International Journal of Research in Engineering and Science (IJRES)
ISSN (Online): 2320-9364, ISSN (Print): 2320-9356
www.ijres.org Volume 11 Issue 3 ǁ March 2023 ǁ PP. 400-408

Risk Perception among Settlers Living Along Major Highways in Benin City, Edo State-Nigeria.

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ABSTRACT
Encroachment along facilities right-of-way especially onshore transmission pipelines, high tension overhead power transmission cables and major highways, has become common place among residents in many Nigerian communities especially in the Niger Delta region of Nigeria. The imminent consequences of this trend have continued unchecked. These consequences include direct damage cost to human life, environmental damages, loss of product, repair cost, clean-up and remediation cost coupled with indirect cost of litigation, contract violations, customer dissatisfaction, political reaction, loss of market share, government fines and penalties, imminent danger to life and infrastructural installations notwithstanding. The trend is becoming the order of the day especially in this era of population explosion. In the light of this, we research that residents living clearly along the right of way of major roads and highways clearly stand the danger of accidents from road users especially by cars and vehicles. We examine and report the risk perception of many residents living along major highway in Benin City of Edo State especially in instances where major interferences with the stipulated right occurs. Interference with the right of way of most major roads in Edo state, without the analytical perception of the inherent risk and dangers it posses could lead to injuries, disabilities or even death. A case study of structures erected along Uselu-Lagos road from five junctions to main gate was undertaken and an obvious violation of the 30th specified right of way was observed and noted.

Keywords: *risk perception, violation, encroachment, imminent consequences, population explosion, accidents*

Date of Submission: 07-03-2023 Date of acceptance: 20-03-2023

I. Introduction

Research has shown in most developing countries that their Governments do not record information able for identifying the real causes of accident on their major roads and those data system virtually recorded are not analysed critically to allow the easy identification of accident clusters areas and allow the preparation of priority lists of hazardous sites that needs attention duly. One of the most important environmental problems today is how to manage societal and individual risk of inhabitants living along major highways. As population increases and cities become more industrialized, many tends to reside along major roads for better accessibility; thus, so does the volume and composition of the road accidents increases. This is significant to cities in the developing world, whose population and economics are rapidly expanding, though the necessary machinery to manage the ensuring problems is inadequate. As the number of vehicle users increases in a country so does the number of road traffic accidents increases; hence, one of the main responsibilities of all government is to ensure a safe living environment for the country's inhabitants' as is realistically possible.

Road right-of-way width is established by deed, statute, or through the platting process. Regardless, lands within the road right-of-way are reserved for use of the traveling public and maintenance of the county road system. The Brundtland Commission reported in 1987, when highlighting the rapid growth of cities, that the problems relating to urban life indicated that "our century is one of urban revolution" (World Environment Commission, 1991, p.262). Two thirds of the so-called traffic accidents that result in injuries have taken place within urban areas (Marín & Queiroz, 2000).

Each year there are over 4 million incidents on the highway, ranging from fatal accidents to minor falls or damage. Research conducted by TRL in the 1980s found that over three-quarter of accidents were solely due to human error. The combined effect of under-reporting, under-recording and misclassification suggests that there may be 2.76 times as many serious casualties than are provided in the national casualty figures and 1.70 slight casualties (Simpson H.F. 1982).

Recently, the Edo State Government began embarking on the dualization of major roads in the state in order to make the ever busy, congested and accident prone major roads, safe. Thus, to avoid the increased road safety problems that can occur. It has shown that thousands of people live along this major highway without been aware of the risk that is involved. In this project we try to see how we can educate the inhabitants of the risk that is involved as a result exhaust fumes that is given off in the environment, risk of been exposed to road accidents, also provide the possible distance at which a building will be safe from the highway. In this thesis, Benin City was used as a case study. A major road that connects the busy environs in Benin City, and interconnect various states in Nigeria was used (UGBOWO – LAGOS Road), this road links information centers, hospitals, banks, supermarkets and schools which are of great importance to the state. A good accident data system from Main Gate to Five (5) junction enabled us in determining where accident cluster occurs frequently. There was a need to determine those accident areas that would respond to remedies measure as not all location have easy identification patterns that can be improved. From the foregoing, the safety benefits that were derived from identifying hazardous location through the careful analysis of accident data and then designing the appropriate remedial measures has proven to be particularly high. The benefit achieved by low cost remedial measures was proved to be many times the cost of their implementation. As a result of proximity to the major highway, the inhabitants were seen to be exposed to high rate of risk such as road accident, loss of properties, as well as the inhaling of exhaust fumes which contains carbon (II)) oxide [CO_2] is released to the environment which have adverse effect on the inhabitants. There is need to re-emphasize safety concern of the area.

