An Auto Telematics System For Insurance Premium Rating & Pricing.

Irode Philip Luvuga, Elisha O. Abade, Andrew M. Kahonge

Abstract: Insurance telematics is a new technology that has been poised to transform and change the way we buy and underwrite insurance by 2030. Insurance Premium Rate is a major variable that determines if a client will buy or take up a policy cover or not. With the current stiff competition being felt in the Industry, the local insurance industry continues to suffer big losses due to unhealthy business practice of competitor undercutting among the insurers to attract more clients but exposing the underwriting companies to potential high risks. This, in most cases means that the product is totally underpriced to the extent that it would be uneconomical and unsustainable in the long run for the insurance firms. This research outlines a technology defined model that should be used to determine the ideal premium rate payable in the Motor Insurance industry, taking into account all the variables and the risk exposure of the policy holder. The system model is able to determine the insurable risk based on the drivers attributes, and profile, location of the vehicle in relation to risk geo-locations map, monitoring the driving parameters of the vehicle by the driver, and the driving style. This enable the insurance company determines costs associated with the risk cover based on factual facts which are scientifically determined by the real risks.
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Index Terms: Dynamic Traction Control, Global System for Mobile Communication, Pay-As-You- Drive (PAYD), Pay –How- You Drive (PHYD), Telematics.

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1 INTRODUCTION

Telematics data usage has been adopted in various forms in our everyday life. Telematics has been introduced in the insurance industry for underwriting decisions, risk vectors and exposure evaluation. It has been proven (Paefgen J, University of Allen; 2013) that in-deed telematics provides for the inconsistency of information between the insured and insurer. In Kenya, the Insurance industry is regulated and the premium rate is defined by the state agency (IRA) Insurance Regulatory Authority, which in most cases does not represent the true risk index of a motor vehicle driver or a policy holder. The current fixed rate pricing of auto insurance is therefore inefficient and actuarially inaccurate since motorists in different risk classes are subjected to pay the same amount of premium rates regardless of the number of times or frequency they are on the road, their driving behavior, geo-location and how often they are on the road (Litman 2008). Thus, this research proposes a risk rating model and prototype system based on Telematics that takes into consideration causal data that is not factored into in the common conventional risk rating model as proposed and enforced by the regulatory body Insurance Regulatory Authority (IRA).
These are;

- Geo-location.(Based on the security clustering of Nairobi County)
- Distance Driven in a given period (Mileage) for the insured car or motor vehicle.
- Time of day when driving.(Day or Night).

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2 LITERATURE REVIEW.

According to Ptolomeus, Telematics refers to the integrated use of telecommunication and Information Technology, (ICT) in Motor vehicles (Ptolomeus 2016). There are a number of applications of Telematics in our modern lifestyles. Telematics is being used in providing services such as real-time navigation assistance, road side assistance, lost vehicle recovery assistance and more recently, motor insurance. (Ptolemeus Consulting Group, 2012) This Technology driven innovation is now making it possible for insurers to use the miniature motor vehicle devices to provide and develop market-rich personalized insurance products and rates based not only on regulatory defined rates but also utilizing demographic data and real actual customer related variable data. A Telematics system incorporates three main basic concepts and capabilities. These are;

1) Two-way communication capabilities on Wireless Networks.
2) Location aware/sensing technology (GIS/GPS) and
3) Computing Platform for System control, Data processing interface to automotive electronic systems.

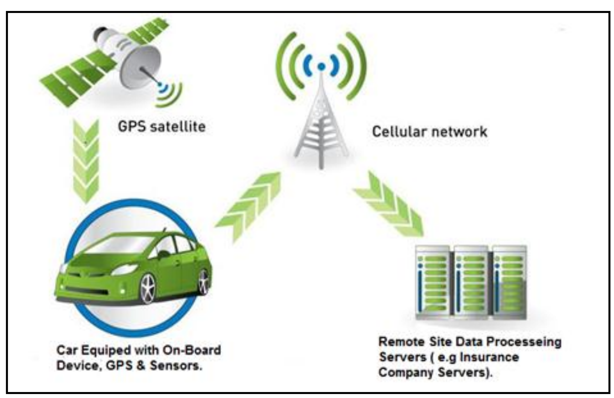


Illustration of Essential components of Telematics
Source: *http://www.csio.com/assets/images/csio-telematics-english.jpg*

