IMPACT OF EROSION ON SUSTAINABLE ROAD CONSTRUCTION PROJECT IN NIGERIA

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1: INTRODUCTION

Soil erosion is the wearing away of the top layer of the earth by natural forces of water and wind or through forces associated with the activities of man.

Soil erosion depletes compacted soil, thereby causing loss of soil structure, with resultant effect of soil debasement. These forms of soil debasement, genuinely add to accelerating soil disintegration.

Basically, Roads are constructed to encourage the movement of individuals and products, and to promote the turn of events Bhattacharyya. [1]Thus, disintegration of basement structural formation of these roads has resulted to unsatisfactory reports over the state of the roads built in our society today especially within our country Nigeria. Soil disintegration remains one the major the major dangers to global ecological situation, that takes place under collaborative conditions reliant on land use, environment, soils and geology Megahan,[2].

Environmental challenges caused by soil erosion on roads have economic implications related to road rehabilitation and construction and can be controlled through, extream velocity concentrated-fumes, channels and water ways, likewise spillways, dam overtopping and levees, culvert outlets,grade control stuctures storm water control and infiltration though highly effective ACB and TCB are often more expensive to use, InstaTurf [3]. This research therefore considers the cost implication of constructing road along a gully Erosion site in comparison with a none gully Erosion site so as to verify the Economic impact of gully Erosion on road construction project. Thus, it becomes pertinent to run through different literature on road construction projects affected by soil erosion to have a better understanding of the impacts of erosion on road construction projects and a considerable methods of assessment that could be put under consideration as guide for future

development so as to help recommend best management approaches for efficient monitoring of roads affected by erosion at a minimal cost especially within a financial resource resource-scarce environment. The Impact of Erosion on road construction project could span from economic implications of road construction to damages on constructed roads that can cause damages to motorist, with its associated dangers of accident increasing the level of mortality and morbidity in the affected areas, Barton [4]. Erosion actually occurs in backward direction at a point when heavy rainfall occurs on the earth surface, and moves in line with the law of gravity, causing segments of the precipitation to saturate the soil in attempt to renew earth's ground water, thereby causing a large portion to stream downhill as spillover Elliot *et al* [5]. The transportation of soil particles by overland wide sheet stream is accelerated by disintegrations brought about by heavy raindrop Sheridan *et al* [6]. Erosion is actually in sighted by disintegration, at various rates, because of physical, synthetic and mineralogical structure, component and nature of soil. Franco *et al* [7]. Moreover, Water transportation includes the motor energy which eliminates and ships the dirt particles, and the opposing powers which hinder disintegration Lascelles *et al*.[8]. As watershed is urbanized, a large part of the vegetation is supplanted by impenetrable surface, along these lines decreasing the territory where invasion to ground water can happen Musa *et al* [9]. Spillover is critical. It does not exclusively serve waterways and streams, yet in addition changes the scene by an activity of disintegration Musa *et al*, [10].Flowing water has gigantic force, it can move rocks and cut out gulches Arnaez et al [11]. Water disintegration should be controlled to keep up engine capable Roads, and reduce sedimentation and stream contamination. Disintegration issues are essentially brought about by human abuse of regular assets and the expulsion of the defensive front of common vegetation (Sutherland *et al* [12]. Overflow can be clarified further as the piece of precipitation on uncontrolled surfaces, streams, waterways, channels, sewers or Road, which may additionally be grouped by the speed of appearance after precipitation or liquefying snow as immediate or base spillover. Quentin. L and David. R [13]. The global urbanization trend, impacts heavily on road, parking areas and structures through several anthropogenic sources that consequently reduces soil compatibility and exposes the soil to erosion of the mostly damaging gully type. David[14] Disintegration on roads that gives access to people into their home has been a hazard under examined and should be given attention before its damaging effect becomes more catastrophic Thus its catastrophic nature can be controlled by establishment of vegetation, building of earth wall and construction of concrete blocks and when these measure are not put in place,

project delay would not fail to occur. Loukrakpam and Oinam [15] stated that, Soil erosion is considerably, one of the main indicators of soil degradation the global environment scenario. Moreover, landslides are resultant impact of erosion in the hilly regions of our study area that affects the cost of road construction project execution. Impact and methods of proffering solutions for the issue of disintegration on road ways is very necessary in order to prevent the high level economic losses that may be incurred in the course of reconstruction such roads. Consequently, this study examines the impact of erosion on road construction project delivery in Nigeria by mostly profiling the economic implications and cost.

