APPLICATION OF GEOGRAPHICAL INFORMATION SYSTEMS (GIS) TO ANALYZE CAUSES OF ROAD TRAFFIC ACCIDENTS (RTAs) – CASE STUDY OF KENYA

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Key words:

ABSTRACT

In countries where economies are weak, it becomes crucial for those concerned with developmental policies to adopt approaches which will ensure that every single cent available is used to develop the country. Such a situation therefore calls for economic planners to team up with the relevant technocrats in all fields to facilitate a conducive environment for economic development.

Road traffic accidents have been recognized as one of those adverse elements which contribute to the suffocation of economic growth in the developing countries, due to the high cost related to them, hence causing social and economic concern. A case study of Kenya is presented to indicate how the growth in travel demand, carries with it the increase of rate road traffic accidents.

This paper discusses the how to alleviate the problem of road traffic accidents through the inclusion of new technologies in developing countries, so that proper decisions can be taken to precisely to remedy the occurrences of road traffic accidents. Geographical Information System (GIS) is a technology which when incorporated in the analysis of road traffic accidents, can alleviate this menace. This approach is argued as feasible since it will facilitate a quick way of data retrieval, in addition to facilitating a means of making precise remedial engineering designs to improve road sections which are prone to road traffic accidents.

1. INTRODUCTION

Travel demand arises as a result of land development in a region. The development type will cause generation of, and attraction of certain categories of traffic to the region. One effect of land development is the increase in transport demand facilities, hence the demand for means of transport facilities. And due to the weak economies experienced in the developing countries, the automobile scores very highly as a means of passenger and goods transport mode, hence the fast growth of vehicles ownership in these countries.

The increase in the number of automobiles in developing countries, with the unrestricted mixing of several classes of vehicles have created problems of traffic congestion and hence

travel delay in the urban set ups, road traffic accidents (RTAs), in addition to environmental pollution problems.

Among these diverse problems, the ones which are most conspicuous are road traffic congestion in urban areas, and the loss of human lives and property destruction through road traffic accidents.

Globally, it is estimated that on average, RTAs cost up to 1% of a country's Gross Domestic Production (GPD), and the sub-Saharan Africa has the highest road accident death rates in terms of fatalities per registered vehicle, as compared to any other region in the world. It is also reported that road safety in the African region is a major social and economic concern in that although the region has about 4% of the world's motor vehicles, 11% of the world's reported fatalities are due to RTAs (TRL, 2001). Further, the cost of road traffic accidents was crudely estimated to be US $ 3.7 billion in 1997 in this same report.

This calls for serious efforts that should be put, in order to incorporate methods of accurate determination of causes of RTAs on our roads, especially so in the developing countries. Then the meagre resources which we have can be used in the development of our countries.

The traffic safety problem in developing countries has obviously become more and more important day by day. It is related to a general trend of both urban and motorization growth and mostly the increase in usage of road transport facilities.

In the past 25 years, urban areas have been developing at a fast pace in most African countries. For example, it was reported that in Kenya, the national car ownership rate was 0.125 vehicles per head population a figure which was expected to remain at that same level (Mwatelah, 1994). However, considering that population continues to grow, it implies that the number of vehicle-kilometres tremendously increase.

In Nairobi the urban growth has been recorded as 7% per annum (Central Bureau of Statistics; Economic Review, 1997). Such an increase, has a direct effect in the increase of travel demand. In effect, this phenomena increases the likelihood to precipitate high probabilities of conflict points in space, location and time, resulting in high tendency for the accidents occur.

1.1 Case study of the Kenyan situation

1.1.1 National Perspective of Road Traffic Accidents

In Kenya the road transport accounts for about 45% of the bulk goods and passenger transport services (Economic Review, 1997). This may be seen to as a result of the convenience this transport mode of service renders to its users. However, this service has its adverse share to the economy of the country, as a result of the high costs of road traffic accidents.

Road traffic accidents (RTAs) constitute a serious problem in Kenya and the occurrences of RTAs has been on a steady increase as evidenced in the table 1.

Table 1: Annual National RTAs Occurences

Year	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
RTAs	7,250	7,524	8,023	8,229	8,474	9,066	9,783	-	10,106	10,308
Year	1991	1992	1993	1994	1995	1996	1997	1998		
RTAs	-	12,738	12,355	11,705	12,960	13,890	14,849	14,342		

Source: Central Bureau of Statistics of Kenya

The figures presented in the above table 1, constitute all categories of RTAs ie fatal, serious and slight injuries, collected and stored under the custody of the enforcement agent of the government. However, the current data storage system, is quite cumbersome such that spatial information data can not easily be accessed especially when such data is needed to answer such questions as to where and when such an accident occurred. This information becomes quite essential when redesign of the road section is being planned and also for solving insurance related cases, especially so when such an event occurred several months ago.

1.1.2 Road Traffic Accidents in Nairobi

Nairobi, the capital city of Kenya houses over 60% of the vehicles owned in the Republic of Kenya. This is because Nairobi is the heart of the economy of Kenya, and being a metropolitan city, most industrial activities are located here. Another factor is that it is at the cross roads of the great trans-African highways; these are the highways from eastern to western Africa and from southern to northern Africa.

It is most reasonable to think that in an urban set up, due to the many decisions that have to be taken by various road users, then the likelihood that more accidents are likely to occur in towns is higher than in the rural set up. However, most of those accidents that occur in towns are injurious and occasionally fatal. While the accidents which occur in the rural highways are mostly fatal and or causing serious injuries, and property damage.

This may be contributed to the speed limits set for road users in these various categories of highways; rural highways having higher speed limits than those in urban areas.

Road traffic accidents trend figures for Nairobi and Kenya were collected and a comparison is made as to the three categories of accidents (see table 2).

