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Adopting Geographic Information System (GIS) for Land Valuation for Infrastructure Development

Subash Ghimire

Abstract: In many developing countries, infrastructure development projects are not sustainable due to land valuation conflicts. Mostly, land valuers have assessed land value based on their experiences and without inference. They carry out the subjective land valuation. The detailed spatial analysis of the parcel is not considered for land valuation. The main objective of this study is to analyze the use of GIS in land valuation for land acquisition in infrastructure development. The study is carried out by a literature review with secondary data and primary data. The result shows that adopting GIS for land valuation is necessary and very important for establishing a realistic land valuation system. The model uses various criteria for weighted land valuation and follows an analytical hierarchical process.

Keywords: geographical information system, land acquisition, land valuation.

I. Introduction

There is no official land valuation system in Nepal except Adhoc land valuation for compensation during land expropriation (Tuladhar, 2004) and is still the case in Nepal. The unfair procedure of land valuation and management, delayed payment of compensation, and inequitable compensation can reduce tenure security, harm public faith, and confidence in government and the rule of law. When this process is done poorly, it may leave affected people homeless, farmless, and jobless with a feeling that they suffered a grave injustice. Appeals against unfair procedure may delay the project and increase project costs that exceed the previously estimated costs (FAO, 2008). The land conflicts, such as low compensations, unfair compensations, etc. arise due to lack of reliable, consistent, transparent and efficient land valuation model for land acquisition in infrastructure development. The detailed spatial analysis of the parcel is not considered for land valuation. The current land valuation for land acquisition in developing countries, such as Nepal is done conventionally as given in Equation 1 and Equation 2, therefore, is not based on its objective analysis of geographical location.

\[ V_i = R \times A R E A_i \] \hspace{1cm} (1)
\[ \text{Value} = \sum V_i \] \hspace{1cm} (2)

Where, \( A R E A_i \) = Area of each parcels, \( \text{Value} = \) Total land value of each parcel, \( R = \) Rate of land and \( i = 1 \) to \( n \) (number of parcels)

II. Objective

The objective of the study is to develop the land valuation model by adopting GIS. To support the main objective, the following sub- objectives are formulated as:
- To analyses the criteria affecting land valuation for land acquisition in infrastructure development
- To integrate the knowledge of GIS in land valuation for land acquisition in infrastructure development

III. Materials and Methods

The desk, and case study are followed for the research and desk study is followed by the scientific literature review in the field of geo-information science, and technology, land valuation and infrastructure development. The qualitative and quantitative research approaches were used to collect primary and secondary data in a case study area at Kathmandu Terai Fast Track Road Project in Makwanpur district, Chatiwan VDC of Nepal. Household survey, key informants’ interviews, focus group discussion and field observation were conducted to collect primary data while the relevant documents such as detailed project report, property valuation document and spatial data (cadastral data, image etc.) was also collected for the study. The formula given by Glenn (1992) is used for calculating a sample of the respondents for the household data collection because it is very simple to understand, and calculate the sample.

IV. Study Area

The location map of the case study area has been shown in Figure 1.
V. RESULTS

The results are discussed in following subsections

a) Weight allocated based on Analytic Hierarchy Process

Analytic Hierarchy Process is an effective tool for dealing with the complex decisions by setting priorities and makes the best decision. According to Saaty (2008), it is a theory of measurement through pair wise comparisons and depends on the judgments of experts to find out a priority. Pair wise comparisons are based on forming judgments between two particular criteria rather than attempting to prioritize an entire list of criteria. Saaty (2008) has shown that weighting activities in multi-criteria decision-making can be effectively dealt with using the hierarchical structure and pair wise comparisons. An AHP aim is to obtain quantitative weights from qualitative statements on the relative performance of alternatives and the relative importance of criteria obtained from the comparison of all pairs of alternatives and criteria. As graduation scale for quantitative comparison of alternatives, the following numerical values are graduated as shown in Table 1.

Table 1: Graduation scale for quantitative comparison (Row vs Column)

<table>
<thead>
<tr>
<th>Comparison Level</th>
<th>Numerical Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Extremely less important</td>
<td>1/9</td>
</tr>
<tr>
<td>Very strongly less important</td>
<td>1/7</td>
</tr>
<tr>
<td>Strongly less important</td>
<td>1/5</td>
</tr>
<tr>
<td>Moderately less important</td>
<td>1/3</td>
</tr>
<tr>
<td>Equal important</td>
<td>1</td>
</tr>
<tr>
<td>Strong more important</td>
<td>3</td>
</tr>
<tr>
<td>Moderately more important</td>
<td>5</td>
</tr>
<tr>
<td>Very strongly more important</td>
<td>7</td>
</tr>
<tr>
<td>Extremely more important</td>
<td>9</td>
</tr>
</tbody>
</table>

Source: (Saaty, 2008)

AHP is working with the matrix comparing each criteria to each other. The pair wise comparisons of different criteria by its importance carried out from the response of different stakeholders in Fast Track Road Project, Chatiwan VDC are mentioned in Table 2. The criteria are chosen based on (Yomralioglu & Nisanci, 2004), (Koirala et al, 2015) and from primary data collection.
Table 2: Calculating Eigen vector

<table>
<thead>
<tr>
<th>Land valuation criteria</th>
<th>Road</th>
<th>Slope</th>
<th>Built up</th>
<th>Natural environments</th>
<th>Soil type</th>
<th>5th root of product</th>
<th>Eigen vector</th>
</tr>
</thead>
<tbody>
<tr>
<td>Road</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>5</td>
<td>5</td>
<td>2.371</td>
<td>0.360</td>
</tr>
<tr>
<td>Slope</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>5</td>
<td>5</td>
<td>2.371</td>
<td>0.360</td>
</tr>
<tr>
<td>Built up</td>
<td>0.333</td>
<td>0.333</td>
<td>1</td>
<td>3</td>
<td>3</td>
<td>0.998</td>
<td>0.160</td>
</tr>
<tr>
<td>Natural environments</td>
<td>0.2</td>
<td>0.2</td>
<td>0.333</td>
<td>1</td>
<td>1</td>
<td>0.419</td>
<td>0.060</td>
</tr>
<tr>
<td>Soil type</td>
<td>0.2</td>
<td>0.2</td>
<td>0.333</td>
<td>1</td>
<td>1</td>
<td>0.419</td>
<td>0.060</td>
</tr>
<tr>
<td>SUM</td>
<td>2.733</td>
<td>2.733</td>
<td>7.666</td>
<td>15</td>
<td>15</td>
<td>6.578</td>
<td>1.000</td>
</tr>
<tr>
<td>SUM*PV</td>
<td>0.983</td>
<td>0.983</td>
<td>0.830</td>
<td>1.157</td>
<td>1.157</td>
<td>5.110</td>
<td></td>
</tr>
</tbody>
</table>

Table 3: Land valuation criteria & the Eigen vector and its weightage

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Land valuation criteria and Eigen vector</th>
<th>Weightage calculated from AHP</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Road</td>
<td>0.36</td>
</tr>
<tr>
<td>3</td>
<td>Built up</td>
<td>0.16</td>
</tr>
<tr>
<td>2</td>
<td>Slope</td>
<td>0.36</td>
</tr>
<tr>
<td>4</td>
<td>Natural environments (River &amp; forest)</td>
<td>0.06</td>
</tr>
<tr>
<td>5</td>
<td>Soil type</td>
<td>0.06</td>
</tr>
</tbody>
</table>

Similarly, the mathematical model for land valuation is:

\[ V_i = R \times \text{AREAI} \times \sum_{i=1}^{n} W_i \]  

\[ \text{Value} = \sum_{i=1}^{n} V_i \]

Where, \( \text{AREAI} = \) Area of each parcel, \( W_i = \) Factor weight calculated from weighted overlay \( i=1 \) to \( n \), Number of each parcel, \( R = (0.6 \times \text{Market rate} + 0.4 \times \text{Government rate}) \) and \( \text{Value} = \) Total land value of each parcel.

The governments valuation is taken from (Government of Nepal, 2017). The process and result of GIS overlay are shown in Figure 2 and Figure 3.
VI. Conclusion

An unrealistic land valuation system in infrastructure development generates conflicts during land acquisition and compensation. It is seen that there is dispute in the government land valuation and owner demand of land price during the land acquisition process. Therefore, an appropriate land valuation model has been developed for fair land valuation. The integration of GIS and the AHP concept in the land valuation process is appropriate for land acquisition in infrastructure development. The model has used several...
land valuation criteria and its weights to develop a land valuation model of land acquisition and compensation in infrastructure development. The input data are of different layers in a vector formats such as points, lines, or polygons. They are changed in raster format, and the criteria are used in the valuation process in proximity analysis. The AHP uses different combinations of criteria and weights to calculate for a combination for a weighted overlay of different criteria.