2: MATERIALS AND METHODS

This research used both quantitative and qualitative techniques in design and analysis of results. It considered a study population of about 67 road construction workers selected randomly from different sectors of the construction company. Therefore, primary data was acquired through the distribution of questionnaire while secondary data was acquired through already existing data from road construction companies. The data were basically, information regarding economic cost of road construction project, carried within gully erosion prone area as well as, data from road construction project from area of stable terrain. This was done with aim of collecting information to help us analyze the impact of erosion on road construction project delivery. The collected data were analyzed using the Statistical Package for Social Sciences (SPSS) version 21 software package. We also analyzed our results using simple linear regression method. The results were presented in the form of tables and charts. Hypothetical statements were presented as $H0_1$: stating that gully erosion has significant effect on sustainable road construction project, $H0_2$: stating that topography of the soil has significant effect on sustainable road construction project and $H0_3$: which stated that Poor drainage construction does not have significant effect on sustainable road construction project in Nigeria.

3: RESULTS AND DISCUSSION

Table 1: Does gully erosion affect road construction project?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	disagree	7	10.4	10.4	10.4
	agree	24	35.8	35.8	46.3

	strongly agree	36	53.7	53.7	100.0
	Total	67	100.0	100.0	

Table 1 above, that out of 67 respondents, from the distributed questionnaire on effect of gully erosion on road construction project, 36(53.7%) strongly agreed, 24(35.8%) agreed, while 7(10.4%) disagreed.

Table 2: Does topography of the soil increases erosion affect road construction project?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	disagree	5	7.5	7.5	7.5
	agree	24	35.8	35.8	43.3
	strongly agree	38	56.7	56.7	100.0
	Total	67	100.0	100.0	

Table 2 above displayed that out of 67 respondents from the distributed questionnaire the possibility of topography of the soil increasing effect of erosion road construction project, 38(56.7%) strongly agreed, 24(35.8%) agreed, while 5(7.5%) disagreed.

Table 3: Poor drainage construction induces formation of gully erosion soil erosion?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	disagree	10	14.9	14.9	14.9
	agree	24	35.8	35.8	50.7
	strongly agree	33	49.3	49.3	100.0
	Total	67	100.0	100.0	

Table 3 above, shows that, out of 67 respondents, from the distributed questionnaire on possibility of poor drainage construction inducing gully erosion soil erosion, 33(49.3%) strongly agreed, 24(35.8%) agreed, while 10(14.9%) disagreed.

Table 4: Do you agree that soil erosion has effect on flooding of road ways during rain?

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid				

	disagree	12	17.9	17.9	20.9
	agree	20	29.9	29.9	50.7
	strongly agree	33	49.3	49.3	100.0
	Total	67	100.0	100.0	

Table 4 above, shows that, out of 67 respondents, from our distributed questionnaire on the possibility of soil flooding inducing soil erosion during torrential rainfall. 33(49.3%) strongly agreed, 20(29.9%) agreed, while 12(17.9%) disagreed.

The regression analysis that stated both the null and alternate hypothesis

(H_0: Gully erosion does not have significant effect on sustainable road construction project and H_1: Gully erosion has significant effect on sustainable road construction project) with a decision rule, rejecting the null hypothesis when p-value is less than α-level of significance (0.05).
The analysis of variance displayed on the table 5 below, shows that, the p-value of 0.038 is less than 0.05 therefore, we reject the null hypothesis which indicated that gully erosion does not have significant effect on sustainable road construction project. This brings us to the conclusion that gully erosion has significant effect on sustainable road construction project.