2.1 Early Telematics Adopters.
Early implementations have been reported and adopted in the United States, (USA) Italy and United Kingdom (UK), Japan and South Africa. Therefore despite the articulated direct and quantifiable benefits that are direct derivative from Telematics adoption, the penetration of this service has remained stagnant or below expectations not only globally but even here in Kenya. Among global leaders who have already put some Telematics solution in operations include;

- Admiral Insurance “Pay How You Drive – UK.
- AIOI “Pay-as-You – Drive – Japan.
- American Family Insurance - USA
- AVIVA – Canada
- Hollard “Pay-As-You-Drive - South Africa

2.2 Telematics Insurance In Kenya.
Telematics is yet to be fully adopted as an Insurance platform in Kenya as a whole, let alone Nairobi County. The most common and prevalent implementations of Telematics is currently in motor vehicle /car tracking, fleet monitoring management and recovery. In 2012, Gateway Insurance led the pack by unveiling a Telematics usage-based insurance which is billed and premium paid based on actual mileage travelled (Standard Media Newspaper , August 26th 2012,). We have had other organizations which have also joined in by unveiling their respective products offerings; these include, Britam General Insurance, APA and Jubilee.

2.3 Research Objective.
The objectives of this research is to create an insurance pricing system prototype that uses real time data derived from the functionality and mobility of the motor vehicle, its location and assign respective risk indices that accurately map the related risk to the insured for premium calculation and subsequent payment.

2.4 Methodology.
In Kenya, the current premium calculation and billing in motor vehicle insurance as is not optimally tailored and reflective of the risk exposure of the end user. Very key and important variables and parameters such as mileage travelled in a certain period, types of roads being driven on, geo-location and weather conditions etc. are not considered for the premium risk rating and calculation, yet these are very key essential variable that greatly determine the potential of an accident or a claim for that matter The objective of this research was to come up with a prototype of a solution which uses the defined variable to identify and provide a scientifically verifiable premium rate based on the variable. The block diagram below represents the conceptual model of the solution.

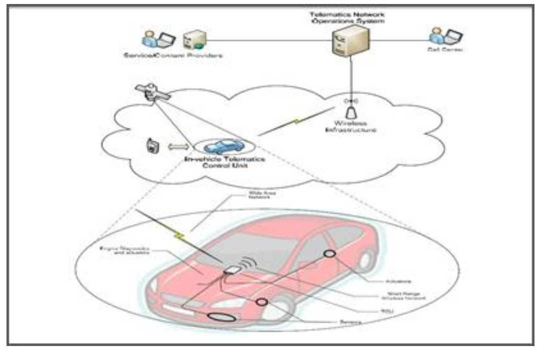


Illustration of Telematics Functionality.
Source: *White Paper on Automotive Telematics –HSC.Com*

3.0 Conceptual Framework.
By adopting Telematics technology, where the various variables related to the driving habits, location and mileage of the users are monitored and analyzed, we will be able to appropriately deduce and provision different premiums to various users. This will reflect the different risk exposures indicated by the various variables, i.e. driving mileages in a certain period, night/day driving, geo-location of driver in related risk profile of the area etc.

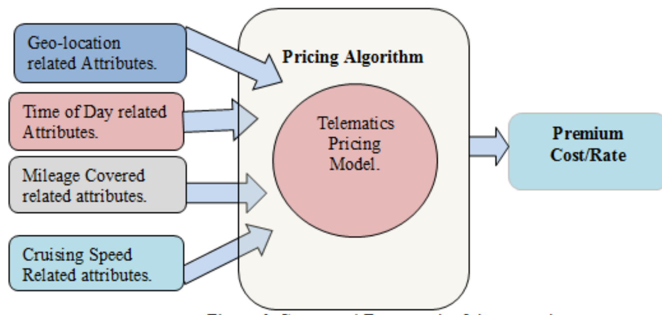


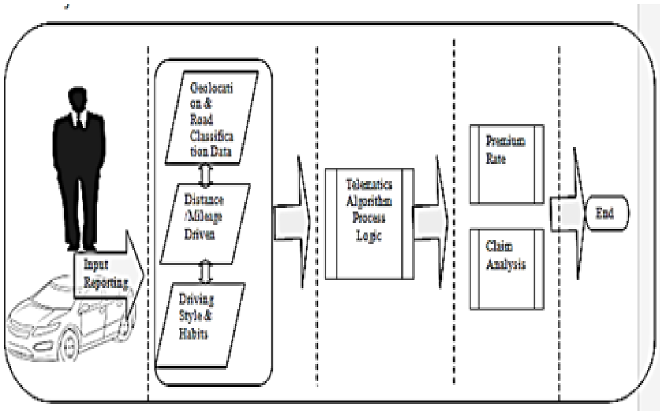
Figure 6: Conceptual Framework of the research.