REFERENCES/ RÉFÉRENCES/ REFERENCIAS


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Prediction of Soil Nitrogen Depletion in Crude Oil Contaminated Soil in Southern Nigeria

N. L Nwakwasi, B. U Dike, E. U Nwakwasi, A. N. Nwachukwu, H. U. Nwoke & J. C. Agunwamba

Abstract - Oil spillage is a major environmental threat in south-south of Nigeria where most of the oil exploration and exploitation activities take place. If this goes on unchecked or poorly managed, it will lead to the total annihilation of the ecosystem. The objective of this study is to develop a model for the prediction of soil nitrogen depletion in crude oil contaminated soil with time using regression analysis. Each sample containing 10kg of soil were artificially polluted with 0.5, 1.0, 1.5, 2.0, and 2.5 liters of crude oil (Bonny Light). The Soil Nitrogen concentrations were determined using standard methods. Results show that the concentration of residual soil nitrogen in the soil for all the volumes of crude oil introduced into the soil depleted significantly with time when compared to values obtained for the control sample. The residual concentration in the control soil sample was about three times higher than the concentration obtained for other samples. The results obtained from the derived model were very close to the experimental value. The model is suitable for determining Soil Nitrogen content in crude oil polluted sites.

Keywords: crude oil, pollution, soil nitrogen, model, niger delta.

I. Introduction

In Nigeria, oil spillage in the Niger Delta region, especially on Agricultural Lands, has been a significant issue of concern both to the government and the people in the area. The outcome of this research work can serve as a vital tool in resolving problems associated with oil pollution and bioremediation of affected lands. Oil has hostile effects on the physicochemical properties of soils, plant and, animal community. Beyond 3% concentration, crude oil has been reported to be increasingly deleterious to soil biota and crop growth (Osui et al., 2006). Unfortunately, available data to manage the ecological spoils of the Niger Delta Region has been found inadequate. Though existing data has found various uses in the Post spill management program of the affected ecosystem and communities, recent advances have shown that such data has been specific to particular sites and incidences, predominantly because of the nature of the crude oil contaminant and possible environmental modifications (Osui et al., 2006).

Soil fertility is the result of the interaction between the biological, chemical, and physical properties of soil due to soil type, land use, and effects of climate. Soil chemical properties are related to the supply of plant nutrients that is essential for plant growth. Generally, oil affects the physicochemical properties in plant communities in soil. Oil spill reduces crop yield, land productivity, and greatly decreases farm income. Observation shows that a 10% increase in oil spill reduces crop yield by 1.3% while farm income plummeted to 5% (Oduwuederhie et al., 2006). According to Shell 1996, half of the volume of the crude oil spill is due to the corrosion of aging facilities mostly flow line. Another 21% happens in the course of operations to produce oil, while about 28% is due to sabotage. The remaining 1% is mainly due to engineering and drilling activities. There have been numerous reports on the impact of crude oil spill on farmland in the Niger Delta region (Osui and Nworie, 2007; Eneje et al., 2012; Onwuka et al., 2012, Uzoho et al., 2007 and Choron et al., 2010).

Mathematical Models can be used to predict the impacts of crude oil spill on the physicochemical properties of soil to reduce the complaints about polluted farmlands. In predictive modeling, data are collected for relevant predictors (variables that are likely to influence future behavior or results) followed by a model formulation, then predictions are made, and the model is validated. The different approaches to deciding model validity include conceptual model validation and operational validation (Nwaogasi, 2006). A case in which n- control variables X₁, X₂, X₃ to Xₙ are involved a corresponding linear multiple regression equation is of the form

\[ Y = A₀ + A₁X₁ + A₂X₂ + A₃X₃ \ldots + AₙXₙ \]

The regression coefficient for A₀, A₁ to Aₙ can be obtained using Panel Data Computer Software.

II. Methods

They carried out the study over a period of sixteen (16) weeks using different containers measuring 17cm (height) by 18.5cm (diameter). The study area is the research farm of the Federal University of Technology Owerri, located in Owerri, Imo State Nigeria. The soils are derived from coastal plain sands called acid sands – Benin formation (Orajaka, 1975). Samples measuring 10kg polluted soil were placed in each of the...
containers and exposed to the same atmospheric and environmental conditions.

Table 1: Layout of experimental design

<table>
<thead>
<tr>
<th>Polluted Soil Sample</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vol. of crude oil in Liters/kg of soil</td>
<td>0</td>
<td>0.05</td>
<td>0.10</td>
<td>0.15</td>
<td>0.2</td>
<td>0.25</td>
</tr>
</tbody>
</table>

Variable monitored for ABCDEF was: Soil Nitrogen

The soil used in the study was collected from the Federal University of Technology Owerri (FUTO) Research Farm from 15cm to 20cm depth with a shovel. It was measured into containers and taken to the laboratory for treatment (greenhouse treatment).

The soil was air-dried for two weeks and sieved through 2.0cm sieve. The soil samples labeled B, C, D, E, F, each weighing 10kg were polluted with 0.5, 1.0, 2.0, 2.5 liters of crude oil (Bony light), respectively, and thoroughly mixed on a polythene sheet and put in a labeled container.

Sample A was not polluted and was used as the control. To maintain the moisture content of the soil, 50cl of water was sprinkled on each polluted soil sample at two weeks intervals.

The polluted samples were allowed to stay 14 days before the commencement of analysis. The representative samples from (A, B, C, D, E, F) containers were taken at two weeks intervals to the soil science laboratory of Department of Crop, Soil and Pest Management, School of Agriculture and Agricultural Technology, FUTO for analysis to determine the fate of soil nitrogen nutrient with time at various levels of pollution with crude oil. The concentration remaining after 14, 28, 42, 56, 70, 84, 98 and 112 days intervals were obtained.

Ten grams (10g) of air-dried soil sample was introduced into a dry 500ml macro-kjeldahl flask, and 20ml of distilled water was added and allowed to stand for 30 minutes after a little swirling. 30ml of concentrated H₂SO₄ was annexed into the mixture and heated at low heat at the digestion stand. The mixture was allowed to boil for five hours. The digest was transferred carefully to a clean 750ml flask, and 50ml of H₃BO₃ indicator solution was added and placed under the condenser of the distillation apparatus. As distillation commenced, the condenser was kept cool below 30°C, allowing sufficient cold water to flow through and to regulate heat to minimize fronting and prevent suck-back. 150ml distillate was collected, and the distillation process was stopped. The Nitrogen (NH₄-N) in the distillate was determined by titrating 0.01N standard HCl at 0.1ml intervals, and as the color changes from green to pink. The percentage of Nitrogen (%N) content of the soil was read and recorded. This process was repeated for various levels of crude oil pollution for the soil samples.

The Panel Data Computer Software called Stata 13 version was used to obtain the regression coefficients B₀, B₁, B₂, B₃ and B₄ and the model equation for soil nitrogen using the data obtained from the laboratory. The model equation for the soil nitrogen is expressed as:

\[ Y_{it} = B_0 + B_1 C_{vit} + B_2 T_{it} + B_3 T_{it}^2 + B_4 \sqrt{C_{vit}} + U_{it} \]  (2.0)

Where,

- \( Y_{it} \) = soil nitrogen
- \( B_0, B_1, B_2, B_3 \) and \( B_4 \) = model coefficients
- \( T_{it} \) = Number of days
- \( C_{vit} \) = Crude oil volume in litres
- \( U_{it} \) = Random error of the model
- \( i \) = crude oil pollution levels (0, 0.5, 1.0, 1.5, 2.0)
- \( t \) = contact time for pollution (days)

III. Results and Discussions

Table 2 shows the soil nitrogen remaining in the soil after any given time (t = 14 to 112 days), for values of soil samples with crude oil pollution volume ranging from 0 to 2.5L per 10Kg of soil.

<table>
<thead>
<tr>
<th>Time (days)</th>
<th>0</th>
<th>0.5</th>
<th>1</th>
<th>1.5</th>
<th>2</th>
<th>2.5</th>
</tr>
</thead>
<tbody>
<tr>
<td>14</td>
<td>0.287</td>
<td>0.143</td>
<td>0.123</td>
<td>0.115</td>
<td>0.121</td>
<td>0.126</td>
</tr>
<tr>
<td>28</td>
<td>0.285</td>
<td>0.148</td>
<td>0.128</td>
<td>0.120</td>
<td>0.127</td>
<td>0.128</td>
</tr>
<tr>
<td>42</td>
<td>0.291</td>
<td>0.150</td>
<td>0.133</td>
<td>0.125</td>
<td>0.130</td>
<td>0.134</td>
</tr>
<tr>
<td>56</td>
<td>0.300</td>
<td>0.152</td>
<td>0.136</td>
<td>0.128</td>
<td>0.127</td>
<td>0.140</td>
</tr>
<tr>
<td>70</td>
<td>0.298</td>
<td>0.154</td>
<td>0.138</td>
<td>0.130</td>
<td>0.134</td>
<td>0.142</td>
</tr>
<tr>
<td>84</td>
<td>0.300</td>
<td>0.158</td>
<td>0.14</td>
<td>0.133</td>
<td>0.140</td>
<td>0.143</td>
</tr>
<tr>
<td>98</td>
<td>0.300</td>
<td>0.159</td>
<td>0.14</td>
<td>0.134</td>
<td>0.140</td>
<td>0.144</td>
</tr>
<tr>
<td>112</td>
<td>0.300</td>
<td>0.159</td>
<td>0.14</td>
<td>0.134</td>
<td>0.137</td>
<td>0.144</td>
</tr>
</tbody>
</table>

Table 2 shows the soil nitrogen remaining in the soil after any given time (t = 14 to 112 days), for values of soil samples with crude oil pollution volume ranging from 0 to 2.5L per 10Kg of soil.
The \( R^2 \) for the determination of the proposed model is 0.9824, with a root mean square error of 0.06255, as shown in table 3. The root mean square error is small; hence the adopted model fits (Chang, 2015). The P-value of 0.00 shows that there is a strong relationship between soil nitrogen and concentration of crude oil spilled at any given time. The equation for prediction of soil nitrogen fate in crude oil contaminated soil is therefore

\[
N = 0.1927 + 0.1124C_{vit} + 0.00097T_{it} - 2.102eT_{it}^2 + 0.2754\sqrt{C_{vit}} + 0.06255
\]

The model was checked and adjusted using another set of experimental data. The model validation is represented in fig 1 and table 4, respectively. The values indicate the closeness of the predicted values with the observed values, thus confirming the validity of the model developed (Essington, 2005).