Table 5: ANOVA

Model		Sum of Squares	df	Mean Square	F	p-value
1	Regression	.016	1	.016	5.933	.038[b]
	Residual	1.149	65	.018		
	Total	1.166	66			

b. Predictors: (Constant), Does gully erosion affect road construction project?

The analysis on the next hypothesis which stated that **(**H_0: Topography of the soil does not have significant effect on sustainable road construction project and H_1: Topography of the soil has significant effect on sustainable road construction project, showcasing the decision rule that there should be a rejection of null hypothesis when p-value is less than α-level of significance (0.05). Since the p-value of 0.528 is not less than 0.05, we accept the null hypothesis which indicates that topography of the soil does not have significant effect on sustainable road construction project. This brings us to a conclusion that topography of the soil does not have significant effect on sustainable road construction project.

The hypothetical statement showcasing H_0: states that, Poor drainage construction does not have significant effect on sustainable road construction project and H_1: Poor drainage constructions have significant effect on sustainable road construction project. The decision rule: rejects the null hypothesis when p-value is less than α-level of significance (0.05).

Table 7: ANOVA

Model		Sum of Squares	df	Mean Square	F	p-value
1	Regression	.028	1	.028	7.601	.010[b]
	Residual	1.138	65	.018		
	Total	1.166	66			

b. Predictors: (Constant), Poor drainage construction induces formation of gully erosion soil erosion?

Since the p-value 0.010 is less than 0.05, we reject the null hypothesis which indicates that poor drainage construction does not have significant effect on sustainable road construction project; therefore, we conclude that poor drainage construction has significant effect on sustainable road construction project.

Table 8: Cost of road construction projects at gully erosion site and none gully erosion site

Impact of erosion on road construction project	Cost associated with road construction site within gully erosion areas (per km)	Cost associated with road construction site within areas without gullies (per km)
Increase in road construction Project cost/ Budget	200,000000	60,000000
Increase in cost resulting from delay in time of road construction Project delivery	45,367000	15,256000
Increase in Labor cost for road construction project	6,412342	4,216345
Increase in cost of hiring equipment for road construction	7,346578	4,325656
Increase in cost of road construction materials	67,890,567	25,865,689

The cost implication of impact of erosion on road construction project goes a long A long way in influencing the overall budget cost which is displayed on the Difference between a gully site and none gully site. Thus displaying budget Fluctuation between 200,000000 and 60,000000. Furthermore delay in time Increased the cost of road construction projects considering the data in table above. Going by the difference between road construction works within gully areas and None gully areas to the tune of 45,367000 and 15,256000. The same case was Displayed on increase in labor cost to the tune of 6,412342 and 4,216345. The next Increase in cost of hiring equipment for road construction was shown on the table Between roads constructed within gully sites and the ones within a table terrain

The different cost are 7346,578 and 4325,656. The cost of road construction

Materials also increased within a road constructed at a gully erosion site at a cost

Cost of 67 890 567 and 25,865689 for a road constructed within an erosion free

Area. Figure below shows a graphical representation of data from table 8 showing

Percentage rate of increase in cost for the different cost criteria.