III. Methodology

It is important to develop quantitative expression of risk in order to use it in determining mortality rates of persons living along main gate to five junctions by auto crashes. From the above definition of risk (The product of probability and consequence, and is expressed as the probability of frequency of occurrence of an undesirable event), for example, if 10% of the house violating right of way along main gate to five junction were randomly driven into my cars "F", the risk of getting "F" is 0.1 "F" per total number of cars crashing into these buildings. The probability is 0.1 and the consequence is "F". The units in which risk is expressed incorporate both the probability and some measure of consequence.

The frequency of occurrence of the auto crash along main gate to five junctions among the road users is written as; $F = X/N$

Where; F - frequency, X - number of auto crashes, N - number of auto users plying main gate to five junctions. This frequency is often called a probability P, and written without units.

If the effect is death from road accident and the death occurs after a long latency period, the effect is called Latent Accident Fatalities or LAF.

The risk aversion is represented mathematically by increasing the expectation of the total number of deaths, E(Ndi) , by the desired multiple K of the standard deviation before the situation is tested against the norm. Rule (5) can be transformed in to similar expression valid at plant level by taking into account the number of independent installations Na. it can also be transformed mathematically into a VROM-type of rule applicable at plant level as shown n the same paper:

$$1\text{-FNdi}(x) \leq Ci\, x^2 \text{ for all } x \geq 10 \ldots\ldots 6$$

Where; $Ci = [\beta\mu\ 100/\sqrt[k]{NA}]^2$

For values of $\beta i = 0.03$, $k = 3$ and $N^A = 1000$ The Rule Equates Exactly To the VROM-rule, which appears to be a specific case in a more general framework. Bohnenblust (1996) judges the number of casualties after correction with a factor j(x) in an economic framework. Weighing the societal risk SR in the light of the cost of measure to improve safety an optimal decision is reached. Changing the summation into an integral, the expression proposed by Bohnenblust reads:

$$SR = \int x.\varphi(x).f(x)dx \ldots\ldots 7$$

Although not explicitly stated by wehr and Bohnenblust (1995), it can be deducted from a graph in the paper that $\varphi(x) \sim \sqrt{(x/10)}$. So the SR measure could be expressed as

$$SR=10.\ \sqrt{10}.X^{1.5.}\ Fn(x).\ dx \ldots\ldots 8$$

Relative risk is the ratio of the probabilities that an adverse effect will occur in two different roads. For example the relative risk of accident involving inhabitants /users of Main Gate to Five Junction may be expressed as:

$$\frac{P_s}{P_n} = \frac{\left(\frac{Xs}{Ns}\right)}{\left(\frac{Xn}{Nn}\right)}$$

Where; Ps = probability of road accidents among inhabitants/users of main gate to five junction, P_n = probability of road accidents not involving inhabitants/users of main gate to five junctions, X_s = accidents among inhabitants/users of main gate to five junctions, X_n = Accidents not involving inhabitants/users of main gate to five junction, N_s = Total number of road accidents involving inhabitants/users of main gate to five junction, N_n= Total number of road accidents not involving inhabitants/users of main gate to five junction,

Relative risk of death is also called Standard Mortality Ratio (SMR) which is also written as;

$$SMR\ \frac{D_s}{D_n} = \frac{P_s}{P_n}$$

Where; Ds = observed road accidents among inhabitants/users of main gate to five junction, D_n = expected road accidents among inhabitants/users of main gate to five junction.