**Fig. 1:** Experimental and predicted soil nitrogen over time
**Table 4:** Experimental and Predicted Values for Soil nitrogen over Time

<table>
<thead>
<tr>
<th>Time/Day</th>
<th>Experimental Data (ED)</th>
<th>Predicted Value (PV)</th>
<th>Percentage Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>7</td>
<td>0.119</td>
<td>0.122</td>
<td>2.50</td>
</tr>
<tr>
<td>14</td>
<td>0.1192</td>
<td>0.1248</td>
<td>5.10</td>
</tr>
<tr>
<td>21</td>
<td>0.1191</td>
<td>0.1270</td>
<td>4.40</td>
</tr>
<tr>
<td>28</td>
<td>0.1210</td>
<td>0.1260</td>
<td>4.10</td>
</tr>
<tr>
<td>35</td>
<td>0.1270</td>
<td>0.1310</td>
<td>1.50</td>
</tr>
</tbody>
</table>

**Table 5:** Experimental and Predicted values of Soil Nitrogen at various pollution levels using model equation

<table>
<thead>
<tr>
<th>TIME</th>
<th>COV</th>
<th>ED for N</th>
<th>PV for N</th>
<th>% Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>14</td>
<td>0</td>
<td>0.287</td>
<td>0.281146199</td>
<td>2.039652249</td>
</tr>
<tr>
<td>28</td>
<td>0</td>
<td>0.285</td>
<td>0.285761297</td>
<td>-0.267122925</td>
</tr>
<tr>
<td>42</td>
<td>0</td>
<td>0.291</td>
<td>0.289586693</td>
<td>0.485675427</td>
</tr>
<tr>
<td>56</td>
<td>0</td>
<td>0.300</td>
<td>0.292622387</td>
<td>2.459208073</td>
</tr>
<tr>
<td>70</td>
<td>0</td>
<td>0.298</td>
<td>0.29468439</td>
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</tr>
<tr>
<td>84</td>
<td>0</td>
<td>0.300</td>
<td>0.29632479</td>
<td>1.225074084</td>
</tr>
<tr>
<td>98</td>
<td>0</td>
<td>0.300</td>
<td>0.296991438</td>
<td>1.002858043</td>
</tr>
<tr>
<td>112</td>
<td>0</td>
<td>0.300</td>
<td>0.29686414</td>
<td>1.043866037</td>
</tr>
<tr>
<td>14</td>
<td>0.5</td>
<td>0.143</td>
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<td>0.148</td>
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<td>0.150</td>
<td>0.15105704</td>
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<tr>
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<td>0.154</td>
<td>0.15638841</td>
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</tr>
<tr>
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<td>0.158</td>
<td>0.15779519</td>
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</tr>
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<td>0.5</td>
<td>0.159</td>
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<td>0.33845706</td>
</tr>
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<td>112</td>
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<td>0.159</td>
<td>0.15833883</td>
<td>0.540932135</td>
</tr>
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<td>0.123</td>
<td>0.11849087</td>
<td>3.94383326</td>
</tr>
<tr>
<td>28</td>
<td>1</td>
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<td>0.12276417</td>
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</tr>
<tr>
<td>42</td>
<td>1</td>
<td>0.133</td>
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<td>4.81987577</td>
</tr>
<tr>
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Where
COV = Crude oil Volume
ED for N = Experimental Data for soil Nitrogen
PV for N = Predicted value for soil Nitrogen

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Figure 2 shows the graph of the control sample in comparison with the soil nitrogen at various levels of crude oil pollution with time.

Nitrogen content of the soil at various levels of crude oil pollution varied with time of pollution as shown in Fig. 2. In control (no crude oil added), soil nitrogen increased with time of pollution up till sixty (60) days and remained almost constant till 112 days after. Best soil nitrogen concentration at 60 days of pollution was 0.315%, with the fluctuation in value before and after this time (60 days). This could be ascribed to Nitrogen transformation processes, especially mineralization and immobilization (Catherine et al., 2004).

At 0.5 liters (equivalent to 629 barrels per hectare), of crude oil pollution, N concentration increased with time up till 70 days and then decreased, before a second increase at 112 days. The trend for the 1.0-liter rate of pollution was an increase to 84 days and a second decrease up to 112 days. Values of Nitrogen (N) for the 14, 28, 42, 84 and 112 days of pollution were 0.12, 0.13, 0.13, 0.14, 0.135% respectively. The nitrogen content at 1.5 liters of crude oil pollution increased with time up till 84 days after pollution until a decrease from the 84 to the 112 days of pollution. Values of Nitrogen (N) varied as 0.12, 0.13, 0.13, 0.14, 0.135% respectively. The nitrogen content at 2.0 and 2.5 liters of crude oil pollution increased with time of crude application.

Fluctuations in Nitrogen (N) content with time for various crude oil pollution rates could be attributed to differences in Nitrogen mineralization and immobilization.
processes. Generally, soil nitrogen content, averaged over time of crude oil pollution, was three times higher at the control than other rates of crude oil pollution. The low concentrations of N at various crude oil application could be due to reduced microbial activity and depressed nitrogen mineralization, occasioned by toxic and damaging effects of crude oil on soil organism. This bad influence decreased with time of application resulting to improved nitrogen concentration with time.

The percentage of soil nitrogen content at all levels of crude oil pollution with time was below 0.15%, which is the critical nitrogen limit for soils of southeastern Nigeria (Enwezor et al., 1990). This shows that despite crude oil pollution at various levels, the nitrogen content of the soil was low and could hardly sustain crop production.

IV. Conclusion

The impact of crude oil pollution on the physicochemical properties of soil about soil fertility in the Niger Delta Region of Nigeria has been reviewed. Modeling of soil nitrogen in crude oil contaminated soil over a period was carried out. The soil nitrogen value for various crude oil levels of pollution increased with time being lowest at 14days.

References

7. Onwuka, F., Nwachoko, N. &Anosike, E. (2012). Determination of Total Petroleum Hydrocarbon (TPH) and same Cations (Na+, Ca2+ and Mg2+) in a Crude Oil Polluted Soil and Possible Phytoremediation by Cynodon Dactylon (Bermuda grass), Journal of Environmental and Earth Science 2(6), pp. 13-17.
Identification of Environmental Impacts on Duplication and Restoration of BR-401/RR

Author: Luana Kariny Borges Bessa, Francilene Cardoso Alves Fortes, Emerson Lopes de Amorim, Raimundo Jean Tavares de Luna & Lucas Matos de Souza

Abstract: With the growth of cities, it is becoming increasingly necessary to expand the number of roads, consequently increasing the generation of environmental impacts. This article aims to verify the considerations about the negative and positive impacts caused by the pavement of the Highway BR-401/RR. It has by methodology the application of questionnaire and case study, through a qualitative, exploratory approach of bibliographical and documentary character. It is concluded that the results obtained during the study are very relevant for the improvement of the duplication and restoration projects of BRs.

Keywords: environmental impacts, road construction, duplication and restoration of highways.

Resumo: Com o crescimento das cidades, torna-se cada vez mais necessário a expansão do número de estradas, consequentemente o aumento da geração de impactos ambientais. Este artigo tem por objetivo verificar as considerações sobre os impactos negativos e positivos causados pela pavimentação da Rodovia BR-401/RR. Tem por metodologia a aplicação de questionário e estudo de caso, através de abordagem qualitativa, exploratório de caráter bibliográfico e documental. Conclui-se que os resultados obtidos durante o estudo são bastante relevantes para melhoria dos projetos de duplicação e restauração de BRs.

Palavras-chave: impactos ambientais, construção de estradas, duplicação e restauração de rodovias.

1. Introdução

No Brasil onde predomina o transporte rodoviário, a construção de rodovias assume especial relevância, sua ausência implica em perdas de produtos perecíveis, além de impactar na exportação de produtos. Exemplo disso foi durante a greve dos caminhoneiros quando houve interrupção das rodovias provocando escassez de combustíveis, gás de cozinha e outros produtos.