Table 2: Road Traffic Accidents Trend by Type of Injury

Year	1993			1994			1995		
Type	Fatal	Serious	Slight	Fatal	Serious	Slight	Fatal	Serious	Slight
National	2156	7734	14150	2403	7535	12926	2617	8661	14332
Nairobi	391	690	4603	470	789	4044	481	727	4243
%Share	16	9	33	20	11	31	18	8	30

Year	1996			1997			1998		
Type	Fatal	Serious	Slight	Fatal	Serious	Slight	Fatal	Serious	Slight
National	3000	9313	15333	3022	9618	16133	2972	9632	15888
Nairobi	478	773	4674	530	726	5318	503	723	5347
%Share	16	8	31	18	8	33	17	8	34

Source: Central Bureau of Statistics of Kenya

The order in the number of annual road traffic accidents occurrence is seen as follows:
1] slight injuries type
2] serious injuries
3] fatal.

This trend confirms the discussions presented in above. However, it is yet difficult to peg cost to each category of accident due to the complicated concept of cost in relation to loss of human life, injury to people and hence its effect in the economy of a country.

Table 3: National and Nairobi Occurrences of RTAs During Day and at Night

Year 1995			1996			1997			1998		
Time	Day	Night	Day	Night		Day	Night		Day	Night	
Nairobi	8286	4674	8803	5873		9092	5757		8797	5542	
National	2530	1861	2721	2055		2899	2325		2805	2532	
%Share	31	40	31	35		32	40		32	46	

Source: Central Bureau of Statistics of Kenya

Table 3 gives the breakdown of the types of RTAs and the time of the day when these accidents occurred for the last four years of the data collected. Such information is regarded as crucial in the decision as to what remedial measures should be taken to improve the road facility. However, this information is not enough to enable appropriate engineering measures to be taken to improve a road section.

Other aspects which have also to be put into consideration are the:
1] weather conditions at the time the time of the accident,
2] state of the pavement,
3] the geometrical conditions of the road, and
4] other environmental conditions at the site of accident.

2. IDENTIFICATION OF ROAD TRAFFIC ACCIDENT SPOTS

The tendency of RTAs to cluster or concentrate at a few spots on road sections usually known as “black spots” or “ accident spots” is very common on our roads. These spots can be considered as sources of spatial information on road traffic accidents (Suna, et al 1996).

Identification of such spots helps the enforcement arm of the government, in conjunction with the implementing agencies of the government to put remedial measures to alleviate the occurrences of RTAs. However, more precise information need to be availed, identifying the causes of these accidents so that proper measures may be taken, especially where the contributory factors are technically based, to improve the road facility so that driving can be done safely at these spots.

3. CREATION OF GEOGRAPHICAL INFORMATION SYSTEM DATA BASE

Geographical Information System (GIS) is seen as a tool that can be used to supplement the analysis RTAs data in order to accurately identify the contributory factors of RTA s through analysis of the road alignment in three dimensions, information data on causes of those RTA as reported by relevant officers, and hence try to correlate these two aspects. This approach can provide useful information in order to come up with appropriate geometrical highway design principles to reduce RTA occurrences on our roads.

Several attempts have been made to try and identify accident black spots by different methods including subjective assessment techniques. This paper however, pre-supposes that “accident spots” have been located.

In order to address this issue of rapid increase of RTAs and reverse this trend, adequate safety measures have to be developed . Development of such measures can be achieved when RTA data and attendant data can be stored, accessed and analyzed using modern technologies to improve efficiency and accuracy.

Safety measures for highways should include the contemporary engineering design of new highways and improvement of existing ones. And for transportation engineers and planners to be able to efficiently achieve this, the digital terrain model (DTM) data defining the terrain is necessary (Uren and Price,1994). Digital terrain models are rapidly becoming a basic requirement in modern highway design and digital mapping. However, in the developing countries, like Kenya, little has been done to develop high resolution DTMs useful in computer aided design and drafting (CADD) to assist in the design and improvement of new and existing highways which are safe to road users.

Geographical Information System (G.I.S) is new powerful computing tool for managing large amounts of heterogeneous data and would be invaluable in addressing sections of roads with prevalent road traffic accidents occurrences. Once the DTMs have been created, at each of the spot, the attributes which are assessed as having caused the accidents are stored as accurately as possible. This information will then consist of the data that can be

easily accessed and or referred to when crucial decisions have to be made in relation to the type of improvement to be done at that particular section of the road.

Monographic data type consists of attributes and relative spatial relationships. Attributes describe the qualities e.g. with regard to the number of lanes, pavement type, road traffic accidents of the highway.

The G.I.S. software can be used to create data layers of the above mentioned attributes and spatial distributions at every identified accident spot in the following manner:

i) Location map showing accidents spots
ii) Digital Terrain Model at the accidents spots
iii) Road traffic accidents distribution by types i.e. fatal, serious and slight injuries and time (day light or night).

This information forms a basis for determining:

a) whether the vertical and or horizontal alignment needs to be re-designed and or a full rehabilitation of the road done, and or
b) a road intersection needs to be improved so that grade separation can be introduced and or
c) the road furniture needs to improved to avoid road users making ambiguous decisions when obtaining services from the road facility.

Thus using this tool, several combinations of spatial information can be analyzed through the combination of different layers, in the process of reducing road traffic accidents on our roads.

4. CONCLUSIONS AND RECOMMENDATIONS

The approach presented here is aimed at the creation of an important data base which will allow for the analysis of road traffic accidents on our highways using Geographical Information System (GIS) software. This new technology is a powerful tool which will facilitate fast retrieval of information and is easy to update when the need arises. In addition to that it has the capability of adopting to the changing needs of the road planners and engineers in the process of these technocrats would want to re-design the road transport facility for the safety of its users.

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