3.1.2 Different Measures and Limitations of Societal Risk

It seems generally accepted that the FN – curve is a fairly accurate description of the societal risk. However, in the communication with the public and representative decision makers a schematization of the FN – curve to one or two numbers may bring certain advantages. As to the limitation of the societal risk to acceptable levels, many different rules are proposed by scientists and regulatory bodies. Disagreement is especially found on the question if societal risk should be judged with a risk averse or a risk neutral attitude. One of the oldest simple measures of societal risk is the Potential Loss of Life (PLL), which is defined as the expected value of the number of deaths per year.

$$E\ (N) = \int x.fNdij(x).dx \ \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots..1$$

Where; $fNdij$ = the p.d.f of the number of deaths resulting from activity i in place j in one year

Ale (1996) has proposed the area under the FN – curve as a simple measure of societal risk. Although this is not immediately clear, it can be mathematically proven that the area under the curve FN – curve equals the expected value of the number of deaths.

$$E\ (N) = \int (\,1 - fNdij(x).dx \ \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots..2$$

An absolute limit to the expected value of the number of deaths is not mentioned in the literature. The use of the expected value seems very valuable in the comparison of various alternatives. VROM (1988) limits the societal risk at plant level by a line that is inversely proportional to the square of the number of deaths. This absolute requirement that formed the basis for the regulation and the sitting of hazardous installations or new developments in the Netherlands during the last decade reads;

$$1 - fNdij(x) < {10^{-3}}/{X^2}$$

$$For\ \geq 10\ deaths$$

Where: $fNdij(x)$ = the c.d.f of the number of deaths resulting from activity I in place j in one year (the subscript dij will be omitted further on).

The HSE (1989) remarks that the judgment of the societal risk at plant level by the VROM rule is overly risk averse. HSE proposes to change the value of the exponent in the expression from 2 into 1 in order to from a more even judgment. In recent papers, Cassidy (1996) of HSE defined the risk integral RI as an appropriate measure of societal risk that should be further explored.

$$RI = \int x\left(1 - F(x)\right).dx \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 4$$

A limiting value is however, not yet attached to this new concept. Vrijling (1995) notes that the societal risk should be judged on a national level by limiting the total number of casualties in a given year in the following way:

$$E(Nd_i) + \ k\sigma(Nd_i) < \ \beta_i 100\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots5$$

Where K = risk aversion index. The formula (5) accounts for risk aversion, which will certainly influence acceptance by a community or a society. Relatively frequent small accidents are more easily accepted than one single rare accident with large consequences, although the expected number of casualties is equal for both cases.

After carrying out field work (physical trekking) from Main Gate to Five Junction, we were able to find out that more than 2000 people live along this major highway and as such exposed to road accident.

Using accident data above, 19 people were found to have died as a result of road accident along this route being considered.

From the population (Main Gate to Five Junction) the chance of having death as a result of road accident is;

$$\frac{19}{2000} = 9.5 \times 10^{-2}$$

∴ in 2000 people, the likely number of death (X) is given as; $9.5 \times 10^{-2} \times 2000 = 19$

In other words, the exposed individual from main gate to five junctions has an annual risk of 19 in every 2000 persons or about 9 persons approximately die in every 1000 persons through road accident.

The probability is 9×10^{-2} and the consequence is death.

However, this allows us to estimate that the average annual probability of a car accident from main gate to five junction is $9.5\ X\ 10^{-2}$. If there are 1633 cars travelling from Main Gate to five junction per hour for 3 days, and the average distance from main gate to Five Junction is 5.23Km per car.

∴ to get the number of accident involving cars moving from main gate to Five junction is

$$(3 \text{ days}) \times \left(9.5 \times \frac{10^{-3} \text{ accidents}}{1hr} \text{car km}\right) \times \left(1633 \text{cars} \times (5.23 \text{km/car})\right)$$

= 243.40 accidents involving cars moving from main gate to Five junction.