Diante dessa tendência mundial na expansão na construção de estradas, relevantes impactos ambientais devem ser sentidos. Torna-se assim, essencial procurar formas de se prevenir ou, ao menos, minorar os impactos negativos (REZENDE e COELHO, 2015). As construções de estradas melhoram o tráfego entre as cidades circunvizinhas, trazendo benefícios econômicos para a população local, facilitando o transporte de mercadorias, aumentando a geração de renda e novas oportunidades de emprego. Sendo assim, a ampliação e restauração da Rodovia BR-401/RR é de extrema importância para melhoria da qualidade de vida da população roraimense, além de subsidiar o desenvolvimento dos aspectos socioeconômicos.

Mesmo com todos os benefícios citados, a rodovia causa impactos que afetam o meio ambiente, principalmente na área de seu entorno por meio antrópico. Mas sabe-se que para inicialização de qualquer rodovia é importante realizar um levantamento dos impactos ambientais abrangentes, a fim de verificar os possíveis danos que a pavimentação irá causar ao meio físico, biótico e antrópico, antes da implantação do empreendimento.

Pensou-se na BR-401/RR, devido a realidade socioeconômico, dos principais impactos encontrados, que estão relacionados às alterações nas atividades econômicas das regiões por onde a trajetória da rodovia transcorre, ocasionando mudanças nas condições de emprego, e, consequentemente, na qualidade de vida dos habitantes. Além dos impactos no meio biótico que estão ligados aos atropelamentos de animais na pista, que podem também acarretar em situação de perigo aos motoristas, sem falar na redução da cobertura vegetal presente na faixa de domínio da via. E no meio físico, problemas na instabilidade de cortes e taludes ao longo da pista.

Diante disso, o objetivo deste trabalho foi verificar as considerações sobre os impactos negativos e positivos causados pela pavimentação da rodovia BR-401/RR. Além disso, em específico propõe identificar os principais impactos ambientais decorrentes da
duplicação e restauração; propor medidas mitigadoras e remediadoras com intuito de garantir que a intervenção humana seja a menor possível para o meio ambiente; e avaliar as expectativas da população do entorno da rodovia quanto à duplicação e restauração.

a) Implantação de rodovias em Roraima

Rocha (2015) relata à Confederação Nacional do Transporte (CNT) que divulgou os resultados da Pesquisa de Rodovias (2015), onde apontou que 74,6% (731 km) da extensão avaliada no Estado de Roraima, nas BRs 174, 210, 401 e 432, apresentam algum tipo de deficiência, sendo o estado geral classificado como regular, ruim ou péssimo. Somente 25,4%, ou seja, 249 km tiveram classificação ótima ou boa. A Pesquisa da Confederação Nacional do Transporte percorreu 980 km no estado e, em todo o Brasil, foram mais de 100 mil km avaliados.

Em 2018 foi perceptível mudanças na malha rodoviária do estado, segundo informações do DNIT exposto na folha de Roraima, onde diz que atualmente o estado está com 90% de sua malha rodoviária coberta por contratos de manutenção e cerca de 96% em condições boa ou regular. No entanto a capacidade de mobilidade de produtos está seriamente comprometida, devido ao péssimo estado de conservação das rodovias, tendo como consequência um subdesenvolvimento que compromete o equilíbrio socioeconômico regional.

b) Rodovia: BR – 401/RR

O estado de Roraima concretizou um sonho de mais de 50 anos com restauração e melhoramento da BR-401, no trecho que vai da Capital Boa Vista até o acesso ao Município de Bonfim (Folha de Boa Vista, 2018). Em 2018 o Ministro dos Transportes, Portos e Aviação, Maurício Quintella, e o Secretário Nacional de Transportes Terrestres e Aquaviários, Luciano Castro, estiveram no Estado para entregar os 90 quilômetros concluídos da rodovia.

“Tenho a grata satisfação de entregar à população de Roraima esse trecho pavimentado e sinalizado. Em breve, estaremos concluindo o restante da obra, que vai melhorar a qualidade de vida do povo roraimense”, afirmou o ministro, que lembrou que, para a conclusão do trecho, ainda serão investidos mais R$ 56 milhões (FOLHA DE BOA VISTA, 2018).

Além disso, a obra incluiu construções de novas galerias para suportar o fluxo de água durante o período das chuvas, devido a ocorrência de alagamento nos anos de 2011 e 2017, a restauração inclui duplicação da rodovia em dois segmentos além de melhoria e construção de acostamento, beneficiando assim a população em geral (CORREIA, 2018).

c) Impactos gerados na implantação de uma rodovia

Com o crescente aumento da população urbana de Boa Vista, há uma íntima relação entre desenvolvimento socioeconômico e a existência de rodovias. É notório que a construção de rodovias implica em relevantes impactos ambientais, por isso tornou-se fundamental analisar o meio impactado: biótico, físico e socioeconômico.

Além disso, Santangelo (2003) diz que a disposição inadequada dos materiais de bota-fora, a exploração inadequada das jazidas e das caixas de empréstimo, poderá causar carreamentos de sólidos e assoreamento da rede de drenagem e de corpos d’água. E a supressão de vegetação nativa encontra-se diretamente associada às etapas de topografia e cadastramento, abertura das vias e da faixa de domínio, implantação de canteiros e alojamentos, desmatamento das matas ciliares que causa assoreamento, em consequência disso às substâncias acumuladas por esse processo provoca redução da profundidade do corpo de água e o seu volume.

Para Coelho et al. (2011) desde a extração do material, passando pelo serviço de pavimentação nas obras até a duração do uso do asfalto, implicará em risco de contaminação ambiental, devido sua composição química e física. Isto fica mais evidente durante o processo de produção do asfalto, quando as usinas se tornam fontes poluidoras, contaminando o solo, a água superficial e subterrânea, o ar, além de gerar adensamento e compactação do solo. Gerando assim menor qualidade de vida do planeta e dos homens.

Com o surgimento do tráfego nas rodovias construídas é comum ocorrerem atropelamentos de animais silvestres, esse é um problema ambiental especialmente preocupante devido a grande frequência em sua ocorrência. Há estimativa de que 14,7 milhões de animais são atropelados a cada ano no Brasil (MOTTA, 2013). A perda de ambientes naturais, mesmo que degradados, bem como a retirada da cobertura vegetal, gera um número elevado de animais em situação de fuga e busca de novos abrigos mais seguros, potencializado a ocorrência de atropelamentos nas estradas.

Já Rezende e Coelho (2015) relatam que a interferência com a qualidade das águas superficiais e subterrâneas poderá ocorrer durante a fase de construção, como efeito do carreamento de sólidos, assoreamento da rede de drenagem, além da utilização de banheiros, cozinhas, refeitórios e outras estruturas de apoio às obras como as usinas de asfalto e centrais de britagem. Possível, ainda, acidente com vazamentos de cargas nas proximidades dos cursos de drenagem, que podem provocar a contaminação das águas superficiais e subterrâneas.

d) Leis vigentes

Sabe-se que estradas são vitais para o crescimento da economia do estado de Roraima, contudo, os impactos ecológicos causados por
estradas têm sido considerados por muitos autores acima citados um dos principais fatores responsáveis pela perda da biodiversidade. Neste sentido, nota-se como o projeto torna-se relevante em identificar esses impactos e adequar a sua construção aos conceitos de consciência ambiental.


Nota-se a importância deste trabalho, quando se pensa no lado socioeconômico ao idealizar os benefícios da duplicação da BR 401/RR. Porém é importante dar ênfase à questão ambiental e seguir as recomendações dos Órgãos Ambientais, que exigiu que as empresas vencedoras das concessões implantassem o Sistema de Gestão Ambiental, dando assim um salto de qualidade e eficiência com relação ao tratamento e proteção dos recursos naturais, garantindo maior conforto, segurança e satisfação ao usuário da Rodovia.

### II. Metodologia

A pesquisa foi realizada na obra de duplicação e restauração da BR-401/RR, no trecho: Entroncamento BR-174/RR (Boa Vista/RR) - Fronteira Brasil/Guiana (Bonfim/RR), de caráter qualitativo, bibliográfico, documental e de campo, onde foram aplicadas técnicas de coleta de dados como: visitas, diálogo participativo com a comunidade e observações in loco.

A fim de identificar os principais impactos nos meios: físico, biótico e socioeconômico na duplicação da BR 401/RR, utilizou a matriz de interações proposta por Leopold (1971), adaptada por Dagoni (2003), que permitiu identificar os impactos na fase de implantação e operação do empreendimento possíveis de serem afetadas (BRAGA et al., 2002).

Com o intuito de propor medidas mitigadoras e remediatórias para a duplicação e restauração da BR-401/RR, utilizou o método de superposição de cartas, na Figura 1. Conforme Braga et al. (2005) com o avanço da tecnologia, este método tem ganhado valor na mesma proporção, visto que sua utilização além de evoluir para um formato mais preciso, torna-se menos complicada.

#### Classificação de Impactos

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<td>Escassa (1)</td>
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<td>Média (2)</td>
<td>Baixa (1)</td>
<td>Aceitável</td>
<td>Acima de -9</td>
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<td>Provável (2)</td>
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<td>Local (2)</td>
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<td>Alto</td>
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<tr>
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<td>Média (2)</td>
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<td>Médio</td>
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**Figura 1:** Valorização de impactos

Para apresentar as expectativas da população do entorno da rodovia quanto a duplicação e restauração da BR-401/RR, será aplicado um questionário na área supracitada.