Understanding user and functional requirements is an integral part of any system development and it’s critical to the success of the specific system (M.Maguire et al 2002; User Requirements Analysis) and contributes largely to the general acceptance of the system. Considering that Telematics is not a mature technology, problems anticipated at the development of the project include;

- Perceived thinking’s based on the current Telematics set-up and lack of innovations.
- Addressing Challenges that are unforeseen by unstructured data.
- User unaware of what they envisage the system to address.
- What will the system do, who and when will it be used

3.1 Implementation.
This is the longest stage in any project delivery initiative. It involves putting into actualization the development of the intended system. It also involves coming up with user interface screens based on described models defined in the use cases and to be able to test the output of the system based on the functional needs. A core aspect of security which forms a basic functional objective of this

research has to be demonstrated that it has either been achieved or otherwise.



3.2. Functional Model & Data.

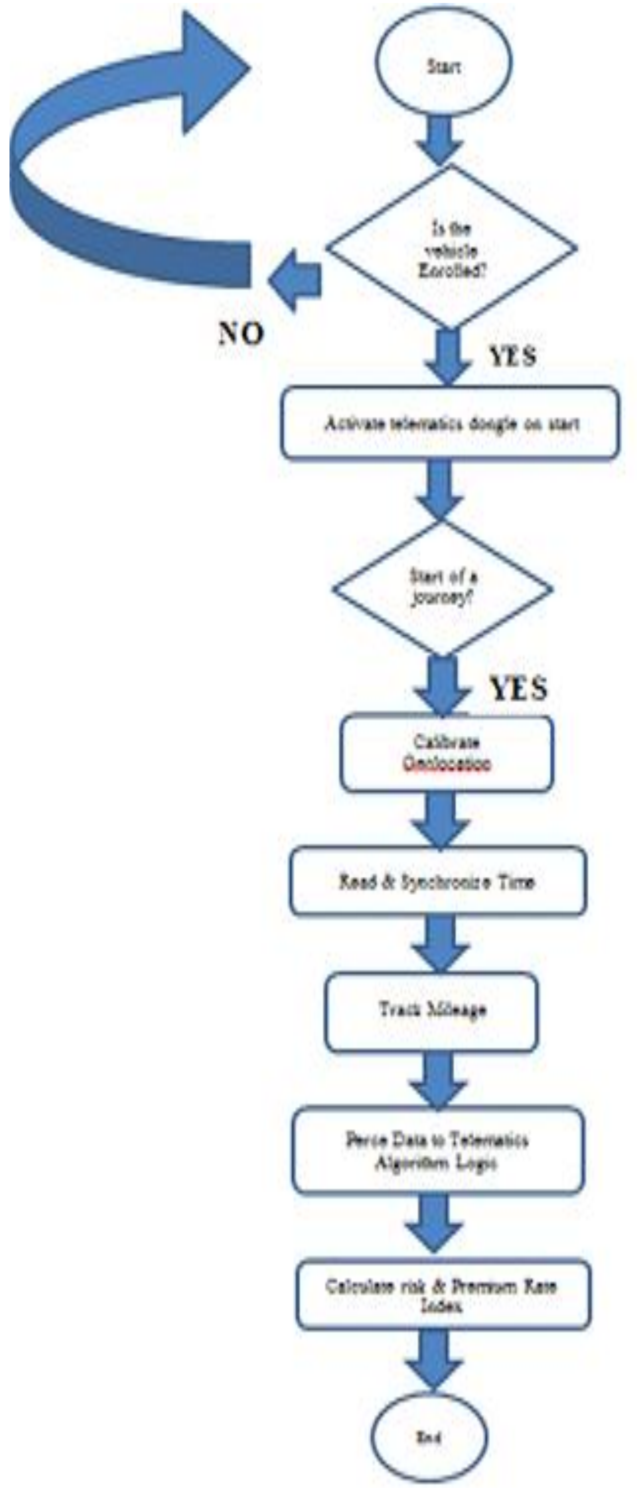
The functional aspect of the system is achieved by zoning, Aggregating and clustering Nairobi County based on the Risk ranking and profile. This is achieved by reviewing the city based on Social, Economic, and Infrastructural and Technological availability of risk potential or adverse services. This is through the information available from the data sources collected from the field. These sources are