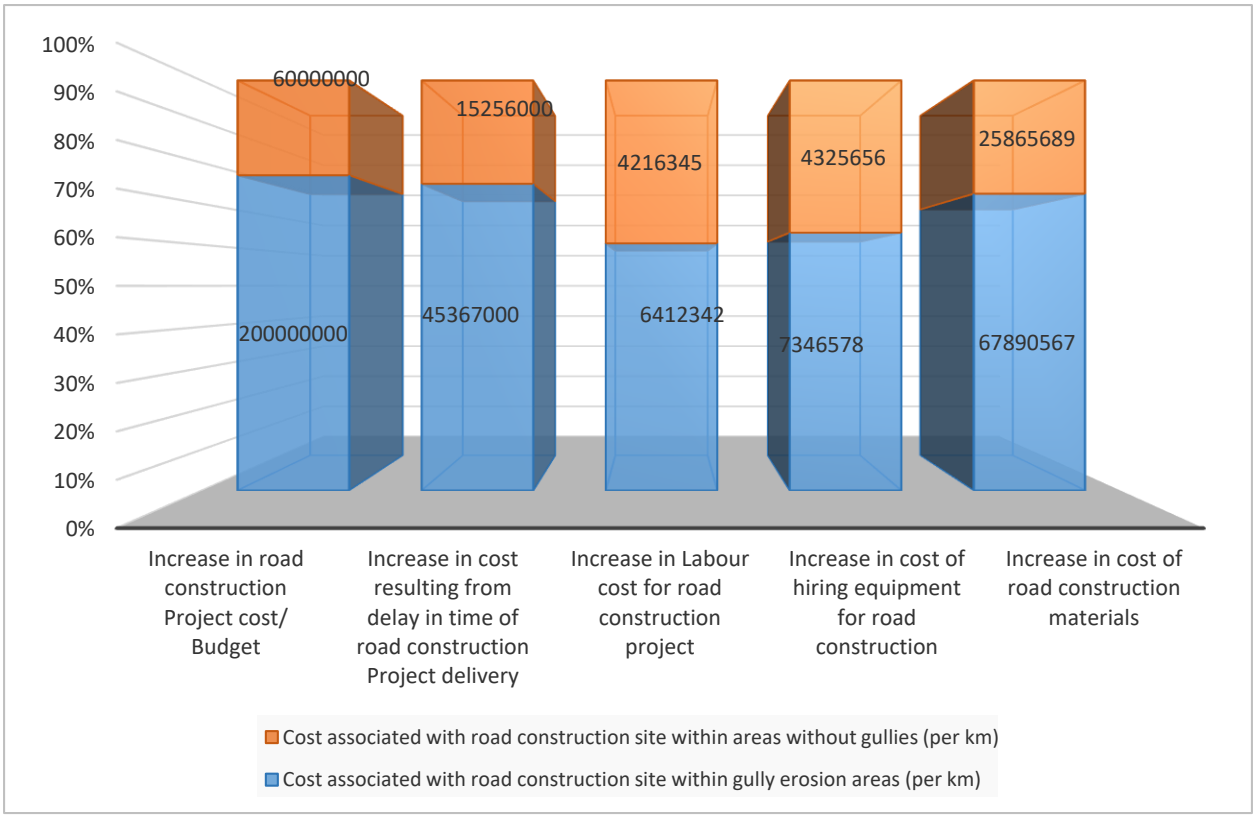

Figure 1: Difference in cost of road construction projects at gully erosion site and none gully erosion site

3.1: Impacts of Construction Project delay caused by uncontrolled Erosion

The results from different construction company's records on construction project delay caused by uncontrolled erosion was displayed on the table below between 2010 to 2020 based on the number of clients the companies lost, level of customers dissatisfaction and the number of projects abandoned.

Year	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020

Loss of client	23	14	32	17	27	19	31	29	35	22	35
Costumer dissatisfaction	26	17	35	20	32	24	39	34	40	27	37
Abandoned Projects	7	9	5	10	8	6	11	9	7	4	12

Table 9: Impact of construction project delay

Source: Construction company's data base (2021)