### III. Resultados e Discussões

Para avaliação e identificação dos principais impactos ambientais decorrentes da duplicação e restauração da BR-401/RR, foram estabelecidas correlações entre os diversos fatores ambientais diagnosticados e as diversas atividades previstas para o empreendimento, nas suas diferentes fases. E na figura 2 apresentaram-se os impactos negativos no meio físico, biótico e antrópico na fase de implantação e operação na área de estudo e suas medidas mitigadoras e compensatórias.
Figura 2: Matriz de influências de rodovias (DEGANI, 2003)

<table>
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<th>Aspectos Ambientais</th>
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<th>Meio biótico</th>
<th>Meio Antrópico</th>
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<td>x</td>
</tr>
<tr>
<td>Operação</td>
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Fonte: Adaptado pela Autora (2019).

- **Provável redução da capacidade de permeabilidade do solo**
  O processo de compactação do solo favorece o escoamento superficial e a instalação de processos erosivos, devido às ações geradoras de limpeza e desmatamento, movimentação de veículos e movimentação de pessoas. Como medida mitigadora deve-se remover a cobertura arbustiva do solo apenas onde for estritamente necessário, tendo com remediação a recomposição da vegetação e recuperação das áreas degradadas.

  - A retirada da cobertura vegetal na área implicará na valorização do Impacto: -1(2+2+3+1+2+1) = -11 (Negativo – Relevante), ocorrencia muito provável da modificação da qualidade do solo devido a área descoberta, e influência direta, com perturbação regular, importância baixa ou média, dependendo do tipo de pavimento a ser empregado. Estas ações tiveram extensão local, duração média com efeito cumulativo devido à limpeza da área para a execução tanto dos estudos geotécnicos, e instalação do canteiro de obras, sendo este impacto reversível.

- **Contaminação do solo**
  As características do solo podem ser afetadas caso não sejam tomados cuidados na disposição de óleos lubrificantes utilizados pelo maquinário. Como forma de mitigar deve-se realizar manutenção dos veículos em local apropriado, e uma técnica viável é a biotermêdia que envolve a utilização de microorganismos de ocorrência natural ou cultivados, para degradar ou imobilizar os contaminantes.

Na fase de implantação das obras, ocorreu a movimentação de veículos pesados e demais equipamentos, devido às escavações e cortes de grandes espessuras, movimentos de terra, pavimentações, etc. Estas atividades geram gases poluentes e particulados, de importância média, ocorrência pouco provável, extensão local que se depositam sobre as superfícies próximas, cuja valorização do Impacto total: -1(2+2+1+2+1+1) = -9 (Negativo – Relevante). Porém durante o período de exposição dos solos pelas obras de terraplenagem, as chuvas podem carregar material fino para os canais de drenagem, cuja a perturbação é regular, duração curta e reversível.

- **Geração de resíduos durante as obras**
  Os resíduos são compostos pelo acúmulo de lixo e de sucatas nos alojamentos, e áreas de apoio às obras (pedreiras, jazidas, areais, centrais de britagem, usinas de asfalto e outras). A falta de destinação adequada destes materiais pode atuar como um agente de atração de espécies, dentre as quais se incluem ratos que atuam como vetores de diversas doenças. Os resíduos devem ser separados e descartados conforme sua classificação.

A alteração topográfica resultou na aquisição de materiais de empréstimo, de importância média e extensão local, necessários para a substituição de solos moles e construção de aterros. Sendo assim, as escavações foram necessárias para a substituição de material do subleito, que geram sedimentos a serem dispostos em áreas de bota-fora. Na implantação da
obra a valorização do impacto total é de: -1(2+2+3+2+1+1) = -11 classificado como negativo – relevante com perturbação regular que resultou em passivos ambientais, devido cavidades e áreas de disposição de entulhos.

No entanto as modificações no relevo são de ocorrência muito provável, a ser deflagração na área de influência direta do empreendimento. Esse impacto terá duração curta e reversível, mediante recuperação, sendo função da empresa responsável pelas obras.

- Alteração da qualidade do ar

Devido a terraplenagem e construção de aterros, ocorre o aumento dos níveis de poeira em suspensão, e também o lançamento de material partículado e gases resultantes do funcionamento de motores a óleo diesel das máquinas e caminhões utilizados para a construção do corredor de transporte. A remediação neste local deverá ser feita mediante a proteção do material extraído com a utilização de lonas. Além do controle da velocidade de veículos, diminuindo a contribuição de poeiras para o ar, durante os períodos de estiagem; bem como manutenção periódica das máquinas e veículos, contribuindo para a diminuição da liberação de gases para a atmosfera.

O deslocamento de equipamentos para a área do empreendimento ocasionou uma valorização de impactos: -1(2+2+3+2+1+1) = -11 (Negativo – Relevante) de perturbação regular, importância média, ocasionando alteração da qualidade do ar pela emissão de gases gerados pelos motores dos veículos, bem como geração de material partículado e aumento do nível de ruídos. E ocorrência muito provável porque os ruídos emitidos poderão ocasionar o afugentamento temporário da fauna das áreas vegetadas contíguas à área da obra. Porém um impacto adverso de pequena magnitude, de curta duração, extensão local e reversível.

- Alterações dos níveis de rios

Durante a implantação da obra é utilizado máquinas e equipamentos que geram rios, como: escavadeiras, caminhões, rolo compactador, betoneiras e outros. A geração destes rios no local de estudo foi variável de acordo com a fase evolutiva do empreendimento. Isso também foi observado no estudo realizado por Rodrigues (2010). E na remediação deve evitar trabalhos junto às áreas residenciais em horário noturno e controlar emissão de rios gerados por máquinas mal reguladas, além de conservar espaços livres com arborização, a qual funcionará como barreiras naturais, minimizará a propagação dos sons. O intenso tráfego de veículos na região resultou na valorização do impacto total: -1(2+1+3+2+1+1) = -10 classificado como negativo – relevante, de perturbação regular devido à utilização de máquinas e equipamentos geradores de rios, importância baixa, ocorrência muito provável, de extensão local, duração curta e reversível.

- Alteração da qualidade das águas superficiais e subterrâneas

A interferência na qualidade das águas superficiais e subterrâneas poderá ocorrer como efeito do carreamento de sólidos, assoreamento da rede de drenagem, além da utilização de banheiros, cozinhas e refeitórios, possível, ainda, acidente com vazamentos de cargas, nas proximidades dos cursos de drenagem, que podem provocar a contaminação das águas superficiais e subterrâneas. A remediação varia de acordo com a qualidade da água afetada, através de procedimentos como: remoção de contaminantes heterogêneos da água, eliminar misturas de bactérias patogênicas, entre outros.

A geração de sedimentos e o assoreamento de corpos hídricos são processos sempre presentes em empreendimentos que envolvam serviços de movimentação de terras, cuja valorização deste impacto: -1(2+2+2+2+1+1) = -10 foi de classificação negativa – relevante, devido aação erosiva da água da chuva sobre o solo nu ou desagregado. Este impacto de ocorrência provável devido a geração e carreamento de sedimentos ao interior dos corpos d’água transportados pelo empreendimento, bem como dos dispositivos e obras de arte destinadas à drenagem do empreendimento. Cuja intensidade deste impacto de perturbação regular, importância média, está condicionada pelo regime de chuvas no local da obra, pela quantidade do material mobilizado, e pelo tipo de solo e declividade natural do terreno, além, conforme já exposto, da efetividade das medidas preventivas adotadas.

- Interferências na flora local

A supressão de vegetação nativa está associada às etapas de topografia, abertura das vias e da faixa de domínio. Assim deve ser compensada por meio do plantio de mudas de espécies arbóreas nativas da região, de modo a promover a recuperação de alguns fragmentos atingidos pelo empreendimento. Sendo assim, a valorização do Impacto total foi de: -1(2+3+3+2+2+2) = -14 considerado negativo – relevante, pois ocorreu perturbação regular, importância alta, devido à destruição de habitats, afugentamento da fauna, perda de biodiversidade, com ocorrência muito provável e cumulativa, de pequena magnitude. Os efeitos prognósticos são temporários, reversíveis, locais e de media duração, uma vez que após a desmobilização do canteiro as áreas degradadas serão recuperadas.

- Interferências na fauna local

Com a duplicação da BR 401/RR observou a perturbação da fauna em decorrência do trânsito de veículos, pessoas e da geração de rios, bem como
será elevado o risco de atropelamentos de animais, e de colisão de veículos. Este resultado condiz com Mota (2013) que o surgimento do tráfego nas rodovias construídas é comum ocorrerem atropelamentos de animais silvestres, onde estima-se que 14,7 milhões de animais são atropelados a cada ano no Brasil. A remediação pode ser feita com a construção de passagens de animais sob a pista, a fim de preservar da fauna. Além disso, sugere-se a implantação de uma tela de arame, de modo a evitar a circulação de animais, direcionando-os para as passagens.

A valorização do Impacto total: 
\[ 1(2+3+2+2+3+2) = -14 \] (Negativo – Relevante), foi de perturbação regular, importância alta, ocorrência provável, pois poderá sofrer perdas significativas à biota local, extensão local, duração permanente e parcial, devido ao plano de resgate da fauna.

