number of motor vehicles in Kerala is 4%.

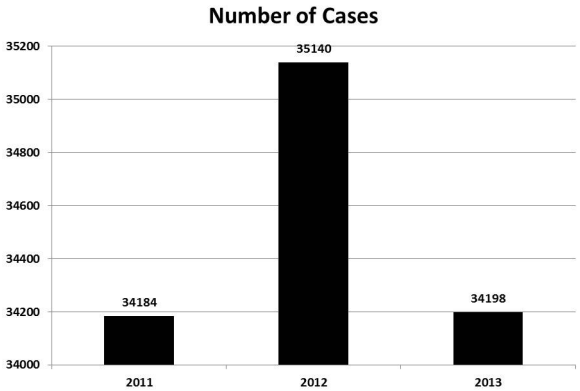

Figure 4 Fault of Driver

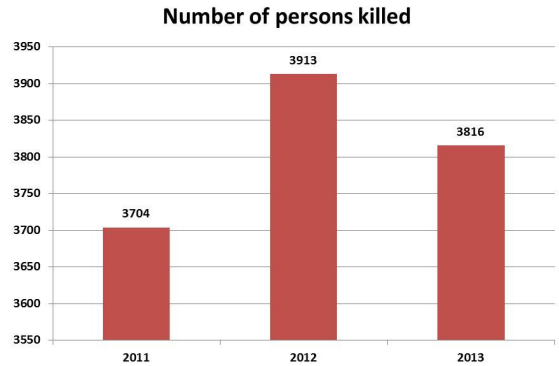

Figure 5 Persons killed by fault due to driver

The decline in the total number of deaths due to road accidents was only 0.65% for the year 2013, while the decline in the total number of accidents was 2.19%, which is significant.

Intoxicated driving was a major reason behind many of the accidents. The reported cases of number of accidents due to drunken driving are comparatively less, to the tune of 0.28% in 2011, 0.46% in 2012 and 0.08% in 2013 of total number of accidents in the respective years. But the measures to prevent it before entering into an accident through breath analyzers was highly effective as the drastic reduction in the number of cases reported in 2013 as in figure 6. The increase of accidents due to drunken driving in 2012 was 66% comparing to 2011 while it was decreased by 83% in 2013 comparing to 2012 and 72% comparing to 2011.

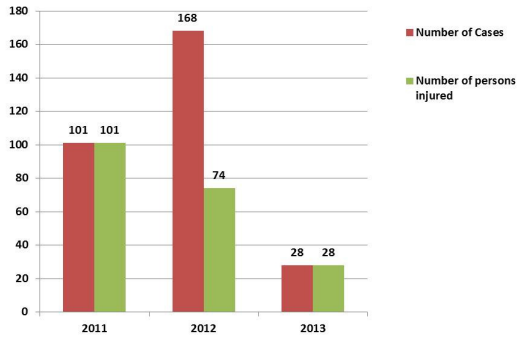

Figure 6 Cases due to Drunken Driving

Even though the decrease in deaths is only nominal, the number of accidents as well as number of killed persons are decreased drastically as in Figure 7 and 8. [12, 13]. The reduction in the total number is a positive sign that the enforcement measures are becoming fruitful.

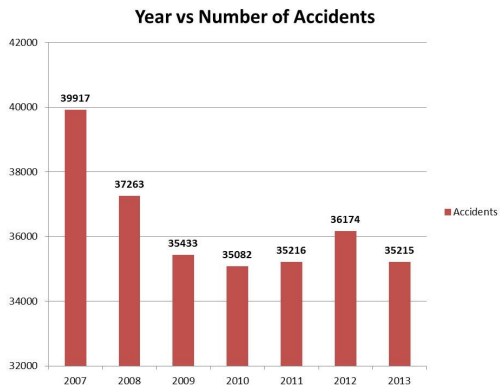

Figure 7 Number of accidents in various years

Other than this, the number of traffic law violations recorded by the camera surveillance mechanism at some points is also a positive indication. The data is not available for all the camera locations, but the revelations of the available data are justifying the effectiveness of ICT based enforcement measures.

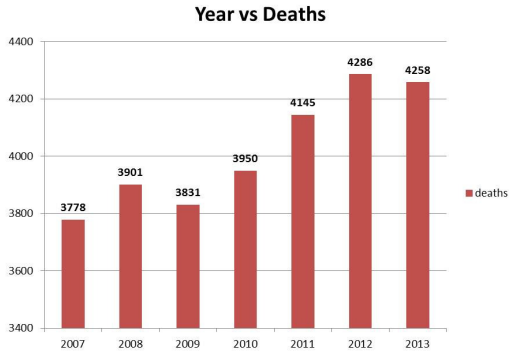

Figure 8 Deaths in various years

An average penalty of Rupees 400/- was charged for any one single instance of violation, totaling a sum more than the cost of camera installations in the entire state, from all the camera surveillance points.

8. Conclusion

The data for the study has revealed that only a few Information and Communication Technologies are been used in the transportation sector in Kerala. As W Murray et al (2012) suggested the use of Extensive Management Information System to allow the visibility of data and use of it. It provides the details of quantification of the individual interventions in the success of programs; even if the intervention is small, the effect may be significant.

The use of these technologies will not only improve the services provided by the departments, but also open the ways for road user to make use of these services in a safer way. The strategy will change later from the authorities to enforce law to the public to obey the laws to make their life safe. The status of dispensation of ICT aids in speed monitoring and control, intoxicated driving, and highway alert will extent to areas like Automated driving test centers, automated vehicle testing centers, computerized driving test centers, Online attempts in the dissemination of knowledge of road safety, etc. soon.

9. Recommendations

The researchers make the following recommendations for consideration by the institutions and other bodies associated with road safety and transportation planning.

9.1 Development of an ICT policy for the transportation sector to guide the stakeholders in the acquisition and use of ICTs in their arena especially to enhance safety and to reduce accidents. This can be made in the similar lines of IT Policy made by Information Kerala Mission for various government departments.

9.2 The employees working in the Motor Vehicle Department, Kerala Police, and the employees working in coordination with the transportation sector need more training in various technological applications and trends in information service and delivery to enhance the service they provide.

9.3 The administrative leadership of the departments must prioritize the acquisition and use of ICTs in enhancing the road safety and make budgetary allocation that could support that drive. The initial investment will be a

concern, and later, these resources will be rewarding in terms of the penalties levied from the violators. More than the investment will be returned within a short run if the law enforcement team is vigilant in collecting the penalties also. This fund can be used for other enhancement of the services and development in the same sector.

9.4 One of the major challenges the study revealed was the frequent power outages that disrupts the flow, contributing the congestion, in many automated traffic signals in cities. The researcher recommends that all these automated intersections are to be equipped with alternative power sources locally to support ICT usage in times of power failure or outage to ensure an uninterrupted power supply. Similarly the functioning and maintenance of the surveillance camera units also should be monitored in a scheduled way so that malfunctions can be minimized.

9.5 The law enforces, traffic wardens, and the employees of all transport departments must create a good relationship with their IT department to ensure constant support and update in the usage of ICTs in their service areas. Mass awareness campaigns can be conducted among the public to utilize these services for a safer world.

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