No	Dataset Characteristics	Data source.
1	Crime Report Statics and Clustering for Nairobi Region	National Police Service
2	Claims & Claims Data	Insurance Companies & Insurance Regulatory Authority.
3	Road classification & Accident Rating Prevalence	National Transports and Safety Authority and the Kenya Urban Roads Authority.
4	Standard General Insurance Motor Rating Premium	Insurance Regulatory Authority and a selected few Insurance companies
5	Population Demographic Distribution – Nairobi County.	National Bureau of Statistics
6	Administrative Boundaries	Ministry of Interior, Nairobi City County and the Survey of Kenya
7	Road Accidents Statistics	Kenya Police, County & Sub-County Hospitals
8	Motor Vehicle Theft & Recovery	Police Divisions & Stations.

In rating and ranking the geo-location of the motor – vehicle users, various socio economic variables were considered which are based on basic infrastructural facilities that impact on the livelihood and risk perception of a location. These were as follows;

- Roads used by the driver and their condition.
- Classification of the respective roads by the National Roads Board of Kenya.
- Infrastructural facilities available in the residential neighborhood where the motorist lives (e.g. Hospitals, Police Stations, Schools, Shopping Centers, Lit Walkways etc.).
- Proximity or availability of an integrated low income informal settlement.
- No of Entertainment spots (Bars & Clubs).
- Known Presence of Organized criminal gangs.
- The respective population (controlled development) of the location.

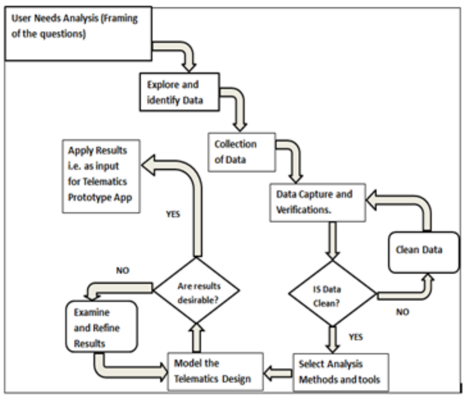
3.3 Functional DFD of the implemented logic.



3.4 Prototype Development Design.

The development of a prototype addressing or meeting our functionalities will depend upon the output provided from the data collected and the continuous iterative review and improvement process. We will use defined structured development methods which encompass a set of activities, methods, best practices, deliverables and automated tools that contribute to the structured development of this system. Using a consistent defined methodology in Software engineering has been noted to be a key contributor in software development through the following;

- Creates efficiencies that allow optimum resource allocation.
- Produces consistent documentation that reduces lifetime costs of maintaining systems.
- Promotes quality



The following Diagram Illustrates the Development Methodology adopted in the Prototype Design.

3.5.1 Vehicle Tracking Module

It comprises of a GPS unit embedded in the vehicles' OBDI (On–Board Diagnostics Interface) and the radio communication transceiver. The GPS unit receives signals from satellites in global positioning satellite system [7]. These signals are processed to identify the geographic location of the GPS receiver according to the well-known GPS technology**..** The GPS device has a communication transceiver, which is a cellular-based transceiver used to receive accident occurrence signal and transmit signals to the wireless GSM network for interfacing with server database and subsequently enabling the display of the vehicles location

3.5.2 Vehicle Risk Calculator Module

This is the prototype model interface based on an algorithm assigning mathematically computed rates to the enlisted client. This is based on the ratings and the data collected form the various data sources. Most of the functionality data is collected and analyzed based on the Motor vehicles telematics dongle communicated through the wireless network, which utilizes GSM and GPRS technology