- Alteração na rotina dos usuários da rodovia

A preparação da área, construção de pontes, terraplenagem acompanhados pelo maior trânsito no área do trecho modificou a rotina da população local cujas propriedades coincidam com o trajeto do empreendimento. Além do aumento do nível de ruído provocado pela passagem e movimentação de pessoas, máquinas e equipamentos, acarretando em transtornos às pessoas que moram próximas à obra. Deve-se alocar placas de sinalização em locais estratégicos e visíveis para assim evitar acidentes.

A valorização desse impacto é de: 
\[ 1(2+2+3+2+1+1) = -11 \] (Negativo – Relevante), de perturbação regular devido aos ruidos provocados pelo maquinário, além da alteração no fluxo de trânsito devido a passagens de materiais e bloqueios da via, importância média, ocorrência provável, a extensão desse impacto se dá no local da obra, com duração curta e reversível.

- Desapropriações

A implantação da BR 401/RR implicou na desapropriação de áreas e deslocamento de populações rurais e urbanas. A remediação seria vistoria, medição e demarcação das áreas indicadas. E para compensar pagamentos de indenização, cadastro socioeconômico e de imóveis.

Portanto a valorização do Impacto total: 
\[ 1(1+1+2+2+3+3) = -12 \] (Negativo – Relevante), de média magnitude, perturbação escassa, importância baixa, ocorrência provável, de extensão local, duração permanente e irreversível.

-Aumento na probabilidade de transito e acidentes

Com os desvios da pista da via por conta das obras e dos acessos às faixas laterais ficaram estreitos e a passagem de pedestres e veículos tomou-se perigosa e confusa, fruto da presença de máquinas e das obras. Para a remediação recomenda-se sinalização adequada e suficiente para evitar ao máximo a ocorrência de acidentes nos trechos em obras, por meio de placas e fitas durante o dia e por objetos geradores de luminosidade à noite.

As obras de duplicação irão ocorrer em áreas de densa ocupação e de tráfego intenso, tais impactos, a serem deflagrados na fase de implantação do empreendimento, cuja valorização do impacto total: 
\[ 1(3+2+2+2+1+1) = -11 \] (Negativo – Relevante), ocorrência provável, com perturbação importante, de ocorrência provável devido faixas laterais mais estreitas, passagem constante de máquinas, com extensão local, duração média e reversível.

Diante dos resultados desse trabalho, pode-se dizer que os impactos foram significativos, bastante relevante na melhoria dos projetos, com à minimização dos impactos negativos e a maximização dos positivos. Neste sentido, propõe-se um estudo mais aprofundado de documentos de cada EIA/RIMA, bem como planos de controle e monitoramento ambiental implantados na área de estudo. A fim de melhorar a segurança aos moradores ali presentes, e reduzir os transtornos à população próxima.

Através dos resultados obtidos é possível estabelecer medidas de remediação, mitigadoras e valorização dos impactos. O DNIT (2016) ainda ressalta a importância de elencar os programas ambientais necessários para uma correta implantação e operação desta rodovia, dentre eles: Plano ambiental de construção – PAC, Plano de recuperação de áreas degradadas e recuperação de passivos – PRADRP; Programa de educação ambiental – PEA; Programa de monitoramento e qualidade da água – PMQA; Programa de monitoramento de atropelamento de fauna.

A fim de analisar o grau de importância da duplicação e restauração, aplicou-se um questionário há 50 moradores mais próximos a área de domínio da BR-401/RR, no gráfico 1 analisou-se o grau de importância da duplicação e restauração da BR-401/RR aos moradores, onde 48% relatam que a obra foi importante, pois trará melhoria de condições de drenagem, novos negócios e melhoria no tráfego diário; 30% acham importante, pois facilitará escoamento dos produtos agrícolas da região; 12% relatam que é pouco importante, não suporta tráfego intenso em pontos críticos, como beira dos morros; 10% acham pouco importante porque daqui algum dia estará cheia de buraco, devido asfalto ruim; 2% acreditam ser sem importância, pois afetará o meio ambiente.
Pode-se dizer que a duplicação do trecho do empreendimento em análise irá proporcionar maior segurança e facilidades da trafegabilidade, na medida em que permitirá o deslocamento em duas faixas, evitando a necessidade de ultrapassagens pela contramão, além de afastar fisicamente as pistas opostas, evitando o cruzamento de uma para a outra.

E de acordo com o DNIT (2016) a rodovia encontra-se em processo de duplicação e restauração visando à segurança dos motoristas, visto que uma das principais queixas dos usuários era a ausência de acostamento, aliada ao fato da via ser muito estreita e possuir abismo em ambos os lados.

Em busca de avaliar as melhorias no gráfico 2, questionou sobre o maior benefício que a obra proporcionará aos usuários, onde 32% relatam que haverá melhoria das condições de tráfego e o aumento da segurança dos usuários; 26% dos entrevistados acredita que irá ajudar na qualidade de vida dos usuários, facilitando o deslocamento entre as cidades; 16% na contribuição para a realização de novos negócios e para a exportação de produtos; outros 16% acolhem na melhoria nas condições de drenagem da rodovia, evitando enchentes, 12% creem nas melhorias de sinalização, resultam na redução de acidentes e atropelamento; e 6% dizem que a obra não trará nenhum benefício, pois o asfalto é ruim e surgem buracos novos nas pistas.

As rodovias são parte indispensável para evolução de uma região, segundo Laurence (2014) e traz diversos impactos positivos, dentre eles: aumento da produtividade agrícola; contribui para o aumento da arrecadação pública, do comércio legal, para o aumento da demanda de bens e serviços; ajuda na qualidade de vida de seus usuários com a facilitação do deslocamento entre as cidades; facilita o escoamento dos produtos da região, evita a perda de produtos perecíveis; além de contribuir para a realização de novos negócios e para a exportação de produtos roraimenses. E Rezende e Coelho (2015) abordam que mesmo indiretamente, o meio ambiente é beneficiado pelo desenvolvimento econômico, com mais recursos orçamentários pelos setores públicos e sua reversão em prol da população, com a melhoria na infraestrutura.
de uma cidade e dos entornos circunvizinhos. Acordo com Lima (2018), cabe aos profissionais responsáveis à análise correta dos impactos e a proposição de medidas eficientes, e ao órgão ambiental a avaliação e monitoramento do EIA. A população deve opinar a respeito do projeto por meio de consulta pública, visando em conjunto para que o crescimento seja sustentável.

IV. Considerações Finais

Conclui-se que a duplicação e restauração da BR-401 trará benéficos inquestionáveis, facilitando o tráfego aos usuários, contribuindo para a redução de acidentes e elevando a qualidade do transporte rodoviário na região. Porém é necessário ressaltar sobre os impactos de ordem ambiental, econômico e social provocados pela sua construção, é importante construir de forma a prevenir ou limitar os impactos ambientais negativos. Se bem projetada, nos locais adequados e com a realização das necessárias medidas preventivas e mitigatórias, contribuirá para a efetividade do desenvolvimento sustentável da população.

Por fim, pode-se dizer que os resultados apresentados neste trabalho podem ser bastante relevantes para a melhoria dos projetos em duplicação e restauração de outras BRs no estado, com a minimização dos impactos negativos e a maximização dos positivos. Neste sentido, propõe-se um estudo mais aprofundado de documentos de cada EIA/RIMA, a fim de verificar o grau de segurança do empreendimento, visando à viabilidade do mesmo.

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The Construction Industry and Modernization - Applying Change Concepts

Nnadi E.O.E

Abstract - Globalization has fully taken its course in no other sector more apparent than in the rapidly growing construction industry. The industry is being forced to change at an unprecedented pace. Nigeria and other developing countries are not exempted as they witness a fast-growing rate of construction activities also. The industry must adapt to a global trend and a sense of camaraderie to meet the huge demands, reduce risks involved; thus, safeguarding quality and profitability. Change is an enormously complex issue but the industry must take cognizance of the change demand to gain competitive advantages. The aim of this study is to examine the effect of change application on the modernization of the construction industry. This paper presents the results of a literature review carried out on change application in modernization of construction industry. It examines the issues that will cause change, reviews the available literature to find how change can be managed and controlled, and develops a model for guiding change programmes in the construction industry. Interviews and questionnaire surveys were adopted tools in getting data and analyzed to achieve the research aim. The research identified effective cost savings with RII of 0.81 as the most importance benefit, earlier completion and improved performance were ranked second and third with RII of 0.80 and 0.78 respectively. The score of 8.5 show that improved performance were ranked second and third with RII as the most importance benefit, earlier completion and higher score.

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On a word-wide level, changes are occurring at a rapid pace, particularly in information technology. The increasing number of computer based applications that are now available to construction companies is changing the nature of the business which we carry out. Research projects funded by the European Union into the area of information technology are showing how we can reuse construction design information and how we can access information generally throughout the industry. Society is now facing an “information technology revolution” which will bring a period of change he has likened to that of the Industrial Revolution. If this is the case, then all organizations must recognize that survival in business will be dependent on their ability to adapt to changing circumstances. The industry must therefore adapt to a global trend to fit in and ensure risks reduction thereby improving quality of project delivery; meeting the target cost and time; thus, ensuring sustainability. This study therefore examines the effect of change application on the modernization of the construction industry in Nigeria. Different areas where change can be applied and effect were identified including change management and control.