3.2 Collection of Data

In the course of study, the project was able to obtain an accident data which was gotten from Save Accident Victims Association of Nigeria (SAVAN), which enable us to estimate the total number of death per population from main gate to Five junction. And also able to collect the statistics of Automobiles using the highway for one hour which we did for three consecutive days. Therefore, it will enable us to determine the exact, the likely possible road accident, and also to predict the future occurrence

Table 2.0

Accident Diary from 2009 – 2010 (Savan)

S/N	Date	Vehicle/Aircraft	No of Sustained Injury	No of Unsustained Injury	No of Deaths	Place of Accident
1	25/1/2009	Private vehicle	2	1	2	Opposite Traditional Ground, Uselu Road
2	6/2/2009	Bike rider/head on collision	1	1	-	Adolor Junction
3	1/4/2009	Bus	4	2	2	Adolor Junction
4	4/6/2009	Edegbe Bus	9	2	-	Along Uselu Road
5	19/6/2009	God's Time Motors	14	-	1	Before Uselu market
6	3/8/2009	Commercial Bus	2	17	-	Uniben Main Gate
7	2/12/2009	Vehicle accident	-	-	3	UBTH Gate
8	5/12/2009	Bike accident	1	1	1	Uwasota Junction
9	2/9/2009	Vehicle accident	-	1	-	Along Uselu Lagos Road
10	6/12/2009	505 Peugeot Car (Red)	-	1	1	Near Uselu MKt. Benin/Lagos Rd.
11	11/5/2009	9111 Lorry	4	5	3	Textile Mill Road Junction
12	2/12/2009	Bike accident	2	-	-	UBTH Gate

13	10/1/2010	Vehicle accident	2	-	-	UBTH Gate
14	24/1/2010	Bike accident	-	2	1	Uwasota Junction
15	9/3/2010	911 Lorry (tipper)	-	-	5	Opposite Uselu Market

IV. Results

For number of injured persons,

$$-\frac{32}{2000}=1.6\times10^{-2}$$

In every 2000 persons, likely number of injured persons will be;

$$1.6\times10^{-2}\times2000=32\left(\text{number of injured persons}\right)$$

$$\left(3\text{ days}\right)\times\left(1.6\times\frac{10^{-2}\text{ accidents}}{1hr}\text{car km}\right)\times\left(1633\text{cars}\times\left(5.23\text{km / car}\right)\right)$$

= 40.9 accidents involving cars moving from main gate to five junctions (INJURED PERSONS)

For number of uninjured person

$$\frac{41}{2000}=2.05\times10^{-2}$$

∴ In every 2000 persons, likely number of uninjured persons will be;

$$2.05\times10^{-2}\times2000=41\left(\text{number of persons}\right)$$

$$\left(3\text{ days}\right)\times\left(2.05\times\frac{10^{-2}\text{ accidents}}{1hr}\text{car km}\right)\times\left(1633\text{cars}\times\left(5.23\text{km / car}\right)\right)$$

= 52.5 accidents involving cars moving from Main Gate to Five Junction (UNINJURED PERSONS)

4.1 Calculations for the risk contour graph

The normal standard feet from the highway is 0.0009144Km (RIGHT OF WAY) from our normal observation and physical checking, there are 2000 persons below 0.0009144Km of the right of way and the probability of accident occurring can be calculated.

The death rate from our SAVAN data table is 19 persons

$$Probability=\frac{19}{2000}=9.5\times10^{-3}$$

Therefore, the number of cars travelling between main gate to Five junction in 3 days from our statistics in 1 hour is 1633 cars in a distance of 5.23Km

$$3\times9.5\times10^{-3}\times1633\times5.23=243.3$$

Possibility of cars involve in accident = 243.4 out of 837576 cars traveling in 3 days in 5.23 Km

The possibility of cars involving in an accident, which is 243.4 is divided by the chance of accident happening according to graduation of the distance in kilometers, hence;

$$\text{Distance of }0.0003048KM\ldots\ldots\ldots\ldots\ldots.\frac{243.4}{0.0003048}=798556.43$$