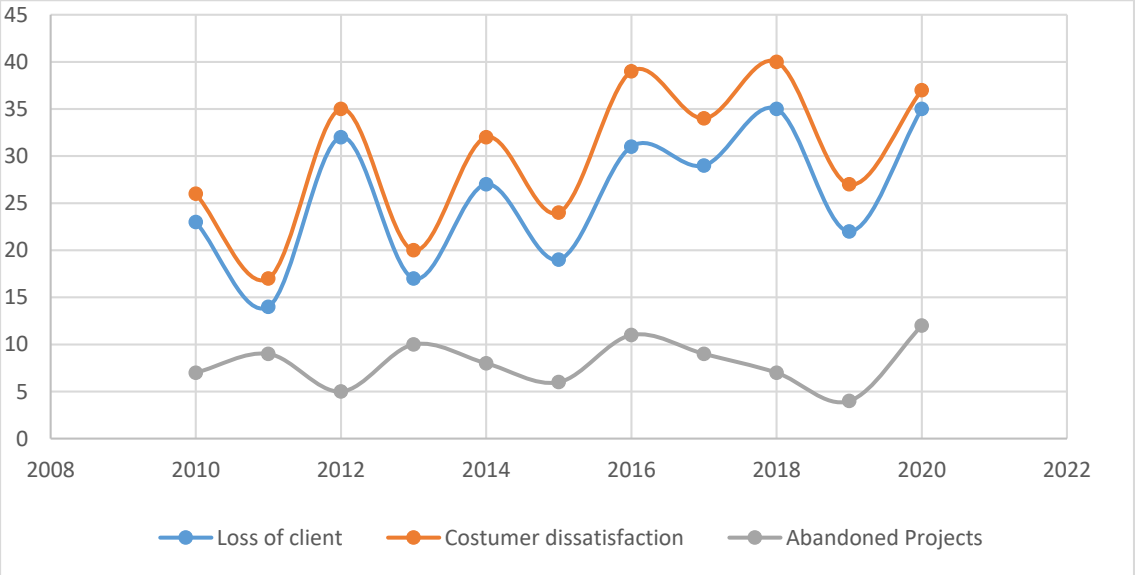

Figure 2: Impact of erosion induced construction project delay criteria

The fluctuating trend of flow of the graph on impact of erosion induced construction project delay criteria indicates that most construction companies handling projects done in area were reported to have experienced loss of clients, costumer dissatisfaction and abandonment. This goes a long way in proving that the devastating effect of erosion has not been checked for possible control over the stipulated period 11 years between 2010 to 2020.

Pie chats below displayed the annual percentage distribution of the individual criterion on table 9 like, loss of client, costumer dissatisfaction and project abandonment.