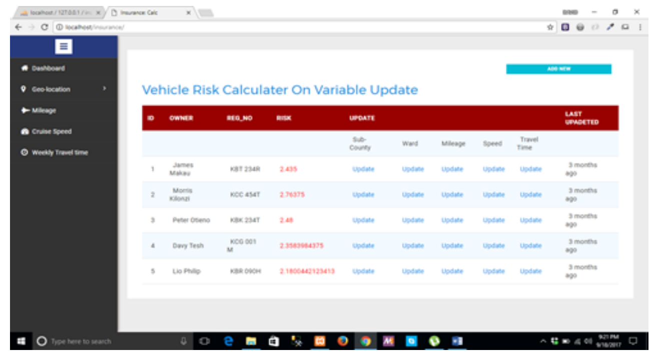


Fig 2. *The Sample Risk Calculation Interface.*

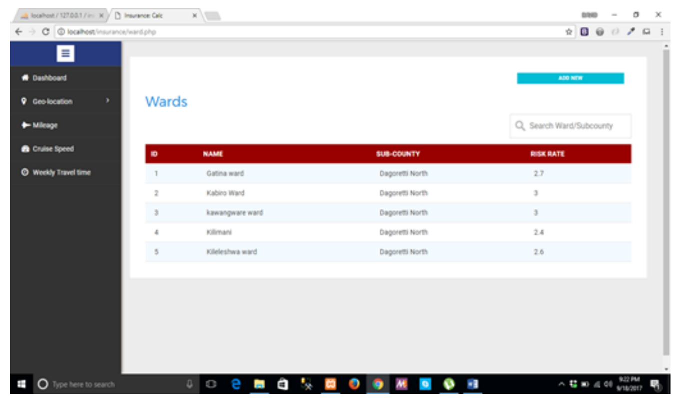


Fig 2. *The Sample Risk Calculation Interface.*

3.5.3 Web User Interface

The host Server from the Insurance provider (Insurance Company) will be updated at regular intervals and maintains all information received from all vehicles into a central database. The computer receives information from each vehicle's GPS devices through a GSM phone network in the Telematics dongle. This information is saved at regular intervals depending on the movement and geo-location of the vehicle and at each and every trip at initialization. The aggregation of this data is then analyzed behind an algorithm that determines for example, the sum total of mileage clocked, the status of the road used based on the geo-location, and time of day when trip was taken. We are then able to provide a comprehensive rating profile that is commensurate with the risk exposure for the appropriate premium cost.

3.5.4 Sample Source Code Algorithm Extract

```
} elseif ($how_long < 60 * 60) {
   $return =  (int) ($how_long / 60) . "minutes";
   if ($isPast) $return .= " ago"; else $return = "{$return} From
Now";
 } elseif ($how_long < 60 * 60 * 24) {
   $return =  (int) ($how_long / (60 * 60)) . "hours";
   f ($isPast) $return .= " ago"; else $return = "{$return} From
…..
……
 return $return
{
       $wd = '<select class="form-control" name="'.$name.'"
id="'.$name.'">';
       $days = array(
              1 => 'Monday',
```

```
        2 => 'Tuesday',
        3 => 'Wednesday',
        4 => 'Thursday',
        5 => 'Friday',
        6 => 'Saturday',
        7 => 'Sunday');
    /*** the current day ***/
    $selected = is_null($selected) ? date ('N', time()) :
$selected;
```

3.5.5 Functional Algorithm & Formula.

The Mathematical function of the logic related to the algorithm can be indicated as below;

Telematics Risk – Risk Upper Limit = TUr
Maximum IRA Rate = IRrMax
Minimum IRA Rate = IRrMin
Telematics Risk – Risk Lower Limit = TLr

The following constraints have to be built into the logic; The Telematics resultant Rate (Tr) cannot be more than IRA Maximum Regulated Rate (IRrMax) and cannot be less than IRA Minimum Regulated Rate (IRrMin). It should not also be less than 2% (Two Percentage Point) for the business productivity and administrative cost.

Basic Default IRA Rate = 6%

Actual Telematics Variable Rate = AtVr

Geo-location Rate = (GlR),
Time of Day Rate = (TodR)
Mileage Covered Rate = (McR)
Cruising Speed Rate = CsR

Therefore Formulae for risk Premium Calculation =

$$\text{IRrMin (2\%)} + \left\{ \frac{\text{GlR+ GlR+ McR+ CsR}}{4} \right\} \times \text{CV.}$$

Where CV = Car Value.

All Variables must be greater than Zero.