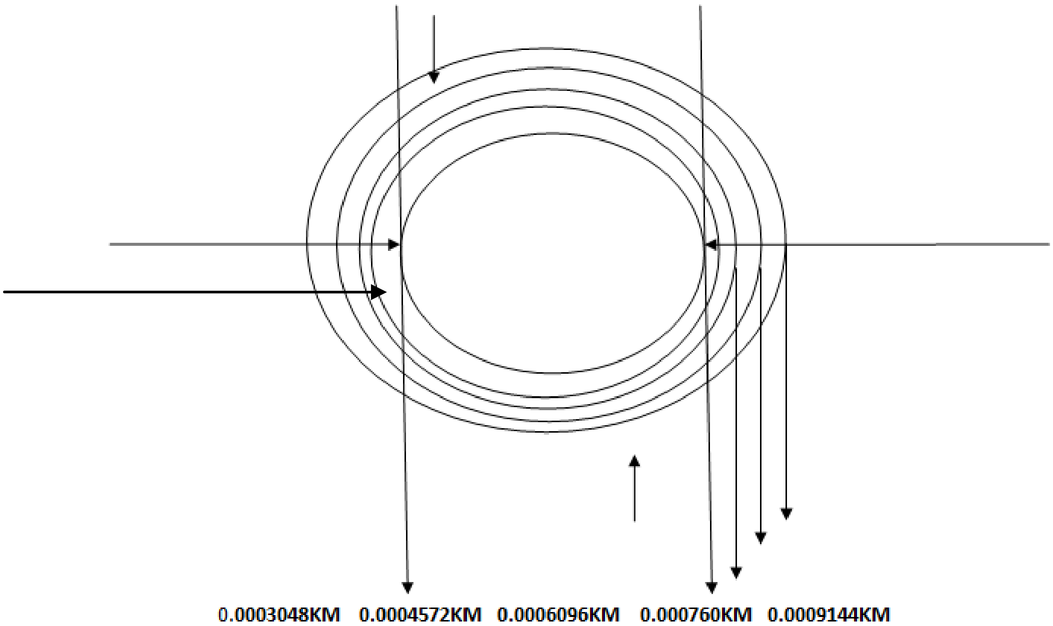
$$\text{Distance of }0.0004572KM\ldots\ldots\ldots\ldots\ldots.\frac{243.4}{0.0004572}=532370.95$$

$$\text{Distance of }0.0006096KM\ldots\ldots\ldots\ldots\ldots.\frac{243.4}{0.0006096}=399178.22$$

$$\text{Distance of }0.0007620KM\ldots\ldots\ldots\ldots\ldots.\frac{243.4}{0.0007620}=319422.57$$

$$\text{Distance of }0.0009144KM\ldots\ldots\ldots\ldots\ldots.\frac{243.4}{0.0009144}=266185.48$$

4.2 Risk Contour Graph



4.3 Measurement Taken

The various measurement from Main Gate to Five Junction as shown below was gotten with help of Goggle earth, which enable us to determine the required distance and the likely houses which are exposed to risk as a result of road accident, unwanted noise and possibly fire.

Main Gate to Estate Junction = 0.55Km
Estate Junction to Conoil Filling Station (adjacent to UBTH) = 0.40Km
Adolor College Road Junction to St. Patrick Catholic Church = 0.57Km
St. Patrick Catholic Church to Technical School Road Junction = 0.40Km
Technical School Road Junction to S & T Road Junction = 0.53Km
S & T Road Junction to Traditional Land = 0.61Km
Traditional Land to meeting point between Uselu Lagos Road and New Lagos Road = 0.88KM
Meeting point between Uselu-Lagos Road and New Lagos Road to Five Junction (End point) = 0.78Km

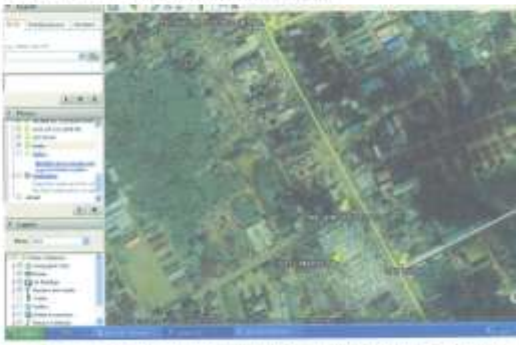
Total distance: 5.23Km

THIS IS A PICTORIAL VIEW FROM GOOGLE EARTH, FROM S&T ROAD JUNCTION TO TRADITIONAL LAND.