Change is not just about how people act, but it is also about how they think and this perspective forms a basis for the link between CM in organizations and internal communication with the people responsible for

Changes in organization and people vary. It depends on the type and nature of changes, but most importantly on how they are managed. The changes are to be managed to maximize the benefits, minimize the penalties, and ensure that both benefits and penalties are distributed equitably. Change occurs in construction industry globally because:

- Global technological advancement
- Successful invention
- Significant shift in the world markets or exchange rates
- Surges in the world or regional demand
- Political decisions by foreign governments
- Project complexity
- Improvement in clients’ satisfaction and meeting project objective
- Ensure effective cost management and control
- Meeting with climatic change/wars and act of nature

Keywords: change, construction industry, globalization, management and modernization.

I. Introduction

Change is defined by as "the act or an instance of making or becoming different, an alteration or modification". There are many different reasons and sources for change which is inevitable. Since changes will never disappear, the best option is to manage them to prevent negative consequences. The impacts and consequences of changes on an

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making those changes happen. Change occurs in construction at two levels: organizational and project level. Throughout a project, construction organizations are faced with many changes, most of which are design changes. Project changes are inevitable even if there had been detailed studies during the design development, and prior to the construction stage. Besides handling changes at project level, construction companies are sometimes required to implement changes at organizational level related to management, technology, people and cultural issues. Change can be introduced in several ways depending on the aim of the change programme. In establishing how to approach a change situation, the effect of change throughout the organization must be assessed at all levels of activity. The four main levels of activity have been defined as:

- **Task Level** - at which individual actions take place as part of a process
- **Process Level** - at which a series of tasks are carried out
- **System Level** - at which number of processes are integrated and managed
- **Organizational Level** - at which decisions are made and actions are taken to determine the strategy of the organization.

These levels are tied together with a complicated series of interfaces through which individuals interact with those in their own organization and in other organizations.

**a) The construction industry**

The industry is subject to the law of elastic and return which can be either way depending on the scope and the nature of the project.

![Diagram showing the interconnection of material, money, men, and management in a project.](image)

Source: Researcher, 2020

The model in fig 1 indicates that the project’s nature or complexity will determine the reactions of other factors or indicators. Therefore, if the project core expands, the support systems must grow to meet the needs of the projects. On the other hand, if the workload contracts, the systems will be downsized to match the demand. It is this dependence on the project core and the cyclical nature of construction activity that brings about a constant state of change in the supporting systems. However, it is also this constant state of change that prevents meaningful attempts at change management in the supporting systems, as the status of the systems is regarded as temporary and any effort to manage the change could be impeded by a change in the project core. Construction organizations can readily apply the latest management concepts and new technology in the context of the project but appear to be reluctant to apply the same principles in an organization wide context. From this perspective, we can see why a construction organization has difficulty with planning for and coping with change. To cope with change, a construction organization must take a more global view of its operations, shifting emphasis from a project approach to a more entrepreneurial approach. Information Technology (IT) is evidently the most strategic means of effecting change in construction system. IT is currently used to a limited extent in: Design; Financial Management; Planning; Monitoring; communication and Reporting. The change includes many existing software packages designed in compatibility with the area. IT thus ensures:

- **Time saving**
- **Automate tasks and thereby cut payroll costs**
- **Proper organization and radically improve the way work is done**
- **Avoid waste and use less paper.**

The most likely underlying cause of the failure to change in the instance of IT implementation is therefore that those managing the change have attempted to implement a change without due regard for the other tasks and processes that would be affected. To avoid this situation, it is necessary to understand the effect of one task or process on another. For change to be effective, the educational curriculum must be adjusted to cope with the change. This is the reason why it seems the standard of education is falling; especially in
developing countries. There is no fall in the standard but the standard should be redesigned to accommodate the expanded change. Previous work by on change management on Irish construction discovered that; even the smallest of changes can affect the working environment of a significant proportion of those who work in the organization This matrix shows that no single change approach will be suitable in all situations. Most changes, will require action at one or more interfaces, along with action at one or more activity levels, a combination of at least two of the approaches will be required to achieve the expected change. He thus concludes that Change is an enormously complex issue, which is possibly one of the reasons for the high failure rates of some change programmes.

b) IT as a Change tool in Nigeria construction industry

The level of technological change in every industry continues to gather pace and the construction industry is no exception. New equipment and methodology has contributed to an increase in productivity, safety and quality of project delivery. Technology has a major role to play a in the change concepts transformation. Changes in designing to construction patterns drive the creation of new technologies necessary for sustainability and their adoption and diffusion at the desired pace. Success in bringing about these changes require substantial reorganization of the industry to accommodate new views and methodologies. Training and financial incentives for the creation and adoption of new technologies will be needed which may include innovative policy reforms. The potential uses of Information Technology (IT) in the industry are enormous. For example:

- Buildings can now be designed and costed electronically thereby facilitating a greater re-use of design and cost information and realizing savings in design costs. Comparative analysis is easily carried out using information technology.
- Planning carried out using computers allows quick comparisons of the time and resources required to complete different designs and shows the effect of design changes on the remainder of an existing project
- Immediate access to technical information held in a computer at a remote location
- Use of e-mail to distribute documents and correspondence
- Electronic bill tendering (e-tendering), e-marketing and so on
- Sourcing of materials and services using Internet style search engines
- Electronic commerce (e-commerce) now allows the ordering of and paying for materials to be carried out electronically
- Meetings can be held using video-conferencing

- Communication are effectively carried out using media channels like whap, you tube etc
- Documents and drawings can be viewed/ recorded / stored / distributed / updated and printed using computers; information gathered on previous projects can be accessed and used to make cost savings on new projects.

Further advances are now occurring on almost daily basis, bringing newer and easier ways to tap the enormous potential of these machines. All of this has caused greater challenges for the management of construction companies. Companies grow and cope with new technology at a rate which could not have been envisaged in few years back. These same companies now face even more challenges in an ever changing construction environment. Now, an individual can use Computer Aided Drawing (CAD) software to draw, for example, a door. The lines and layers of the drawing can be copied and moved within the drawing or between drawings but to the computer they are still a series of lines and layers. It can also have other types of information attached to it such as its cost, availability and any other information required by any party who in any way encounters this door at any stage of the project. The use of Object Oriented Technology promotes a profound change in construction, as it enables different applications to make use of information in a way that has not previously been possible. Internet on the other hand is basically a series of computers in several different locations all over the world that are connected to each other across standard and high speed telephone lines. As computers share information with each other, the greater number of computers connected, the more information is available. The information is held on websites, which may be accessed through any computer connected to the Internet.

However, IT is often seen as a complex field best understood by young minds and many of the directors/managers/chief executives of Nigerian construction companies may not have had the time or the patience to keep up with the rapid pace at which this technology has been developing. Many may therefore not be aware of the direction in which IT is developing. This should be addressed by developing an organization-wide IT strategy to plan and control the increasing use of computers within the industry. New processes must be devised, implemented, monitored and improved where necessary. Changes must first be made where they will have the most noticeable effect thereby convincing all involved that the new processes are to the benefit of everyone.

c) Change for effective cost savings

A change in attitude may be needed by companies to keep trained staff and obtain maximum return for the investment in training. Experience from
other industries should be drawn upon and approaches to staff retention might be considered - for example the Japanese policy of increasing the benefits to the individual as length of service increases. Human resources management must face the challenge of finding and retaining the staff necessary to fulfill the aims of the corporate plan. Plans must be developed and administered to ensure that the company utilizes its staff to full capacity and potential. At Systems level, the promotion of innovation, team working, delegation of authorities and an emphasis on quality must be encouraged to improved workers’ performance and productivity to the advantage of the company. Ever since the Latham Report (1994) cited by ‘stated that UK construction costs to the client could be reduced by 30%, the search has been ongoing to find where such savings could be made. Nigerian construction industry too has not relapsed in their efforts to cut down construction cost in the country. Materials management has subsequently emerged as an area worthy of examination in the search for such savings. 'In Sweden (Laage-Hellman & Gadde 1996), Finland (Wegelius-Lehtonen 1995) and in the UK (Dawood 1997), materials management has been identified as an area where some savings could be made. Each of these pieces of research approached materials management in a changed way. Laage-Hellman & Gadde gave an account of the progress made by Swedish construction company Skanska in its attempts at introducing Electronic Data Interchange (EDI) into its purchasing system. The cost of processing an invoice was found to be SEK 300 (approximately US$45). Laage-Hellman & Gadde state that this cost can be reduced by 90% by using EDI. The possibility of use of the suppliers’ expertise in relation to availability, handling, etc., is not often examined. Such involvement can lead to a 10% reduction in construction times (Agapiou, Flanagan, Norman and Notman, 1998) and is now widely accepted in other countries such as Denmark, Sweden and Japan.  

Thenceforward, the simplification of the materials management process also led to:

- Closer co-operation of the supplier and the contractor
- A higher quality of the information between contractor and supplier resulting in fewer ordering errors
- An increase in the speed of the materials handling process and in the ease with which information could be transmitted.