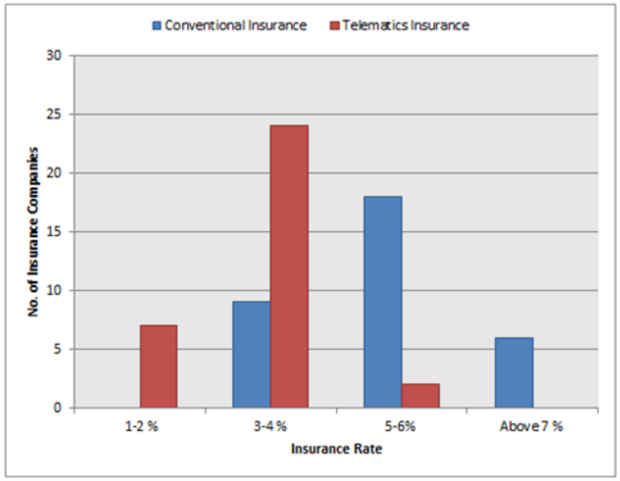
4.0 Results.

After full implementation and testing of the system, evaluation of the prototype was done with the aim to determine if the developed system is delivering the expected results. The following areas were evaluated to provide answers to the research questions set at project objectives and requirements.

4.1 Impact of Telematics on Motor vehicle Premium Cost.

For this objective to be ascertained a comparison was done between normal users in the same geo-location, working within the same proximity, driving in most instances at the same time and in comparison to the standard rate charged by the conventional underwriting method. Based on the clustering and profiling of the various regions, road types and the hours of driving, it was found that indeed, Telematics in the long run provides a reduced premium rate index in comparison to the flat rate promoted by the Insurance Regulatory Authority on most personal private vehicles.

Telematics Insurance as a Premium Cost Control Intervention.	Frequency	Percentage	Cumulative Percentage
Extremely Significant	15	45 %	45 %
Very Significant	13	40 %	85 %
Significant	5	15%	100 %
No Impact at All	0	0%	
Don't Know/Not Sure.	0	0	



This was collaborated by the feedback from the users and opinion leaders from the respective insurance companies and as well as the rating from the prototype amortized for a certain period.

4.2 Reduction in Losses related to Underwriting as a result of Telematics Adoption.

It was established that the adoption of telematics Insurance significantly reduces the loss ratio in underwriting as both the lost motor vehicle and claim details can be easily located. The impacts of Telematics insurance was rated high by the respondents and over 97% of the same respondents also confirmed that the GPS tracking technology was significant as a cost control tool in the insurance industry.

4.3 The Functional Abilities of the Developed Prototype.

This research has successfully shown that given a certain geographic region, one is able to segment the geographic region into regions of varying risk magnitude. Unique risk probability ratios can then be generated and used in generating oa telematics regulated premium rate. This research has also shown that the magnitude of risk increases with increase in population, Societal Infrastructure presence or absence as well as the time of day when trips are taken. Good roads also do not translate to low risk on motor accident and crime incidences. This has been shown by Kasarani Division which is connected by recently completed Thika Super Highway registering one of the highest risk incidences.

5.0 Conclusion.

Due to its advantages, Telematics Insurance pricing model is bound to gain popularity or even dominate the car insurance market locally. This research findings have revealed that already some underwriting insurance companies have already adopted the use of telematics in their underwriting operations, however the use is not fully and exclusively telematics based and neither has it been maximized but has been adopted in varied implementations. Telematics technology provides means to insurers to better align premiums with risk. Telematics insurance is a first step in which the number of driven kilometers, the type of road and the time of day are combined with the traditional self-reported information such as policyholder and car characteristics to calculate insurance premiums commensurate with the risk profile and exposure.

5.1 Further work & Recommendations.

Further research can be carried out to enable:-
The Insurance Regulatory Authority of Kenya (IRA) should review its Underwriting rates to incorporate telematics into the processes and in so doing provide a more realistic rating model that will demonstrate real risk causal data in the Insurance Industry. Insurance Companies also ought to adopt and innovate more technology driven products and re-engineering that will provide competitive atmosphere and business practice that are free from unhealthy undercutting and business practices to foster an environment of growth in the industry. Local Government Institutions and policy leaders and key stakeholders in the Infrastructural sector need to device and adopt efficient are update methods of Handling and collecting data related to key societal and demographics which greatly impact to development decisions and geographical profiling. Cryptography can be used to encrypt the transmitted accident signal from the GPS device, and decrypt it at the surveillance software, thus reducing the brute-force attacks.

5.2 Acknowledgement
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