THIS IS A PICTORIAL VIEW FROM GOOGLE EARTH ,FROM ADOLOR COLLEGE RO JUNCTION TO TECHNICAL COLLEGE ROAD JUNCTION.

THIS IS A PICTORIAL VIEW FROM GOOGLE EARTH, FROM ESTATE JUNCTION TO CONOIL FILLING STATION (ADJACENT TO UBTH).

THIS IS A PICTORIAL VIEW FROM GOOGLE EARTH, FROM MAIN GATE (STARTING POINT TO ESTATE JUNCTION.



THIS IS A PICTORIAL VIEW FROM GOOGLE EARTH, FROM TECHNICAL COLLEGE ROAD JUNCTION TO S&T ROAD JUNTION.

THIS IS A PICTORIAL VIEW FROM GOOGLE EARTH, FROM TRADITIONAL LAND TO THE MEETING POINT BETWEEN USELU LAGOS ROAD AND NEW LAGOS ROAD.

4.4 Information on Road Line:

The default standard for "traveled way is 0.003658KM. highway engineers designing " typical sections refer to the national manual to geometric standards used by most states. The green book recommends adding 0.000061 KM if there is an adjacent curb and adding various additional widths on curved ramps. Recommended width for parking lanes is 0.0002438KM. RIGHT OF WAY IS 0.0009144

V. Discussion

In this thesis, we have been able to analyze the risk of living along a highway and also educate these inhabitants living along the location about the risk involved. We have been able to Calculate for societal and individual risk, of the inhabitants' living along this highway. And also for the Risk contour. The possibility of cars involving in an accident which is 243.4 is divided by the chance of accident happening according to graduation of the distance in kilometers, hence

DISTANCE OF 0.0003048KM……………………………….. $\frac{243.4}{0.0003048} = 798556.43$

DISTANCE OF 0.0004572KM ....$\frac{243.4}{0.0004572} = 532370.95$

DISTANCE OF 0.0006096KM ....$\frac{243.4}{0.0006096} = 399278.22$

DISTANCE OF 0.0007620KM ....$\frac{243.4}{0.0007620} = 319422.57$

243.4
DISTANCE OF 0.0009144KM ....0.0009144 = 266185.48

From the above calculations, it is observed that the farther a particular building is from the highway the less risky it is.

VI. Conclusion

The success of this thesis is undoubtedly a remarkable progress in the reduction of risk in the highway, as the knowledge and skills acquired are of great environmental importance considering the present state of individuals living along the highway (from Main Gate to Five Junction). Though, a major challenge was encountered in obtaining the statistics of inhabitants staying along the highway, the statistic of cars and the accidents that occurs in the location taken (from Main Gate to Five Junction). But, these challenges were overcomed and the results were used with the accident data from SAVAN (Save Accident Victims Association of Nigeria), in the calculations and also for the risk contour. At the end, the thesis was successful and we were able to analyze the risk of inhabitants living along these highways.

VII. Recommendation

This thesis recommends that a satellite be included to monitor these various highways to check for violators, say on a daily to weekly and monthly basis. This satellite system should include an alarm system fixed on it that automatically beeps whenever there is a structure violating the right of way.

This alarm system will automatically alert the appropriate authorities (Ministry of Lands, Survey and Housing). This thesis is also recommended to the Government and those involved in town planning for the adequate planning of a areas and location before structures are erected. Authorities will also need to allocate specific annual safety budget for their plans and ensure adequate funding is set aside within the maintenance budget.

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