These factors in turn resulted in increased cost effectiveness in the construction chain. Objective was to discuss and introduce a new strategy for materials management for the construction industry with a view to minimizing wastage. He observed current practices and discovered that wastage accounts for 8-10% of project costs. By making a few basic changes to some aspects of the building process and by introducing a computer based materials management system. He estimated that construction costs could be reduced by at least 10%. These savings would occur because of reduced wastage, fewer project delays, early selection of suppliers leading to lower prices and greater certainty of availability of materials, greater understanding of the type and amount of materials needed thereby eliminating late and in accurate ordering, and a reduction in on-site overheads. The process of doing things in a changed and new way is termed ‘re-engineering’. ‘defines re-engineering as:"... discontinuous thinking…recognizing and breaking away from the outdated rules and fundamental assumptions underlying operations. These rules of work design are based on assumptions about technology, people, and organizational goals that no longer hold.” Deevy argues that an organization is a living system capable of self-organization and self-renewal- if the right conditions are created. This living system, if allowed, is capable of continuously adapting to the needs of the marketplace and to changes in the business environment. Reengineering the processes should, therefore, be preceded by a major cultural change in the organization. That made 12agrees that up to 70% of BPR projects fail and he identifies the biggest obstacles to successful re-engineering as:

- Lack of sustained management commitment and leadership
- Unrealistic scope and expectations
- Resistance to change.

The search for improvement is also present in the concept of Value Engineering (also known as the Value Method, Value Analysis or Value Management). ‘state that the true value of an activity or product is its relationship to its perceived worth as opposed to its life-cycle costs. In Value Method terms: Value = Worth/ Cost. When an item has a value greater than 1.0, it is perceived to be fair or good value; when an item has a value less than 1.0, it is perceived to be poor or bad value. The opportunity to improve the value of a project is greatest at project inception. This shows that, to maximize savings, value engineering should commence at the earliest opportunity in the development of the design brief. It can continue up to and including the procurement of trade contractors.

There are many ways to approach change and the technique used will depend on the type of challenge that the organization is facing. Process re-engineering is used to achieve drastic improvement in the efficiency of part of an organization and is often used when new technology potentially makes an existing process obsolete. Value Engineering has produced its best results to date when applied as early in the design process as possible and consequently is generally
viewed as a project specific application. The potential rewards of applying change in materials management are considerable. Change techniques related to levels of activity in the industry requires strategic approach. Whatever approaches are used, their success depends on the following factors:

- The change must be fully thought out and meticulously planned.
- The highest level of management within the organization must fully understand and be totally committed to the change process.
- Lines of communication must be opened and maintained across as many levels as possible within the company.
- Training in all aspects of the new systems and all of the skills required by the new systems must be given to all of those involved.

Change is dynamic; therefore, the change process itself must adapt to suit any new circumstances in which their organization finds itself.

Once the change programme has been implemented, the process of change must continue if competitive advantage is to be maintained.

The major hindrance to organizational growth are the managers in change process. The inability of the operators to change their attitudes and behaviour as rapidly as their organizations require; slow down the pace of expected change. Change Management which is the deployment and manipulation of financial, technological, natural and human resources efficiently and effectively to accomplish set goals and objectives.

Summarily, the application of change concepts as shown in figure 2 ensures project durability and sustainability, it increases performance and ensure whole life costing of construction projects.

III. METHODOLOGY

The research methodology was used to achieve the objectives of the project. Basically, we can identify the following steps.

a) Sample selection

The method of the data collection was through a questionnaire survey. The questionnaire was distributed among construction industry professionals working in the building construction industry.

b) The survey

Survey questionnaire was divided into three sections. The first, section was titled “Questions regarding the experience and the about company”. The second section of survey was titled “Questions regarding the impact of change on construction project delivery”. These questions attempted to find out whether the company had adopted an innovation in their working system and identified the benefits of the change methodology in their organization. The questionnaire survey was carried out using three methods. The questionnaire form was distributed among construction industry professionals by hand and via email. Face to face interviews were conducted with selected project managers, site managers and site engineers on several projects.

c) Analysis of responses

After the survey responses were received, analytical examination was carried out. The questionnaire results were ranked according to Likert
scale. The rank results were analyzed relatively to the mean value calculation using equation:

\[
\text{Mean value} = \frac{\sum (n_i \times x_i)}{\sum n_i}
\]

where \(x_i\) is Likert scale for item, \(I = 1,2,3,4,5\), \(n_i\) is frequency of item

**IV. RESULTS AND DISCUSSION**

Extracted information from questionnaires and direct interview can be present as follows.

Survey questionnaire was designed in three sections. The first section included questions regarding the experience and background of the respondent and his company. This section helps to get an idea about responder’s position in this field. According to above result most of responders work as consultants while lesser number as contractors were reached. This is because the consultants are key to ensure new adaptability and monitoring. Working experience in construction industry responders experience was most effecting factor when doing this kind of survey. The highest number of responder are above 15 years in practice, hence, given credibility to the information supplied.

a) **Identified benefits of change in construction industry**

Six key benefits of change were ranked by the respondents. As shown in table 1; the construction consultants such as the Architects, Engineers and Quantity Surveyors who make use of this change tools identified effective cost savings with RII of 0.81 as the most importance benefit, earlier completion and improved performance were ranked second and third with RII of 0.80 and 0.78 respectively. This was not too far from the contractors who identified improved performance as the highest benefits derived from change application with RII of 0.82 while effective cost savings ranked second with RII of 0.80. On the average rankings; effective cost savings came first with RII of 0.81, improved performance of RII of 0.80 and earlier completion with RII of 0.78 were ranked second and third respectively.

<table>
<thead>
<tr>
<th>IDENTIFIED BENEFITS</th>
<th>CONSULTANTS RII</th>
<th>CONSULTANTS RANK</th>
<th>CONTRACTORS RII</th>
<th>CONTRACTORS RANK</th>
<th>TOTAL SAMPLE RII</th>
<th>AV/GROUP RII</th>
<th>GROUP RANK</th>
</tr>
</thead>
<tbody>
<tr>
<td>Improved Performance</td>
<td>0.78</td>
<td>3</td>
<td>0.82</td>
<td>1</td>
<td>0.80</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Earlier completion</td>
<td>0.80</td>
<td>2</td>
<td>0.77</td>
<td>3</td>
<td>0.79</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Effective cost savings</td>
<td>0.81</td>
<td>1</td>
<td>0.80</td>
<td>2</td>
<td>0.81</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Risk reduction</td>
<td>0.68</td>
<td>4</td>
<td>0.74</td>
<td>5</td>
<td>0.71</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>International acceptability</td>
<td>0.67</td>
<td>5</td>
<td>0.72</td>
<td>4</td>
<td>0.70</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Global competitiveness</td>
<td>0.60</td>
<td>6</td>
<td>0.64</td>
<td>5</td>
<td>0.62</td>
<td>6</td>
<td></td>
</tr>
</tbody>
</table>

Source: Researchers work, 2020

Finally, this paper assessed the acceptance level for change and modernization among construction stakeholders. This is to give credit to change implementation and promotion within the industry. The acceptance level was divided into two main factors such as “Change related to meeting client’s needs in terms of cost, quality, time of delivery and sustainability” and “change related to risk reduction, international acceptability and competitiveness”. The level of acceptance was based on the scale of:

- Low acceptance level if score less than 5; and
- High acceptance level if score more than 5.

Result from the questionnaire analysis show that the level of acceptance is high for both categories as shown in table 2.

<table>
<thead>
<tr>
<th>S/N</th>
<th>CATEGORY</th>
<th>SCORE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Client’s satisfaction</td>
<td>8.5</td>
</tr>
<tr>
<td>2</td>
<td>International acceptability and competitiveness</td>
<td>7.8</td>
</tr>
</tbody>
</table>

Source: Researchers work, 2020

The score of 8.5 in table 2 shows that construction stakeholders have highly accepted change which is the key driver for improving client’s relationship. Cost of construction are executed as targeted; project delivered to time and at required quality and sustainability. Change ensures time maximization, risk reduction securing project completion date. The score
level of 7.8 indicates that the construction stakeholders have high level of acceptance towards ensuring international acceptability. The world is a global village. Nigeria and other developing countries should operate in an accepted standard. The change application also gives room for the companies with Nigeria background to measure up and compete with their foreign counterparts.

V. Conclusion

Modern methods of construction change the risk profiles of construction projects. Some development risks become less significant in terms of likelihood of occurring and potential impact. Examples include price fluctuations during the construction process and delays due to bad weather. Other risks become more significant. Examples of these include unpredictable planning decisions and designs that are not suitable to the construction method. The changes necessary to achieve this position include: a value engineering approach applied to the process of materials management in order to minimize the tasks in the process; a re-engineering approach to the tasks that remain in the process; a total quality management approach, with continuous improvement being actively sought in interface areas in the system; a strategic approach with a view to developing partnering arrangements within the industry and an innovative and open-minded approach to be taken to the potential of the use of new technology. If these are put in place, the identified benefits such as effective cost savings, improvement in job, earlier delivery period and so on would be made possible.

References