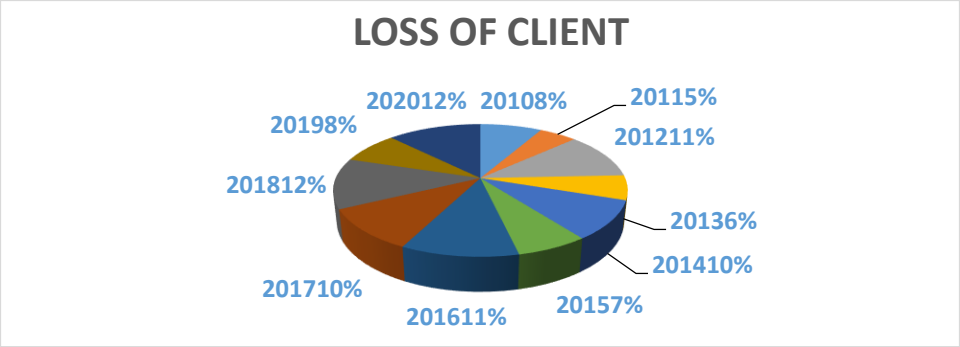

Figure 3: Annual percentage distribution of report on loss of clients

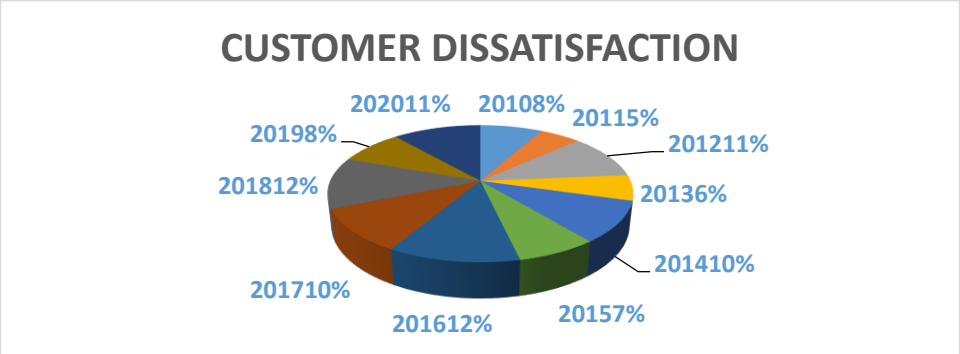

Figure 4: Annual percentage distribution of report on customer dissatisfaction

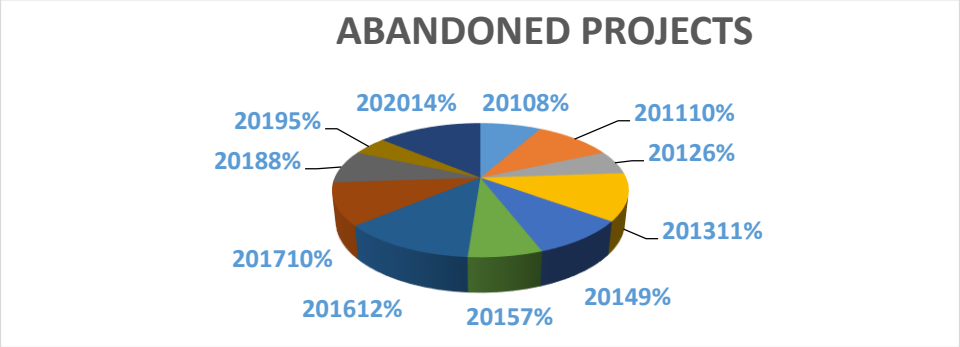

Figure 5: Annual percentage distribution of report on project abandonment

3.2: Sustainability approach to road construction project for reduced erosion impact

The three sustainability pillars which are social, economic and environmental systems was expanded to include technical system which should introduce the latest technological developments that are involved in erosion control in other to reduce the impact of erosion on construction projects. See figure 6 below.

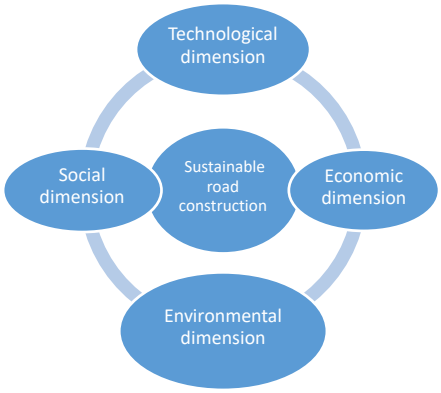

Figure 6: Sustainable approach to road construction project to reduced erosion impact

Sustainable road construction projects are systematically affected by erosion with its several impacts ranging from increase in general cost of project execution, increase in labor cost, and delay in project delivery timeline, loss of client and costumer dissatisfaction. Discuss on technological dimension is based on different latest technological approach implored to control erosion in other to reduce its impact on construction projects and they include: *articulated concrete blocks* involving revetment systems, constructed in numerous shapes and thicknesses where blocks form grid of interconnectivity used for erosion control waterways and artificial drainage channels, *Mechanically stabilized earth (MSE)* walls used as replacement for many traditional concrete retaining walls in recent times. The numerous advantages of MSE over conventional reinforced concrete walls, include ease and speed of installation, *Turbidity barriers* used to prevent soil erosion and migration of contaminants in water basically made of a floating geotextile membrane anchored to the bottom of the water body using heavy weights they also used for supplemental sediment control, *Geotextiles* are used in erosion control and improvement of soils over which roads, embankments, pipelines, and earth-retaining structures are built depending on the application, geotextiles sometimes have open mesh weave, a warp-knitted structure, or a closed fabric or nonwoven surface. The criteria for selecting specific type of geotextile used include separation, filtration, drainage, reinforcement, sealing, and protection, *French drain* system involve underground piping known as drain tile that channels surface and groundwater to exit point. It involves drain tile perforated to allow water to slowly move into the soil below the tile while excess water is transported to exit point. Their installation is made to slope of about 1 inch of drop per 10 feet of horizontal run, *Soil nailing* resists force against slope failures and its installation process is fast. Its main installation procedure involves drilling into the soil as well as

placing series of steel bars and nails, deep into the earth. The surface of the nails are capped facing create barrier, that is like a retaining wall and can also can be driven into the soil, *Riprap method* is used to protect soil from erosion in areas of concentrated runoff using layers of very large stones interlocked to act as barrier on unstable slopes because of seepage problems and areas receiving large, concentration of flow It is used to minimize erosion within lake shores and riverbeds. It is installed over a synthetic geotextile membrane in prevention of soil moving through the riprap and dust control method can be used in construction site with potential for air and water pollution from dust moving across landscape or through the air. The different methods for dust control in soil are, misted water, silt fences and polymer additives. Juan [16]. Another method to control erosion is Backfilling trenches stated by Juan [17] is the process of putting soil back into a trench or foundation once excavation, and the related work has been completed. The backfill process requires skills and heavy equipment as well as knowledge of the specifications, contract requirements, and soil conditions.

The social dimensions involves to investigation into who is responsible for controlling erosion for successful construction project delivery. This answer is simple because there are special professionals who have expertise in soil management and control in geomorphologic processes who can work in collaboration with landscape construction experts. It is only on the basis of their collaborative performance that sustainable erosion control would be handle to follow the global sustainable development approach in favour of erosion control and management while the environmental dimension involves the use of tree planting and other forms of vegetation to control erosion as well as adoption of environmental policies geared towards unnecessary deforestation and avoidance of creating walk ways along green parts.

The economic dimensions would involve using smart erosion control methods of low cost considerations to encourage reduced spending geared towards profit maximization in management and control of erosion for sustainable construction delivery.

4: CONCLUSION

The impact of erosion on road construction projects cannot be overemphasized since the economic implications are so high that the cost of construction a road within an area devoid of erosion is highly minimal in comparison a road constructed within an area that gully erosion preoccupies thus the budget for such road construction increases for the purposes of avoiding project failure as

well as project abandonment. Gullies within road construction project sites, make road construction more cumbersome thereby delay in time of the project execution. The time expected to conclude project within areas that have no gullies cannot be equated with the time that is mapped out for carrying road construction projects within an erosion prone area. This research also verified that Gullies within road construction sites trigger the involvement of more labor and equipment while the other project site without gullies has lower number employed laborers and lesser equipment on site. Gully erosion within road construction project site also increases the volume of construction materials while project sites that have no gullies encounter lesser number of road construction materials. Furthermore, reports were gathered regarding some criteria including loss of client, costumer dissatisfaction and project abandonment, The analysis displayed on the graph shows that gulley erosion which is the most disastrous type of erosion has not been properly checked and controlled in the area. Though the annual distribution of the percentages of individual criterion are low, the percentage distribution shows that there is need for further control of gully erosion to reduce its impact on construction projects, This research therefore recommends proper planning should be carried prior to start of every road construction project in other to avoid emergencies that could negatively impact on such projects by increasing the overall cost of the project execution, increase in time of project delivery, increase in number of laborers that could in efficient project delivery as well as increase the volume of road construction project materials. Reconnaissance survey should be carried prior to the planning stage to verify the overall soil quality so as to incorporate certain eventualities that the nature of the soil may trigger in line with erosion development peradventure the soil is not as compact as it is expect that could support quality road construction that would not be easily affected by erosion. It is recommended that a good drainage system should be construction to save the roads from quick impaction of erosion and increase the life span of such road. Furthermore roads that fall within steep slopes should be properly landscaped to enhance its sustainability and compatibility with the already existing topography.

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